



Arpel Reference Manual for Pipelines Integrity Management



ARPEL Reference Manual for Pipeline Integrity
Management
1st revised edition

Pipelines and Terminals Committee

ARPEL, May 2011



ARPEL Reference Manual No. 1 - 2011

May 2011

This manual was developed within the context of the ARPEL Pipeline integrity Project of ARPEL Pipelines and Terminals Committee:

Julio Alonso - ECOPELROL
Guillermo Boam - ANCAP
Álvaro Castañeda - ECOPELROL (Vice Chair)
Juan Carlos Gómez Haedo - ANCAP
Gabriel Grzona - Repsol YPF (Chair)
Arturo Heinke - Repsol YPF
Luis Loría Luna - RECOPE
Luciano Maldonado García - PETROBRAS
Carlos Navarro - ENAP (Vice Chair)
Paulo Penchiná - PETROBRAS (Vice Chair)
Carla Pereira Imbroisi - IBP
Jaime Rodríguez Salazar - RECOPE
Kelvin Salmon - PCJ
Raul Sampedro Farias - ANCAP
José Sánchez Nuñez - EP-Petroecuador
José Juan Sánchez Ghenno - PEMEX
Gaston Schoffield - ENAP
Brian Taniguchi - Chevron
Manuel Tomey - PETROPERU

ARPEL Pipeline integrity Project Team was in charge of the development and review of this document.

ANCAP: Guillermo Boam. **ECOPELROL:** Arnulfo Gamarra, Juan Carlos Villegas, Julio Alonso, Francisco Ascencio. **EP-Petroecuador:** José Sánchez Nuñez. **PEMEX:** José Juan Sánchez Ghenno. **PETROBRAS:** Anibal Fernandes, Ricardo Dias. **PETROPERU:** Esteban Bertarelli, Manuel Tomey. **RECOPE:** Hanzel Rodríguez. **RepsolYPF:** Arturo Heinke. **ARPEL:** Miguel Moyano.

We would also like to thank for the valuable contribution of the following professionals:

Juan Carlos Gómez Haedo and Raúl Sampedro (ANCAP), John Glanville (PCJ), Jeter de Freitas, Gutemberg de Souza Pimenta and Mario Pezzi Filho (PETROBRAS), Diana Pizarro (RECOPE), Félix Hurtado, Henry Requena, Julio Sánchez and Luis Llompert (PETROPERU), José Luis Martínez González (PEMEX).

The objectives of ARPEL Pipeline integrity Project Team as established by the Pipelines and Terminals Committee are the following:

- To create a reference manual to develop Integrity Management Programs.
- To facilitate the exchange of experiences and common criteria on Pipeline integrity among ARPEL Member Companies.
- To promote the reduction of the pipeline integrity management gaps among different companies.
- To share and develop best practices for excellence in operational integrity management.
- To adopt the best practices as established by international standards.

Copyright

The copyright of this document, whether in printed version or electronically stored or otherwise is held by the Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and the Caribbean (ARPEL). Any copy of this document must include this copyright notice. The user shall give—in future use of this document - full credit to ARPEL for being the source of information.

Disclaimer

Although all efforts were made to ensure the accuracy of the information contained in this publication, neither ARPEL nor any of its Member Companies assume any responsibility for any use made hereof. No references made to names or trademarks of equipment manufacturers and/or processes represent any endorsement by ARPEL or any Member Company.



TABLE OF CONTENTS

1. Introduction and Purpose	1
2. Scope	2
3. Background.....	7
4. Glossary of Terms.....	8
5. Baseline Assessment Plan	23
5.1. Pipe Material Records	24
5.2. Pipeline Construction Records	24
5.3. Infrastructure Records	24
5.4. Records related to environment aggressiveness (fluids and soil)	25
5.5. Right-of-Way or Easement Records	25
5.6. Coating Records.....	25
5.7. Cathodic Protection System Records	26
5.8. Preventive Maintenance Records	26
5.9. Operational Records.....	26
5.10. Historical Failure Records.....	27
5.11. Corrective Maintenance Records.....	27
5.12. Records related to high consequence areas and mitigation of consequences	27
5.13. Checklist for Baseline Assessment	29
6. Risk Assessment and Management.....	31
6.1. Definition of Risk	31
6.2. Risk Assessment	32
6.2.1. Calculation of Probability of Failure (PoF).....	33
6.2.2. Calculation of Consequence of Failure (CoF)	34
6.3. Information required for the risk assessment	35
7. Failure mechanisms due to threats.....	36
7.1. Internal corrosion.....	36
7.1.1. Description of threats of damage due to internal corrosion	36
7.1.2. Types of damage caused by internal corrosion	37
7.1.3. Checklist for internal corrosion	39
7.2. External corrosion	40
7.2.1. Description of threats of damage due to external corrosion	40
7.2.2. Types of damage caused by external corrosion.....	41
7.2.2.1. Selective ERW seam corrosion.....	41
7.2.2.2. Narrow axial external corrosion.....	41
7.2.2.3. Bacterial corrosion - Microbiologically Influenced Corrosion (MIC).....	42
7.2.2.4. Galvanic corrosion.....	43
7.2.2.5. Stress corrosion - stress corrosion cracking (SCC)	43
7.2.2.6. Parasite or erratic current corrosion	44

7.2.2.7. Differential aeration corrosion	44
7.2.3. Checklist for external corrosion	45
7.3. Natural forces.....	46
7.3.1. Description of threats of damage due to the natural forces.....	46
7.3.2. Types of damage produced by the natural forces	47
7.3.3. Checklist for the natural forces.....	48
7.4. Third-party actions	49
7.4.1. Description of threats of damage due to third-party actions.....	49
7.4.2. Types of third-party damage.....	49
7.4.2.1. Dents	49
7.4.2.1.1. Plain dents	50
7.4.2.1.2. Dents with a stress concentrator	50
7.4.2.1.3. Double dents	50
7.4.2.1.4. Dents affecting welds	50
7.4.2.2. Scratches	50
7.4.2.3. Arc burns	50
7.4.2.4. Illegal perforations	51
7.4.2.5. Attacks.....	51
7.4.3. Checklist for third-party actions.....	52
7.5. Operational errors.....	53
7.5.1. Description of threats of damage due to operational errors	53
7.5.2. Types of damage caused by operational errors.....	53
7.5.3. Checklist for operational errors	55
8. Action plans and maintenance program.....	57
8.1. Action plans to mitigate risks.....	57
8.2. Risk re-assessment and changes to the action plan	60
8.3. Management of change in a pipeline integrity program.....	61
9. Integrity Program evaluation	62
9.1. Performance indicators.....	62
9.2. Audits.....	63
9.3. Continuous performance improvement	64
10. Standards, regulations and technical documents.....	65
APPENDIX A – Means, actions and methods to determine and control internal corrosion	68
APPENDIX B – Means, actions and methods to determine and control external corrosion	77
APPENDIX C – Means, actions and methods to determine and control the natural forces	85
APPENDIX D – Means, actions and methods to determine and control third-party damage	91



APPENDIX E – Means, actions and methods to determine and control operational errors	98
APPENDIX F – Alternative actions for control and mitigation of threats – Acceptable repair and prevention methods	101





1. Introduction and Purpose

The integrity of an equipment or facility is its ability to perform the function for which it was designed safely and reliably, without affecting the security of people or the environment. Pipeline integrity management is a set of coordinated actions which objective is to maintain during the useful life of a pipeline and its facilities, the performance planned as it was designed, while efficiently managing the risks related to potential threats and the consequences of any failure on the environment, health, safety, corporate image, customers, economic losses and physical security, within the social responsibility, environmental health and safety policies of the operating companies.

This document aims at providing a general guideline to ARPEL Member Companies and other oil and gas sector operators, so that they may check their own management and/or apply the best practices to ensure the integrity of gas, liquid hydrocarbon and biofuel pipelines in order to achieve excellence in its operational, social and environmental responsible management. The guidelines and practices established in this document are indicative and not mandatory. This document does not reflect the legal requirements of specific jurisdictions. The companies should be aware of the corresponding requirements applicable to their respective jurisdictions.

This Manual is accompanied by an ExcelTM file with check lists to establish the baseline of the pipeline and for each threat (internal corrosion, external corrosion, third party actions, natural forces and operational errors) with the purpose of facilitating the review and compilation of the information required to support the assessment of the probability and consequences of failures during the risk analysis exercise. Although these check lists are described in this Manual, the electronic file allows the user to print it for field work purposes as well as to include comments and distribute it electronically among the professionals responsible of the integrity program of the company.