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Colombiana
de Ingenieros

DEVELOPMENT AND ASSURANCE OF SKILLS FOR MANAGING WEATHER AND EXTERNAL FORCES THREAT IN HYDROCARBON TRANSPORT SYSTEMS

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06 de Noviembre de 2025

AGENDA


- 1. Purpose of the strengthening program**
- 2. Key skills for develop**
- 3. Target team description**
- 4. Skills strengthening program structures**
- 5. Certification Purpose**
- 6. Key aspects expected from the implementation of the program**
- 7. Progress in the implementation of the program**
- 8. Conclusions**





Purpose of the Strengthening program


Develop and assure technical, operational, and behavioral skills among personnel responsible for RoW patrol. Aligned with the principles of ASME B31Q, program targets the enhancement of critical capabilities required to manage threats associated with Weather and External Forces (WEF) and Mechanical Damage by Involuntary Third Parties (MDITP) in pipeline systems


Key skills for develop.

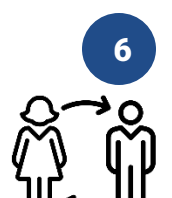
 **1 • Terrain Interpretation and Geotechnical Awareness!**
Assess terrain conditions and detect early signs of geotechnical instability, enabling proactive risk mitigation.

 **2 • Applied Geotechnical and Hydrotechnical Principles!**
Use of foundational engineering concepts to evaluate risks impacting pipeline integrity due to environmental and structural factors.

 **3 • Technology Integration!**
Deploying tools such as drones, Global Positioning Systems (GPS), and Geographic Information Systems (GIS) for enhanced situational awareness and threat detection.

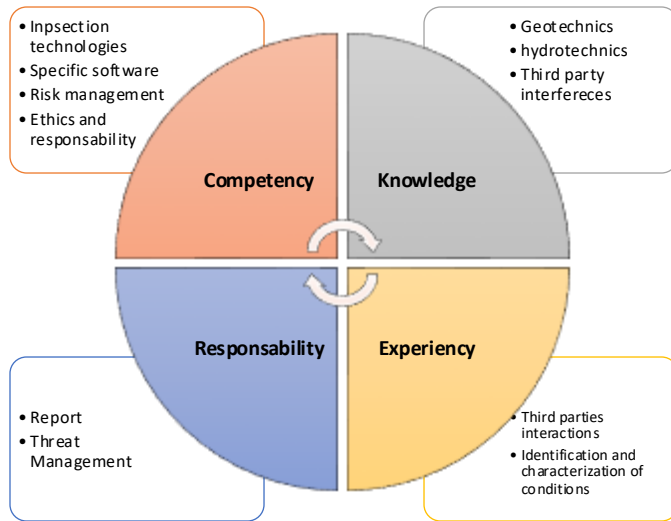
 **4 • Third-Party Threat Identification!**
Recognize, document, and report activities or conditions that may pose risks due to unintentional third-party interference.

 **5 • Procedural Execution!**
Applying established protocols for prevention, mitigation, and response to operational threats and incidents.

 **6 • Stakeholder Communication!**
Effective engagement with local communities and external entities to foster collaboration and ensure timely exchange of information.

SKILLS STRENGTHENING PROGRAM STRUCTURES

7 stages



Stage 1 - Definition of Job Requirements

- Identifies the technical profiles required for each rol (field inspectors and management professionals)
- Ensuring that training content is tailored to the actual demands and gaps of each role.



Stage 2 - Design of Technical Procedures

Standardized procedures are developed based on:

- Current regulations and field experience
- Analysis of real cases
- Design of operational flowcharts
- technical validation by subject matter experts.

ESTRUCTURA DEL PROGRAMA

Arplus⁺



Stage 3 - Training Schedule

Internal Training

- Regulations
- key lessons learned
- Contextual of application of procedures.

External Training:

- Technical regulations
- Risk engineering
- Complementary methodologies.

SKILLS STRENGTHENING PROGRAM STRUCTURES

7 stages



Stage 4 - Certification Scheme Launch

- Evaluation criteria
- Test forms
- Scoring weights
- passing thresholds
- Competency validation process. Transparency at this stage fosters commitment and engagement from participants, while their understanding of the certification system is assessed through diagnostic surveys

Stage 5 - Training and Assessment

Training

- Theoretical instruction
- Workshops about study cases
- Simulation
- Hand-on exercises.

Sequential assessments

- Track progress and allow for adaptative learning strategies

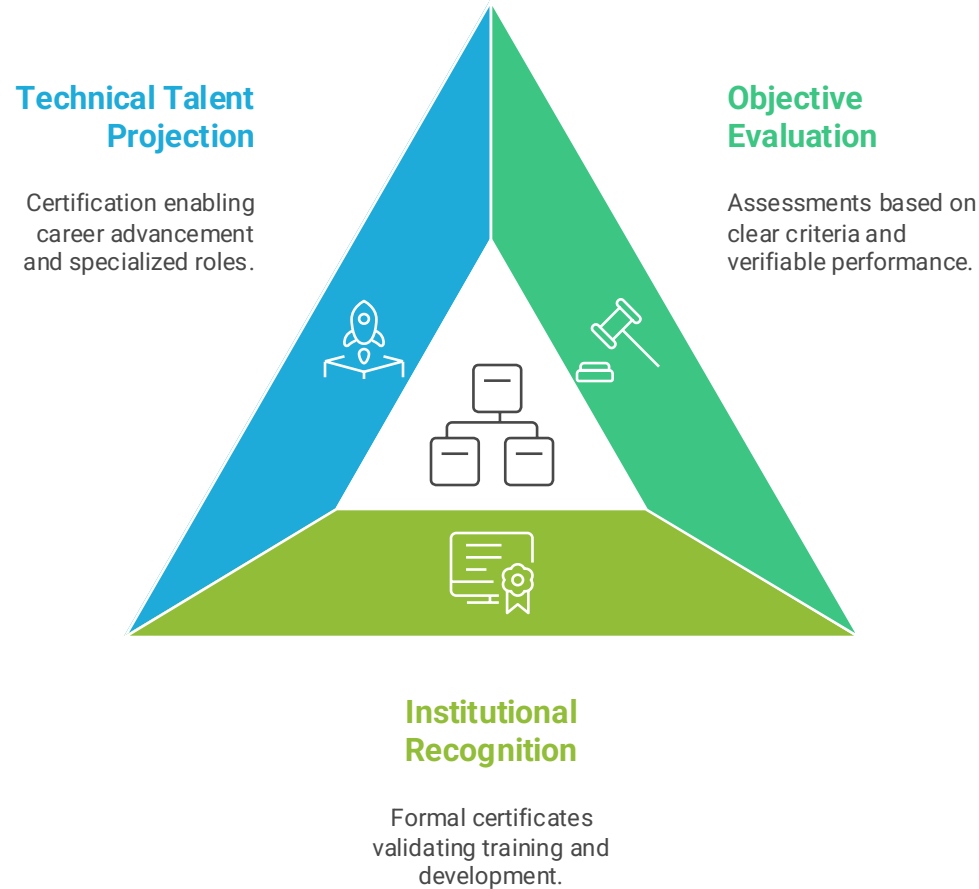
Stage 6 (Supervised Field Period) Stage 7 (Certification Process)

Real-world field activities under direct technical supervision. Validate the practical application of acquired knowledge (evaluation checklist).

A final comprehensive evaluation

- Technical testing
- field performance review
- Verification of procedural compliance.

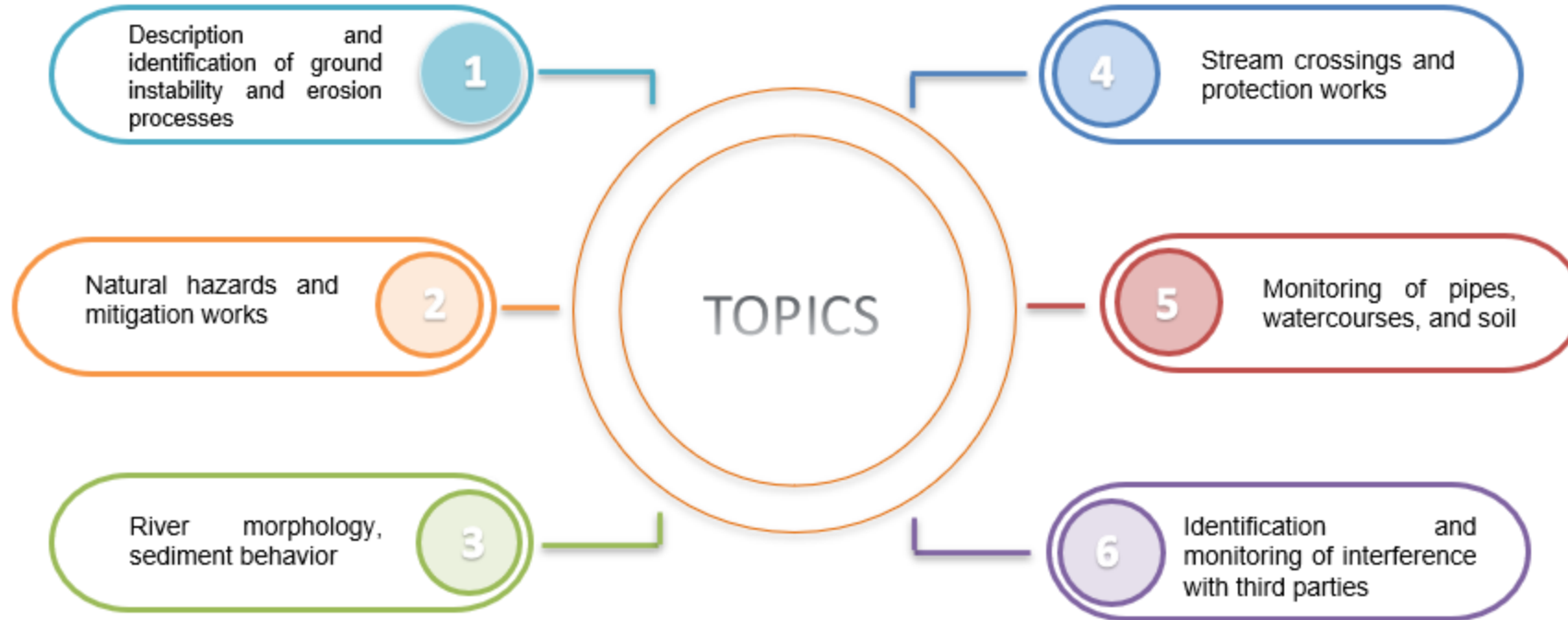
Core Pillars of the Process



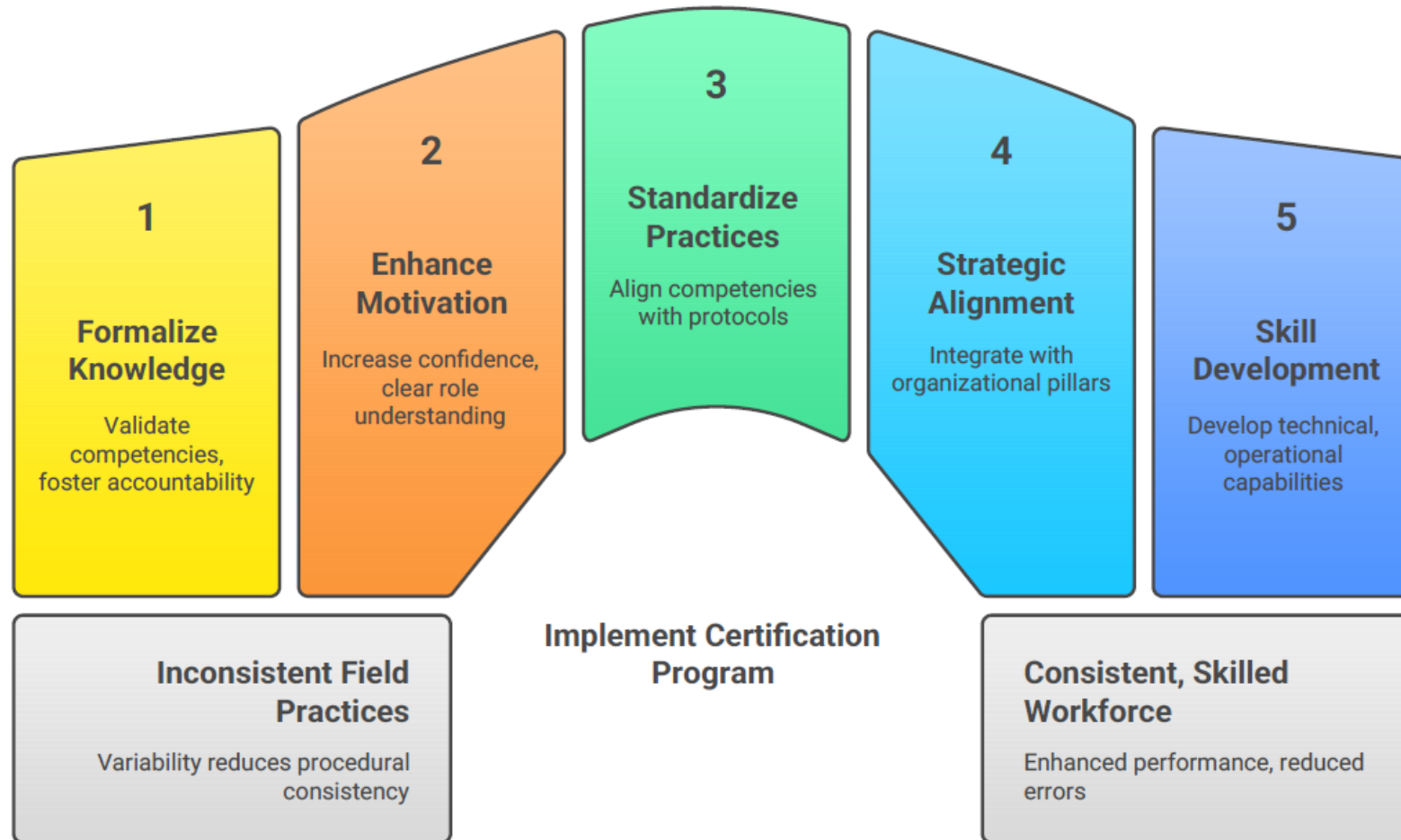
Certification Purpose

Its primary purpose is to recognize the technical mastery achieved by participants upon completing the training process, serving as a catalyst for performance improvement and professional growth.

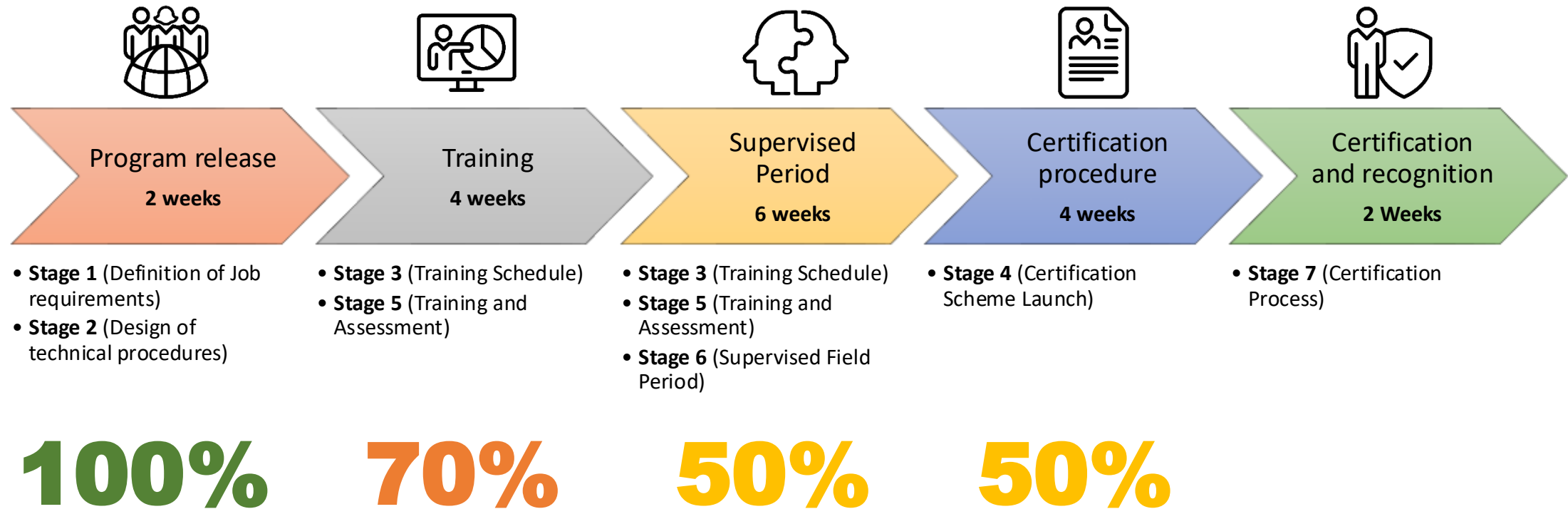
TOPICS TO REINFORCE



KEY ASPECTS EXPECTED FROM THE IMPLEMENTATION OF THE PROGRAM



PROGRESS IN THE IMPLEMENTATION OF THE PROGRAM



Conclusions.

- 1 Skills Program: A Strategic Asset**
The implementation of a skills strengthening program constitutes a strategic asset for increasing operational safety, technical autonomy and workforce development.
- 2 Equipping Teams for Proactive Threat Response**
By aligning skills validation with real-world management of WEF and MDITP threats in hydrocarbon transportation, this program ensures that personnel are equipped to anticipate and respond effectively to critical events.

- 3 Empowering Proactive Threat Management**
The integration of active training methodologies, supervised field practice, and internal certification - though not externally accredited- motivates professional development, projects technical talent toward roles of greater responsibility, and fosters a culture of continuous improvement and strategic organizational strengthening.
- 4 Cultivating a Culture of Prevention & Improvement, alignment with ASME B31Q**
the program contributes to a culture of prevention, accountability, and continuous improvement. Its alignment with strategic frameworks such as ASME B31Q positions it not only as a technical initiative but as a long-term investment in infrastructure integrity and human capital resilience.

The background image shows a long pipeline stretching through a deep, rocky mountain valley. In the foreground, two workers wearing hard hats and high-visibility vests are seen from behind, looking towards the pipeline. The entire scene is overlaid with a semi-transparent red filter.

¡Thanks!

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DEVELOPMENT AND ASSURANCE OF SKILLS FOR MANAGING WEATHER AND EXTERNAL FORCES THREAT IN HYDROCARBON TRANSPORT SYSTEMS

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ABSTRACT

The development and advancement of technologies for monitoring the conditions of the hydrocarbon transport infrastructure in the face of Weather and External Forces Threat serve as a catalyst for fostering and validating workforce skills. Enhancing the ability to anticipate, mitigate and respond to these challenges is essential to ensuring pipeline integrity and maintaining operational continuity.

Continuous training of technical and operational personnel responsible for monitoring and inspecting pipeline right-of-way (RoW) is a strategic pillar in mitigating risks associated with Weather and External Forces (WEF) and Mechanical Damage by Involuntary Third Parties (MDITP). Effective knowledge management in this context must focus on enhancing the team's ability to conduct detailed terrain assessments, recognize early warning signs of potential threats – such as soil movement, vegetation changes or unauthorized encroachments – and leverage advanced technological tools and the application of prevention and response protocols to events that could compromise pipeline integrity and operational safety.

In response to this context, a skills strengthening program has been developed with the aim of standardizing the knowledge RoW patrol personnel and professionals involved in managing WEF and MDITP. This program is designed in a specific and differentiated manner for patrol personnel and management professionals, considering the distinct roles they perform as well as the prior training and experience required in each case.

The program covers technical aspects of geotechnics and hydrotechnics for pipelines, tracking of triggering agents of instability processes, geotechnical monitoring, invasions and impacts on the RoW by involuntary third parties, use of digital tools and electronic equipment such as drones, and mitigation

measures. Competent human talent enables early identification of conditions that could lead to process safety events, by activating preventive actions to reduce the likelihood of threats materializing into incidents, spills or harm to communities and the environment. In addition, it strengthens coordination with environmental agencies, risk management organizations and local communities, fostering a preventive and collaborative approach.

In this way, this article aims to demonstrate how, within the framework of Knowledge Management, developing and ensuring the skills of personnel involved in the inspection and condition assessment of infrastructure enhances the ability to respond to adverse events and promotes a culture of prevention and collaboration among all stakeholders. This, in turn, contributes to the overall integrity assurance strategy.

Keywords: Skill, Knowledge Management, Development and Assurance, Qualification Program

1. INTRODUCTION

In today's rapidly evolving industrial landscape, the strengthening of competencies is not only vital for individual adaptability and professional success, it is also a strategic lever for organizational resilience. The accelerating pace of technological change, globalization, and shifting labor market dynamics demand that professionals adopt a mindset of lifelong learning and continuous improvement.

This imperative is especially critical in sectors where safety and operational integrity are paramount. The ASME B31Q standard [1], developed by the American Society of Mechanical Engineers (ASME), provides a robust framework for implementing an effective Pipeline Personnel Qualification

Program. It ensures that individuals performing tasks that impact the safety and integrity of pipeline systems are properly qualified—technically, operationally, and behaviorally. The overarching goal is to promote operational safety and uphold the integrity of pipeline infrastructure through rigorous personnel qualification.

Competency development in this context transcends individual benefit; it directly influences organizational performance, risk mitigation, and socioeconomic progress. Global institutions such as the International Labour Organization (ILO), the Organization for Economic Co-operation and Development (OECD), and the United Nations Sustainable Development Goals (SDGs) emphasize the need workforce that is flexible, ethically responsible, and capable for responding to complex challenges.

Within this framework, Cenit and its partner Applus Norcontrol Colombia have launched a skills strengthening program focused on enhancing the technical, operational, and behavioral skills of personnel assigned to right-of-way (RoW) patrols and condition analysis. This initiative specifically addresses threats such as Weather and External Forces and Mechanical Damage by Involuntary Third Parties in hydrocarbon transportation systems.

By aligning with Colombian Decrees 946 and 947 of 2022, ASME B31Q and global competency standards, this program not only reinforces pipeline safety and integrity but also contributes to building a culture of prevention, collaboration, and continuous learning—essential traits for navigating the challenges and opportunities of the twenty-first century



FIGURE 1: RIGHT OF WAY ROUTE PATROL

2. SKILL DEVELOPMENT FOR ROW PATROL

This strengthening program is designed to develop and assure technical, operational, and behavioral skills among personnel responsible for RoW patrol. Aligned with the principles of ASME B31Q, program targets the enhancement of critical capabilities required to manage threats associated with Weather and External Forces (WEF) and Mechanical Damage by Involuntary Third Parties (MDITP) in pipeline systems.

The program focuses on developing the following key skills:

- **Terrain Interpretation and Geotechnical Awareness:** Ability to assess terrain conditions and detect early signs of geotechnical instability, enabling proactive risk mitigation.
- **Applied Geotechnical and Hydrotechnical Principles:** Use of foundational engineering concepts to evaluate risks impacting pipeline integrity due to environmental and structural factors.
- **Technology Integration:** Proficiency in deploying tools such as drones, Global Positioning Systems (GPS), and Geographic Information Systems (GIS) for enhanced situational awareness and threat detection.
- **Third-Party Threat Identification:** Skills to recognize, document, and report activities or conditions that may pose risks due to unintentional third-party interference.
- **Procedural Execution:** Competence in applying established protocols for prevention, mitigation, and response to operational threats and incidents.
- **Stakeholder Communication:** Effective engagement with local communities and external entities to foster collaboration and ensure timely exchange of information.

By strengthening these skills, the program empowers field teams with greater technical autonomy, enabling:

- Early identification and anticipation of critical events
- timely and effective response to emerging threats
- Enhanced operational safety and reliability
- Increased personnel commitment to infrastructure integrity.

This integrated approach not only reinforces the safety culture within ROW operations but also aligns with industry’s best practices for pipeline integrity management.

This program seamlessly integrates the principles of Knowledge Management and competency development into pipeline infrastructure systems. By clearly defining covered tasks and qualification criteria, it facilitates the systematic preservation and sharing of operational knowledge across teams. It also emphasizes personnel qualification through targeted training, evaluation, and documentation – enhancing the capacity to anticipate and respond to adverse events. Moreover, it supports a comprehensive integrity assurance strategy, ensuring that safety-critical tasks are consistently executed by competent, qualified individuals.

3. SKILLS STRENGTHENING PROGRAM STRUCTURES

To identify and manage Weather and External Forces (WEF), and Mechanical Damage by Involuntary Third Parties (MDITP) in a timely manner, a competency strengthening program has been designed. The first version of this program is currently under development. This initial version aims to level knowledge and standardize language, targeting the current population of professionals managing these tasks. The following figure illustrates the main characteristics of the individuals

currently conducting RoW patrol and condition analysis, which serves as the baseline for the skills to be strengthened.

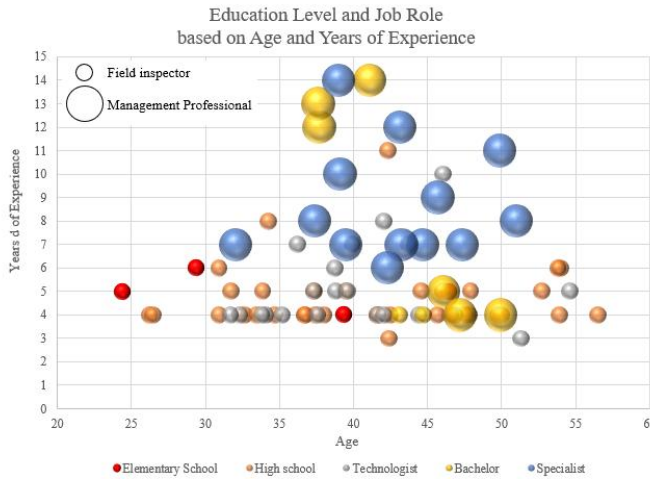


FIGURE 2: CHARACTERISTICS OF ACTUAL PERSONEEL

The program is built around seven progressive stages, designed to ensure a structured and controlled process for acquiring and validating skills. Each stage contributes to a comprehensive framework that aligns training with operational realities and professional growth.

Stage 1 (Definition of Job Requirements): This initial stage identifies the technical profiles required for roles such as field inspectors and management professionals. It defines the specific competencies, knowledge, experience, and responsibilities associated with each position, ensuring that training content is tailored to the actual demands and gaps of each role. This information is documented through competency matrices.

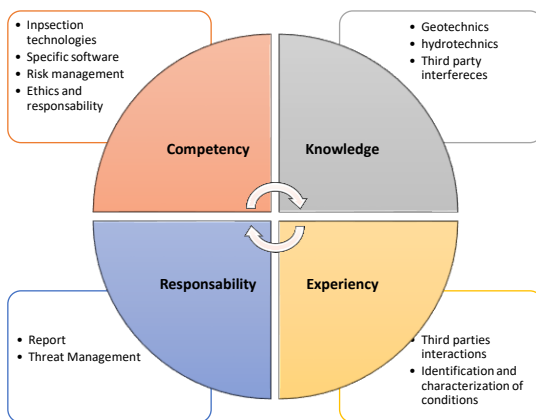


FIGURE 3: COMPETENCIES MATRIX DIAGRAM

Stage 2 (Design of Technical Procedures): Standardized procedures are developed based on current regulations and field experience. The analysis of real cases, the design of operational flowcharts, and technical validation by subject matter experts. These procedures serve as the methodological core upon which the training modules are developed.

Stage 3 (Training Schedule): A structured calendar combines internal and external sessions, a dual approach that strengthens both foundational and advanced technical skills:

Internal Training: Delivered through in-person or virtual sessions led by in-house instructors, this format offers comprehensive coverage of regulations, key lessons learned, and the contextual of application of procedures. Participants engage in quiz-based evaluations and case analysis exercises to reinforce understanding and practical application.

External Training: Comprises specialized modules facilitated by industry experts, focusing on technical regulations, risk engineering, and complementary methodologies. Sessions incorporate interactive workshops and hands-on exercises to deepen practical understanding and skill development.

Stage 4 (Certification Scheme Launch): Prior to training, participants are formally introduced to the certification model. This includes evaluation criteria, test forms, scoring weights, passing thresholds, and the competency validation process. Transparency at this stage fosters commitment and engagement from participants, while their understanding of the certification system is assessed through diagnostic surveys.

Stage 5 (Training and Assessment): Training incorporates active methodologies such as theoretical instruction, workshops about study cases, simulation and hand-on exercises. Sequential assessments (diagnostic, formative, and summative) track progress and allow for adaptative learning strategies.

Stage 6 (Supervised Field Period): After training, during this stage, participants engage in real-world field activities under direct technical supervision. This stage is designed to validate the practical application of acquired knowledge, using a structured evaluation checklist. This checklist serves not only to assess on-site performance but also to deliver immediate, targeted feedback on critical competencies.

Stage 7 (Certification Process): A final comprehensive evaluation includes technical testing, field performance review, and verification of procedural compliance. The goal is to ensure participants are capable of making autonomous decisions. Those who successfully meet the criteria are awarded a certification that recognizes their technical proficiency and supports their professional development formally. However, this certification does not constitute formal accreditation by external entities



FIGURE 4: SKILLS STRENGTHENING PROGRAM PATHWAY

4. CERTIFICATION AS A MOTIVATING PROCESS

The proposed certification model is not tied to an external accreditation system; instead, it operates within an internal framework of structured competency validation. Its primary purpose is to recognize the technical mastery achieved by participants upon completing the training process, serving as a catalyst for performance improvement and professional growth.

This model is built upon three core pillars:

- **Objective and Documented Evaluation:** Assessments are based on clearly defined technical criteria, demonstrated field performance, and verifiable application of procedures.
- **Institutional Recognition:** Participants receive formal certificates that validate their training and can be presented to supervisors or human resources departments as evidence of their development.
- **Technical Talent Projection:** Certification supports career advancement by enabling access to specialized roles or positions of greater responsibility, according to the level of competence demonstrated.

Beyond its formal value, certification functions as a strategic tool for individual motivation and organizational strengthening. It fosters alignment of expectations, reinforces commitment to continuous improvement, and contributes to the development of long-term technical and strategic capabilities.

5. RESULTS AND DISCUSSION

This section presents the key aspects expected from the implementation of the skill strengthening program, analyzing its impact on individual performance, team dynamics, and organizational outcomes. The discussion is organized into five thematic sub-sections that collectively demonstrate how certification functions as a strategic tool for motivation, operational consistency, and long-term workforce development.

5.1 Strategic Role of Certification in Workforce Development

Certification programs serve not merely as compliance mechanisms but as strategic instruments that reinforce

organizational goals. By formalizing knowledge and validating competencies, certification fosters a culture of accountability and continuous improvement. In operational environments where precision and safety are paramount, certified personnel demonstrate higher levels of task ownership and procedural adherence, contributing directly to performance excellence.

5.2 Motivational Impact and Career Progression

The implementation of certification frameworks has shown measurable effects on employee motivation and engagement. Individuals who undergo structured certification report increased confidence in decision-making and a clearer understanding of their roles. Moreover, certification often acts as a catalyst for career advancement, providing a transparent pathway for internal mobility and leadership development. This dual function—skill validation and career signaling—positions certification as a key driver of talent retention and professional growth.

5.3 Operational Strengthening Through Standardization

From an operational standpoint, certification contributes to the standardization of field practices, reducing variability and enhancing procedural consistency. This is particularly critical in sectors where decentralized teams operate under high-risk conditions. By aligning individual competencies with standardized protocols, certification ensures that field personnel are equipped to execute tasks with precision, thereby minimizing errors. The strategic integration of certification into operational workflows thus strengthens the reliability and resilience of the organization.

5.4 Strategic Alignment and Organizational Impact

It is feasible to align the certification framework with the organization's strategic pillars, including safety culture, talent development, and operational excellence. Integrating certification into performance evaluations enhances task accuracy and encourages broader participation in voluntary training initiatives. Benchmarking the program against recognized industry standards, such as ASME B31Q, reinforces its credibility and ensures the robustness of its structure. Finally, certification functions not merely as a technical requirement but as a strategic lever for organizational strengthening.

5.5 Skill Strengthening for Threat Management and Technical Autonomy

A skill strengthening program has been developed, focused on the comprehensive development of technical, operational, and attitudinal capabilities in personnel responsible for right-of-way route patrol. Likewise, this program prioritizes the enhancement of key skills for managing threats of Weather and External Forces (WEF) and Mechanical Damage by Involuntary Third Parties (MDITP) in hydrocarbon transportation systems.

Through this program, the aim is to develop essential skills such as the ability to interpret ground conditions and the early detection of unstable geotechnical conditions, the applied use of

basic geotechnical and hydrotechnical principles in risk assessment, and the handling of advanced technologies such as drones, Global Position System (GPS) and Geographic Information Systems (GIS). Additionally, the importance of identifying, recording, and reporting threats posed by involuntary third parties is emphasized, as well as the implementation of established procedures for prevention, mitigation, and response to events.

The development of these skills enables greater technical autonomy within field teams, facilitates anticipation of critical events, and supports the application of more timely and effective responses. This approach not only increases operational safety but also reinforces staff commitment to infrastructure integrity, promoting effective communication with communities and external entities.

The first version of the program is scheduled to be developed over 18 weeks, as illustrated in the following image.

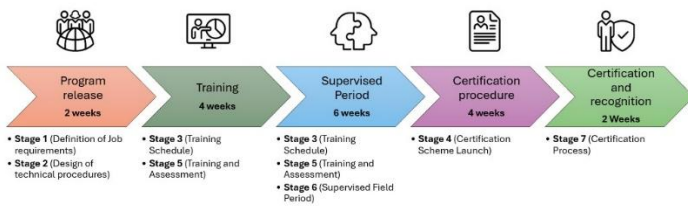


FIGURE 5: SCHEDULE FOR THE DEVELOPMENT OF THE PROGRAM

6. CONCLUSION

The implementation of a skills strengthening program constitutes a strategic asset for increasing operational safety, technical autonomy and workforce development. By aligning skills validation with real-world management of WEF and MDITP threats in hydrocarbon transportation, this program ensures that personnel are equipped to anticipate and respond effectively to critical events.

The integration of active training methodologies, supervised field practice, and internal certification -though not externally accredited- motivates professional development, projects technical talent toward roles of greater responsibility, and fosters a culture of continuous improvement and strategic organizational strengthening. Ultimately, the program contributes to a culture of prevention, accountability, and continuous improvement. Its alignment with strategic frameworks such as ASME B31Q positions it not only as a technical initiative but as a long-term investment in infrastructure integrity and human capital resilience.

ACKNOWLEDGEMENTS

To Cenit for promoting and driving the development of human talent competencies, and to Applus Norcontrol Colombia for embracing the initiative and developing the skills strengthening program.

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