VISION 2030

MAKING SAFETY *SECOND NATURE*

Mary Kay O'Connor
Process Safety Center
Texas A&M Engineering Experiment Station

A WORD FROM THE DIRECTOR

The Mary Kay O'Connor Process Safety Center (MKOPSC) stands at a pivotal moment in its evolution. As we look toward 2030, the Center remains steadfast in its mission to advance the required knowledge, technology, and culture that make safety an intrinsic part of every operation — safety as second nature.

The challenges facing process industries today are broader and more complex than ever. The ongoing energy transition, the rise of digital systems and AI, and the global imperative for sustainability have redefined how we

think about risk, resilience, and responsibility. To address these challenges, MKOPSC must lead through innovation, education, and collaboration, bridging science, technology, and practice.

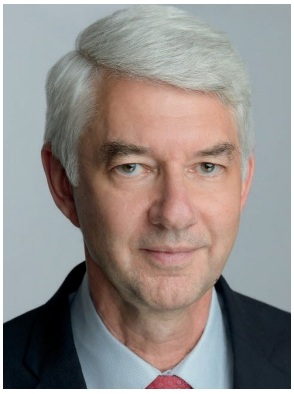
This Strategic Vision 2030 Roadmap represents the collective aspirations of our community, developed through extensive consultations with industry leaders, academic faculty, and students, who share a common goal: to ensure that process safety continues to evolve as an enabling discipline, not a reactive one.

Our goal is to develop knowledge, tools, and highly qualified personnel that transform safety from compliance into culture, where every decision, process, and innovation reflects a proactive commitment to human and environmental well-being.

Through this roadmap, MKOPSC will continue to serve as a global leader in process safety research, education, and outreach, shaping safer, smarter, and more sustainable industries for generations to come.

Sincerely,

Dr. Faisal Khan
MKOPSC Director



A WORD FROM THE CHAIR

As we move toward 2030, the Mary Kay O'Connor Process Safety Center is committed to advancing a future where safety, digital innovation, and human-centered principles evolve together. Artificial intelligence and data-driven technologies are reshaping the industry, and our responsibility is to ensure these advancements strengthen safety, transparency, and resilience.

Our Vision 2030 is anchored in the Center's three core pillars: Research, Education, and Services.

These pillars guide our development of knowledge, preparation of the workforce, and delivery of practical solutions for safer industrial systems. We envision environments where trusted artificial intelligence (AI) enhances human judgment, predicts hazards, and supports responsible decision-making across the lifecycle of chemical operations.

Building on strong collaboration among academia, industry, and government, the MKO center seeks to integrate safety, sustainability, and digital innovation into every industrial and educational practice. The Strategic Vision 2030 Roadmap outlines the objectives, focus areas, and enablers needed to achieve this vision, supported by partnerships, technology, and a commitment to sustainable progress.

To achieve a meaningful impact, the Center will continue to expand interdisciplinary engagement, strengthen global partnerships, and promote rigorous, evidence-based approaches to emerging technologies. These efforts ensure that process safety remains proactive, resilient, and aligned with the rapidly evolving industrial landscape. Our community plays a pivotal role in advancing safe and secure operations, enhancing resilience, and shaping standards that protect both people and the environment. Through collective effort, we can ensure that innovation and safety progress in tandem.

Sincerely,

Mark Slezak
Chair, Steering Committee, MKOPSC

MISSION STATEMENT

MKOPSC's mission is to foster safety as second nature by leading the integration of safety, particularly process safety, through education, research, and service, embedding it into the learning, mindset, and practice of all individuals and organizations. The Center advances understanding and practice of safety principles by developing knowledge, tools, and highly qualified personnel (HQP) that enable the prevention, control, and mitigation of incidents, cultivating a culture of integrity, excellence, collaboration, and impact across industries and academia.

This mission reflects MKOPSC's enduring values of excellence, integrity, collaboration, and impact, emphasizing that the foundation of safety lies not only in tools and technology but also in education and public empowerment.

VISION STATEMENT

By 2030, MKOPSC will continue to serve as the ***global Process Safety Center of Excellence,*** promoting:

- ***Process safety as a personal value*** that is second nature to all stakeholders.
- ***Continuous progress toward zero injuries*** and the elimination of adverse impacts on people and communities.
- ***Integration of safety and process safety*** across digital, sustainable, and emerging industrial systems.

Through pioneering research, transformative education, and deep industry collaboration, MKOPSC will be recognized worldwide as a trusted leader in advancing safe, resilient, and sustainable operations, enabling safety not as a constraint, but as a ***core enabler of innovation and progress.***

MAKING SAFETY *SECOND NATURE*

The Mary Kay O'Connor Process Safety Center (MKOPSC) was established in 1995 in memory of Mary Kay O'Connor, who was killed in a fatal and tragic industrial accident in 1989. The incident ultimately increased awareness of the importance of process safety. The center's mission is to improve process safety performance in the industry through research, education, and outreach activities. The center is a key part of the Texas Engineering Experiment Station (TEES), which collaborates with academic institutions, government agencies, and industry partners to conduct research, develop best practices, and provide training in process safety.

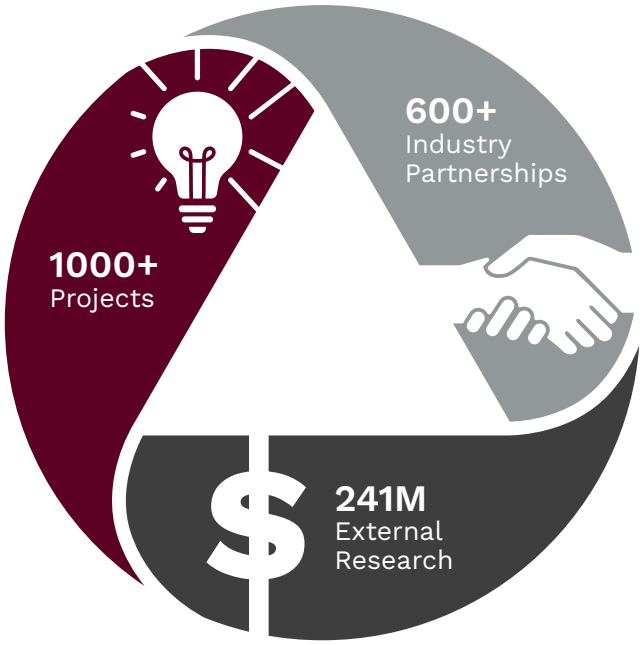
The center conducts research projects to address various aspects of process safety, such as risk assessment, hazard identification, incident investigation, safety management systems, and human factors. The findings from these research projects contribute to the development of guidelines and tools that help organizations enhance their process safety practices.

In addition to research, the center offers educational programs and courses to students, professionals, and industry personnel. These programs cover topics related to process safety engineering, risk management, and regulatory compliance. The center also hosts conferences, symposiums, and workshops to facilitate knowledge sharing and networking among process safety professionals.

The Mary Kay O'Connor Process Safety Center plays a vital role in advancing process safety engineering and promoting a culture of safety in industries that handle hazardous materials and processes. Its efforts contribute to preventing accidents, protecting workers and the public, and minimizing the impact of incidents on the environment and communities.

TEXAS A&M ENGINEERING EXPERIMENT STATION (TEES) FACTS

For over 100 years, Texas A&M Engineering Experiment Station (TEES) has improved lives through basic and applied engineering research and development in Texas and across the nation. As one of eight state agencies within the Texas A&M University System, TEES was established in 1914 as part of the Texas land-grant university system (under State Statute Chapter 88, Subchapter E, Texas Education Code). TEES conducts cutting-edge research, advances the workforce through education and technology transfer, and provides solutions to enhance the quality of life and promote economic development. TEES's structure maximizes research and educational partnerships across the state and nation by forming networks that bring together subject matter expertise from universities, national laboratories, state and federal agencies, and industry. For more information about TEES, see ***tees.tamu.edu.***



STRATEGIC VISION 2030 ROADMAP

MKOPSC is committed to advancing excellence in process, energy, and artificial intelligence (AI)-integrated safety research, education, and services. Building on its strong foundation of collaboration between academia, industry, and government, the Center envisions a future where safety, sustainability, and digital innovation are seamlessly integrated into every industrial and educational practice.

This Strategic Vision 2030 Roadmap provides a structured pathway for MKOPSC to achieve this vision. It defines strategic objectives, focus areas, timelines, and success indicators across three core pillars, Research, Education, and Services, and integrates cross-cutting enablers such as partnerships, technology, and sustainability.

Roadmap Development Process

To ensure this roadmap reflects the collective needs and priorities of the process safety community, MKOPSC followed a consultative, evidence-driven development process. This multi-phase approach was designed to capture diverse perspectives from industry, academia, and students, aligning MKOPSC's mission with stakeholder expectations and emerging challenges in safety science.

ROADMAP DEVELOPMENT PROCESS

1

STAKEHOLDER IDENTIFICATION

Participants included:

- Industry partners: oil & gas, chemical, manufacturing, and energy sectors.
- Academia: faculty across engineering and science disciplines engaged in safety research and instruction.
- Students and trainees: graduate and undergraduate students involved in safety-related projects.

2

SURVEY DESIGN AND DISTRIBUTION

MKOPSC designed a structured online survey covering:

- Priority research areas in safety
- Current challenges in workforce education and training
- Industry expectations from academic partnerships
- Service and engagement need to support technology transfer

Respondents were asked to validate the importance and provide open-ended feedback.

3

VALIDATION AND INTEGRATION

- Survey results and workshop insights were consolidated into actionable priorities.
- The draft roadmap was reviewed by the MKOPSC Advisory Board and refined through iterative feedback.
- Final priorities were aligned with those of Texas A&M University (TAMU) and the Texas Engineering Experiment Station (TEES) in terms of strategic research themes and national safety initiatives.

STRATEGIC FRAMEWORK

RESEARCH

Mission

Lead innovation in process, energy, and artificial intelligence (AI)-integrated safety science through sponsored, collaborative, and fundamental research.

Outcome

MKOPSC is recognized as a hub for safety research, producing impactful methods, tools, and technologies.

EDUCATION

Mission

Cultivate the next generation of safety professionals through degree programs, certifications, and professional training.

Outcome

Trained workforce capable of leading safe operations and advancing safety culture.

SERVICES

Mission

Deliver engagement, advisory, and knowledge transfer programs that connect academia and industry.

Outcome

MKOPSC serves as the premier source for safety expertise, guidance, and technology dissemination.

	Research	Education	Services
Mode	• Sponsored • Collaborative • Fundamental	• Academic (MS, PhD) • Skill Development (Certifications, Short Courses) • On-site Trainings • Technical Presentations to the Steering Committee and at conferences	• Industry and Community Engagement (Local, National, International) • Advisory Services • Technology transfer & knowledge • Workshops, conferences, and seminars
Expertise Domains	• Process Safety • Energy Safety • Artificial Intelligence (AI) Safety • Cyber-physical Systems	• Process Safety • Energy Safety • Material Safety • Artificial Intelligence (AI) Safety	• Process Safety • Energy Safety • Artificial Intelligence (AI) Safety • Cyber-physical Systems
Goals	Develop concepts, methods, models, tools, technologies, and procedures	• Train workforce for safe operations in the industry • Train academics to lead safety education • Provide on-site training • Lead in integrating process safety into Chemical Engineering	• Strengthen collaboration between industry, academia, and regulators • Provide expertise and solutions to improve safety standards globally • Foster knowledge exchange via workshops and conferences • Facilitate the adoption of best practices and innovative safety technologies
Measures for Success	• Industry engagements • Publications and their use • Impact on policies • Impact on procedures • Highly qualified personnel	• Employment in both industry and universities • Number of on-site trainings offered • Number of competency certificates issued	• Number and impact of industry collaborations • Adoption of research outcomes in industrial practice • Feedback and improvements in safety performance indicators • Participation rates in training, workshops, and conferences

RESEARCH ROADMAP

Strategic Objectives

Advance Scientific Discovery: Develop new methods, models, and tools that enable prediction, prevention, and mitigation of process incidents.

Integrate Artificial Intelligence (AI) and Cyber-Physical Safety: Leverage digital transformation for data-driven safety decision-making.

Promote Multidisciplinary Collaboration: Bridge disciplines such as chemical, systems, and computer engineering to solve safety challenges.

Support the Energy Transition: Address safety in renewable, hydrogen, and carbon-neutral energy systems.

Phase 1 (2025–2026)

Initiate 5 industry-sponsored projects

Phase 2 (2027–2028)

Expand digital twin research; publish 25+ peer-reviewed studies

Phase 3 (2029–2030)

Transition validated tools into industry pilots; produce standards and best practice guidelines

Measures of Success

- ≥5 sponsored projects annually with industry participation
- ≥10 publications per year and growing citation impact
- Technology adoption in at least 2 industrial applications
- Maintain MKOPSC's leadership as a top safety research center globally

Expertise Domains and Descriptions

Process Safety and Risk Management

- Develop multi-scale modeling frameworks for risk assessment across plant and system levels.
- Integrate human factors, resilience engineering, and organizational behavior into safety analysis and assessment.
- Create simulation tools for scenario-based hazard evaluation and training.

Energy Safety and Emerging Technologies

- Study ignition, dispersion, and explosion risks associated with hydrogen, ammonia, and renewable fuels.
- Design safety protocols for carbon capture, utilization, and storage (CCUS) facilities.
- Contribute to international standards on clean energy safety design and testing.

Artificial Intelligence (AI) and Cyber-Physical System Safety

- Build machine learning algorithms for anomaly detection, early warning, and autonomous safety response.
- Explore the ethical and explainability aspects of AI-based decision systems.
- Investigate resilience and fail-safe operation in interconnected industrial control networks.

Data Infrastructure and Safety Analytics

- Establish an open-access Process Safety Data Repository hosting industrial incidents and case studies.
- Develop standardized taxonomies for incident classification and cross-sector comparison.
- Enable data-driven insights through visualization dashboards and predictive analytics tools.

EDUCATION ROADMAP

Strategic Objectives

Develop Academic Excellence: Build degree programs that integrate advanced safety concepts.

Upskill the Workforce: Provide continuous learning opportunities through certifications and hybrid training.

Foster Leadership: Prepare the next generation of faculty and professionals in safety innovation and culture.

Phase 1 (2025–2026)

Develop safety course series; 50 trainees certified

Phase 2 (2027–2028)

100 professionals trained

Phase 3 (2029–2030)

Establish global education partnerships; 200+ certifications issued

Measures of Success

- ≥500 trained professionals by 2030
- Integration of safety modules into 10+ academic institutions
- ≥10 professional certifications offered annually
- Documented improvement in safety competencies among trainees

Focus Areas

Academic Programs

- Launch MS and PhD programs specializing in process, energy, and artificial intelligence (AI) safety.
- Integrate process safety content into undergraduate curricula for students majoring in chemical and mechanical engineering.
- Offer cross-listed electives with data science and systems engineering.

Professional and Continuing Education

- Continue offering certifications.
- Deliver flexible, modular learning through in-person, hybrid, and online formats.
- Develop international partnerships to accredit programs globally.

Simulation-Based Training

- Develop a Virtual Safety Learning Environment with real-world accident simulations.
- Develop gamified training modules to enhance risk perception and response.
- Enable remote collaboration and digital twin-based learning scenarios.

Mentorship and Academic Leadership

- Launch an MKOPSC Fellowship Program for graduate students and early-career researchers.
- Host annual “Safety Scholars” symposiums for student presentations.
- Offer mentoring programs connecting students with industry experts.

SERVICES ROADMAP

Strategic Objectives

Strengthen Collaboration: Serve as the link between academia, industry, and policy.

Provide Expert Advisory Support: Deliver evidence-based consulting services for safety management and regulatory compliance.

Disseminate Knowledge and Impact: Ensure MKOPSC research outcomes are effectively applied in practice through targeted training and technology transfer.

Phase 1 (2025–2026)

Initiate advisory partnerships

Phase 2 (2027–2028)

Launch Safety Benchmarking Index

Phase 3 (2029–2030)

Publish biennial "Global Safety Impact Report"

Measures of Success

≥100 active partnerships by 2030

Documented safety performance improvement in partner organizations

Recognition by federal and international bodies as a model advisory center

Focus Areas

Industry and Community Engagement

- Engage the Technical Advisory Committee and the Steering Committee to co-design safety initiatives.
- Conduct regional safety workshops and community resilience programs to enhance safety and promote resilience.
- Collaborate with non-governmental organizations (NGOs) on public safety awareness.

Advisory and Policy Services

- Develop benchmarking tools for assessing safety maturity.
- Partner with regulatory agencies to draft guidelines for new technologies.
- Facilitate expert advisory panels to support the development of national safety frameworks and guidelines.

Technology Transfer and Knowledge Exchange

- Build an online Safety Knowledge Hub for global dissemination of MKOPSC research.
- Offer open-access tools, models, and data repositories for practitioners.
- Host the Global Process Safety Conference on an annual basis.

GOVERNANCE, MONITORING, AND EVALUATION

- Establish an MKOPSC Strategic Oversight Committee to monitor the implementation of the roadmap.
- Conduct annual progress reviews and biennial stakeholder surveys to evaluate impact and recalibrate priorities.
- Publish transparent Impact and Metrics Reports highlighting achievements in research, education, and service outcomes.

KEY PERFORMANCE INDICATORS

- Research: number of projects, publications, patents, and industry adoptions.
- Education: participant count, certification outcomes, student employment.
- Services: partnerships, advisory engagements, and policy influence.

We Thank our Member Companies

CONCLUSIONS

Through this Strategic Vision 2030 Roadmap, the Mary Kay O'Connor Process Safety Center (MKOPSC) reaffirms its commitment to innovation, excellence, and collaboration in advancing process safety. The roadmap, grounded in stakeholder input and guidance priorities. It positions MKOPSC as a global catalyst for safer, smarter, and more sustainable industrial systems.

By 2030, MKOPSC will be a center of academic excellence and a transformational leader shaping the future of safety education, research, and practice worldwide.

Texas A&M Engineering Experiment Station

Mary Kay O'Connor Process Safety Center

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