A world designed to last

Expertise and Modeling

Process, Risk and Safety consultancy



TECHNIP ENERGIES

A unique offering

Technip Energies is a leading engineering and technology company serving the energy industry and its transition. Through an extensive technology, products and services, we bring our clients' innovative projects to life while breaking boundaries to accelerate the energy transition for a better tomorrow.

Projects delivery

- Engineering and project management expertise.
- Technology integration on complex projects
- Diversified contract models and commercial selectivity.

Technology, products and services

- Process technologies, proprietary products (Loading Systems and Cybernetix).
- Concept, feasibility, FEED, studies and licensing.
- Genesis advisory and project management consultancy accelerated by digital.

Extensive market positions

- LNG & Gas monetization
- Sustainable Chemistry
- Offshore
- Refining
- Ethylene
- Petrochemicals
- Fertilizers
- Hydrogen
- CO_2 Management
- Mining & Metals
- Nuclear
- Life Sciences
- Agritech



Process, Risk and Safety expertise and modeling

- Providing practical safety expertise to industries handling hazardous materials
- Supporting process design on specific operational and design issues on our major projects
- Providing critical process safety input to comply with the highest standards

Our Expertise and Modeling department, integrated within our Process and Technologies division, oversees process, risk and safety expertise along with consultancy services. It delivers process and technical safety studies to ensure plant performs at the highest safety standards.

For the past 20 years, our Expertise and Modeling department, in cooperation with our network of corporate experts, has supported the Process and Technologies division to ensure the success of our projects. We have developed a methodology to comply with the highest international standards on process modeling.

Valued Experience

- Expert network for process modeling in thermodynamic and dynamic studies and for effects modeling of gas dispersion, fire and explosion
- Global integration within project execution
- Expertise with all major software providers
- In-house software development
- Full integration with Process and Technologies division: thermal design, onshore-offshore: upstream, gas, LNG, oil refining, ethylene, polymers, life sciences and mining and metals
- Hundreds of safety studies performed in-house since 1980 (Technip is accredited as third party for the French Environment Ministry)
- Safety experiments performed in the fields of explosions and cryogenic releases
- Accident investigations (inluding major accidents like AZF Toulouse and TOTAL La Mède)

Dynamic simulations

Technip Energies provides the best technological solutions and optimizations from conceptual design to detailed engineering and operations.

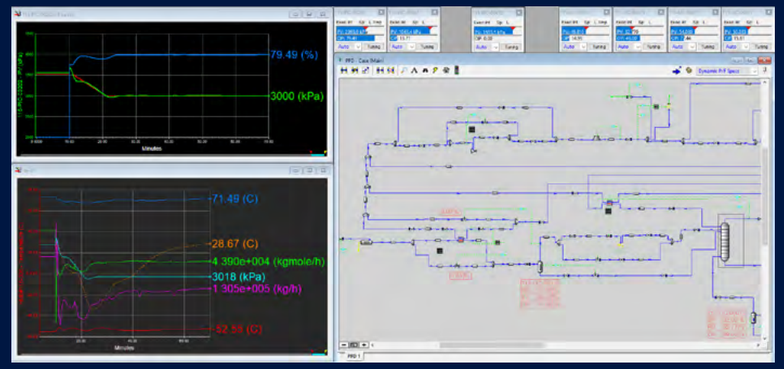
The dynamic simulation team is composed of skilled specialists with up to 20-year experience in dynamic simulation. The team objectives are:

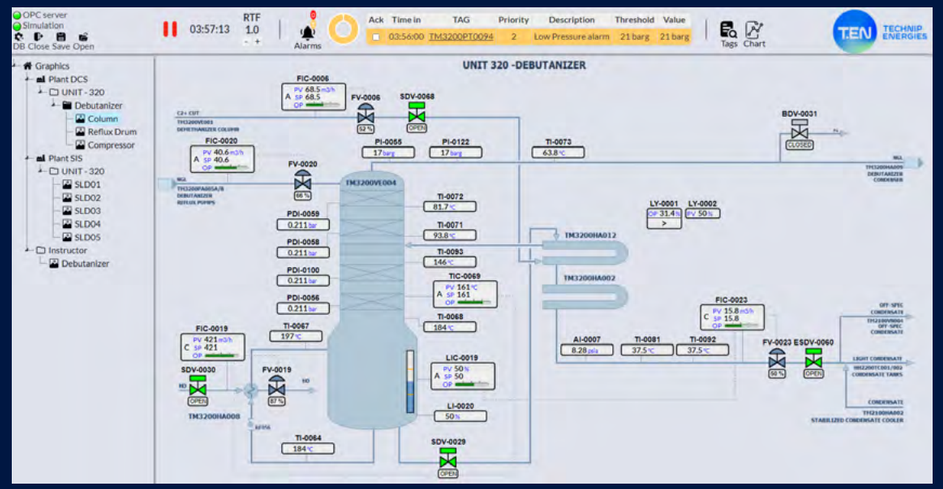
- To perform transient analysis in close cooperation with process engineers as part of Technip Energies projects, from conceptual phase to EPC phase in order to validate process and control design and/or to propose design optimization.
- To provide dynamic simulation model for OTS development inherited from the process studies.
- To support Technip Energies project execution by following up Vendors dynamic simulation results when Vendor dynamic simulation is requested (typically but not limited to cold boxes and compressors).
- To perform specific transient analysis for Technip Energies customers during Operation phase for optimization, revamp or safety analysis.

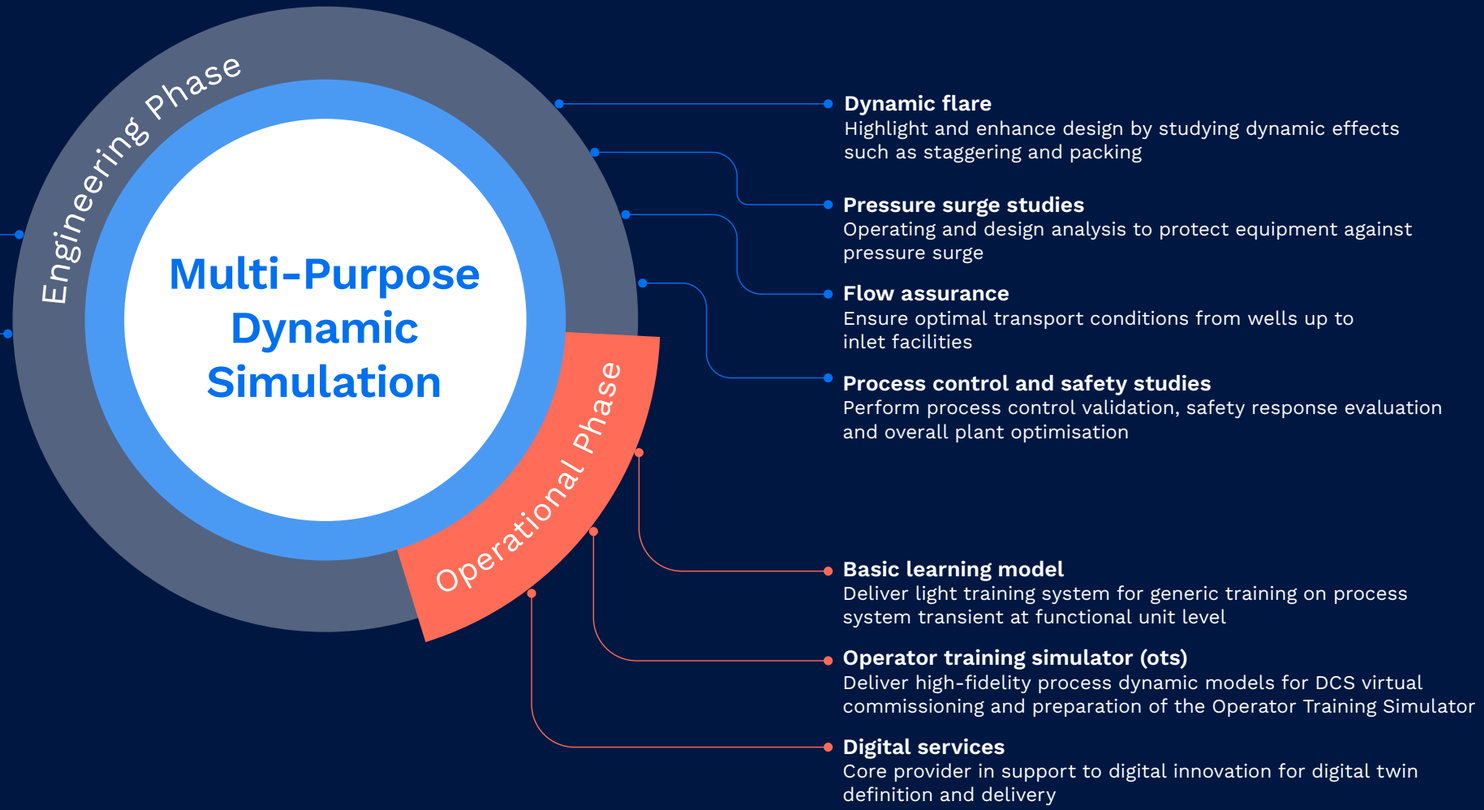
The dynamic simulation team has all the skills to deliver dynamic simulation projects in the LNG/FLNG, Gas Processing, Upstream, Refining, Petrochemicals, CCUS segments, thus covering all Technip Energies businesses.

Compressor analysis
Design validation through analysis of startup and shutdown procedure and safety trip requirements

Thermal analysis
Cold Boxes, heat exchangers, lines cooldown process analysis as input to mechanical stress calculations







Dynamic flare
Highlight and enhance design by studying dynamic effects such as staggering and packing

Pressure surge studies
Operating and design analysis to protect equipment against pressure surge

Flow assurance
Ensure optimal transport conditions from wells up to inlet facilities

Process control and safety studies
Perform process control validation, safety response evaluation and overall plant optimisation

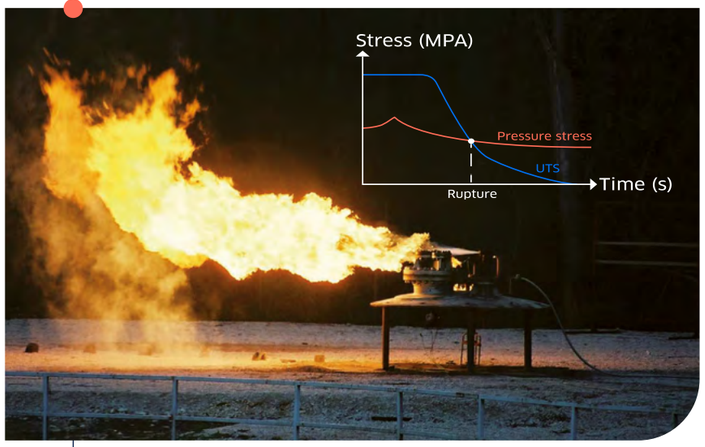
Basic learning model
Deliver light training system for generic training on process system transient at functional unit level

Operator training simulator (ots)
Deliver high-fidelity process dynamic models for DCS virtual commissioning and preparation of the Operator Training Simulator

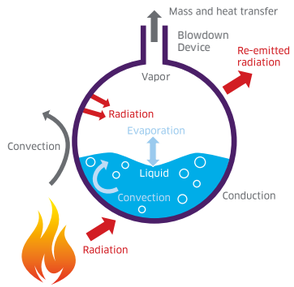
Digital services
Core provider in support to digital innovation for digital twin definition and delivery

Performance-based Flare System design

With more than 30 years of experience in the dynamic simulation of depressurization scenarios and flare design, Technip Energies performs a full process safety study including depressurization and survivability consistent with the latest standard and technical guidelines.

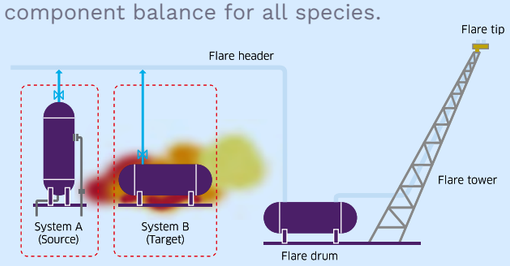


We use in-house software LNGDYN® for dynamic depressurization calculation, considering equipment rupture aspect through DYNSURV®. Our approach is based on the fundamental process safety rules.



LNGDYN®

LNGDYN® is an in-house depressurization software dedicated to assessing depressurization phenomena. The software is based on internal energy balance on fluid under constant volume constraint, rigorous thermodynamics, enthalpy balance with metal wall and component balance for all species.



In collaboration with our Health Safety and Environment Design department and the Process and Technologies division, we provide a performance-based flare system design to define the optimized depressurization flow rate in line with material selection for equipment design, survivability of equipment from fire impact and personnel evacuation time.

CFD: A powerful and flexible tool

Computational fluid dynamics (CFD) is a powerful and flexible tool allowing us to accurately predict fluid flow behavior for a wide range of applications by computing the momentum, mass and energy transfer between the different fluids involved. With our extensive experience using CFD to analyze complex phenomena, we deliver the know-how that keeps our clients' equipment performing at highest quality levels.

Objective

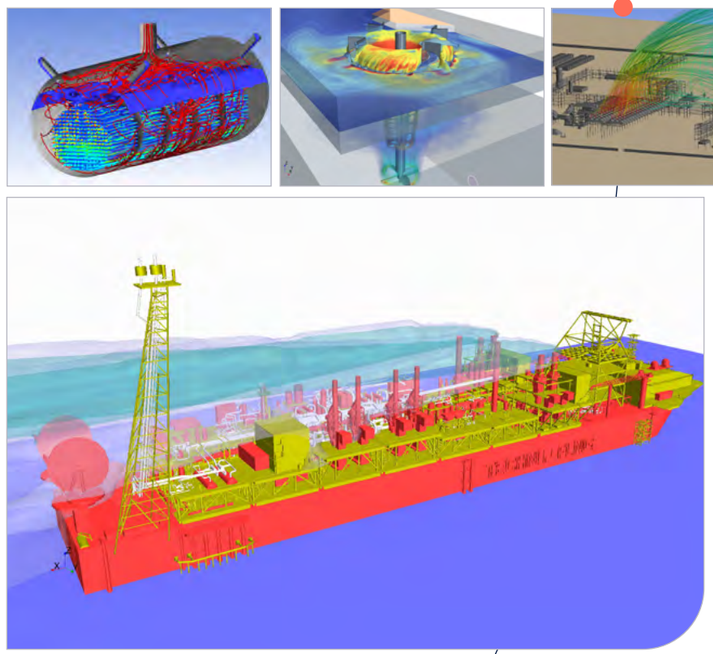
- Evaluating equipment performance
- Optimizing plant layout
- Troubleshooting operating problems
- Developing and validating innovative equipment design

Capabilities

- Importing and meshing of large and complex geometries
- Atmospheric flow modeling
- Multiphase modeling
- Conjugated heat transfer modeling design optimization

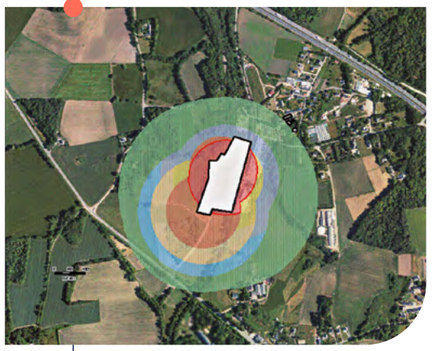
Study Cases

- Hot air recirculation
- Pollutant dispersion
- Sloshing/marinization on floating facilities
- Pressure drop validation in process equipment
- Potential corrosion/erosion location prediction



Risk analysis

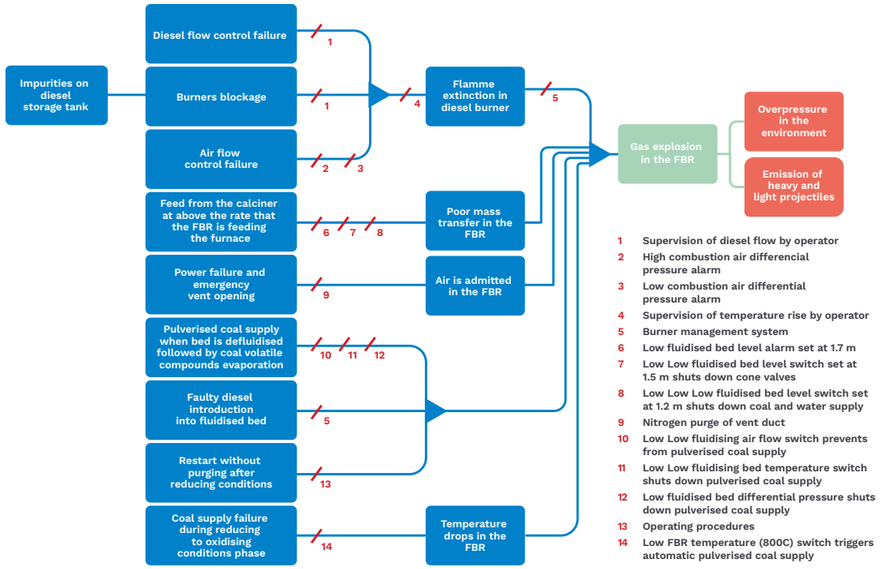
Our aim is to identify, analyze and prioritize the risks impacting people, the environment and assets and check whether the design of facilities takes them into account.



Risk contours around SEVESO plant

Activities:

- Perform Risk Assessments
  - Quantitative: Technological Risk Assessment (TRA) & QRA — Likelihood of accidents: Fault tree, event tree, bow-tie (GRIF® software with use of reliability data base : OREDA, SINTEF, EXIDA).
  - Reviews: HAZOP, Preliminary Risk Assessment (PRA), LOPA.
  - SIL assessment according to functional safety standards as IEC 61511.
  - SIL verification (PFD & PFH calculations with Fault tree or reliability block diagrams).
- Perform safety studies and third-party analysis
- Optimize toxic, fire and gas detection according to consequence analysis studies
- Perform quantitative consequences analysis (fire, explosion, flammable and toxic releases with PHAST® software)
- Perform training courses (risk assessment, consequences analysis, ...)



Effects modeling

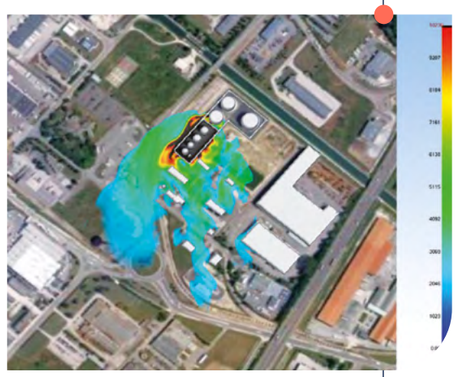
Gas dispersion, fire and explosion

Our aim is to provide accurate modeling of hazardous phenomena according to our clients risks, needs, schedule and budget.

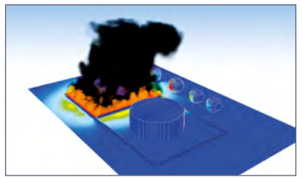
An in-depth understanding of physical phenomena and a wide range of modeling tools, that we have been using for more than 15 years, allow the assessment of explosions, fires, gas dispersion and cryogenic releases phenomena.
Our approaches range from engineering correlations to the use of more advanced CFD tools (FLACS®, AUTOREAGAS®, FDS, KFX®, LS-DYNA®, rApollotr®).

Through research and development programs and internal developments, our HSE experts create new methods or improve and adapt current modeling approaches to meet the ever-changing industry needs.

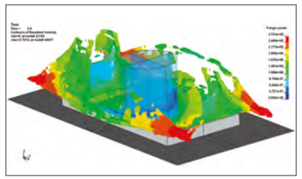
Our services range from spot support on specific safety issues to probabilistic fire and explosion risk analysis via our in-house tool ExploRisk. We also can provide dedicated training on hazard modeling and its integration in the overall design process. One of our defining features is our ability to deal with out-of-the-ordinary safety issues.



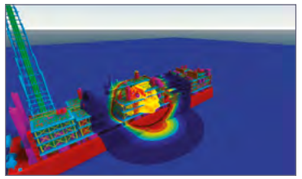
Gas dispersion (FDS)



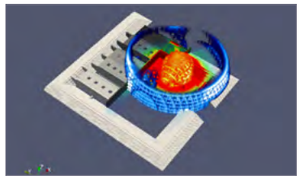
Pool fire (FDS®)



Bund overtopping (Ls-Dyna®)



Offshore gas explosion (FLACS®)



APOLLO®

Examples of calculations:

- Gas explosion on offshore/ onshore facilities
- Flammable/toxic gas dispersion
- Pool fires/jet fires in complex geometry
- Explosive phenomena (BLEVE, vessel burst, high explosive, etc.)
- Bund overtopping due to catastrophic rupture of storage tank
- Effects of high explosives or gas detonations (APOLLO)

Structural response and optimization

- Verification of safety critical elements such as equipment, piping and structures against accidental loads or human threat
- Design optimization by advanced structural analysis

Many of the safety critical elements such as structures, equipment and piping are designed or verified against major accidental events or human threat.

The calculation of the response of structures and equipment against accidental loads or human threat requires a dedicated approach compared to common load cases (e.g. gravity, operating conditions). Common design rules are modified to take into account the magnitude, short duration and low frequency of these loads; otherwise the design will be highly conservative or not possible.

We have continuously developed expertise and effective methods for more than 20 years. Our services range from the simple to the most advanced 3D Non-Linear Finite Element Analysis (NFLEA) tools such as ANSYS® and LS-DYNA 3D®.

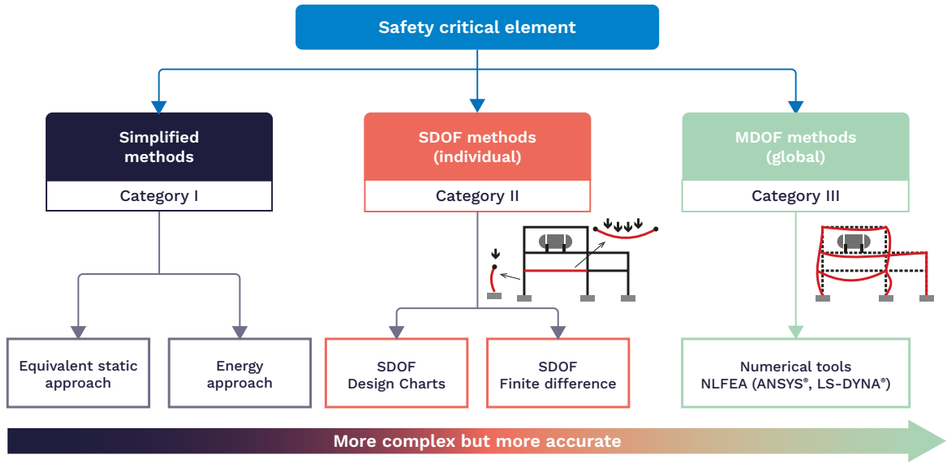
Our integrated approach also enables us to combine CFD results (fire, explosion, etc.) with NLFEA to:

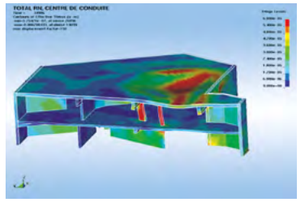
- Optimize design, cost and weight
- Evaluate the integrity of existing mitigation barriers

We also provide practical and cost-effective design solutions and assistance up to the implementation/ construction phase.

Examples of calculations:

- Oil and Gas: Design or verification of living-quarters, control rooms and critical technical buildings
- Nuclear: Design of power plants and specific workshops against explosion
- Defense/Space: Design of explosive storages and workshops
- Local/Public Authorities: Evaluation of existing residential housing protection requirements

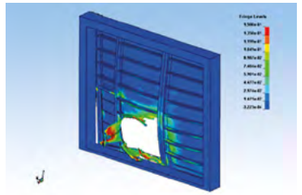




Control room response under external explosion



Domino effects: impact on LPG storage



Existing steel door exposed to human threat



Cryogenic jet (test)

Tests and accident investigation

Experiments are an opportunity to better understand physical processes involved in modeling and accidental phenomena. Our experts are well-versed in both.

Our experiments:

- Small-scale gas explosion test to assess blast reflection factor
- Fire test on nuclear containers
- Detonation tests on fertilizers
- Cryogenic releases tests on carbon steels, cryogenic spill protection and water through a joint industry project led by Technip Energies.

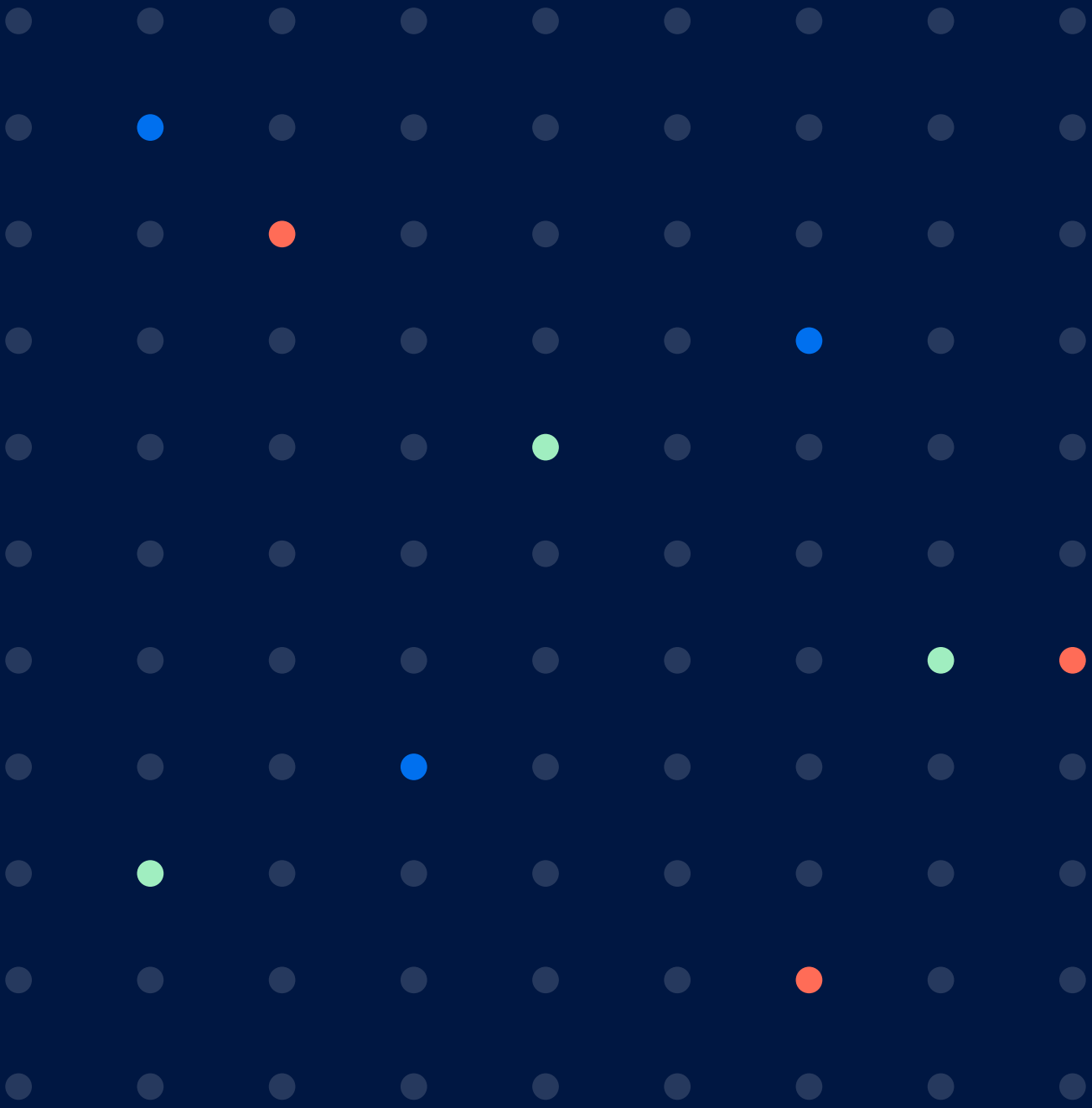
Accident investigation:

Although unlikely, accidents do occur. It is critical to identify incident causes to develop proper safety regulations. We have developed a rigorous and methodical procedure to determine accident scenarios, including:

- Major accidents in a refinery and an industrial site
- Accident with internal casualty and lethal accident
- Malfunctioning on a ground flare



Jet fire deflector (test)



Head of Expertise & Modeling
Michèle Normand
+33 1 47 78 33 18
michele.normand@ten.com

Commercial Coordination
Delphine Cahelo-Roux
+33 1 47 78 33 31
delphine.cahelo@ten.com

www.ten.com

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