

# SUSTAINING WORLD CLASS COMPANY PERFORMANCE BY IMPLEMENTING ASSET INTEGRITY MANAGEMENT SYSTEMS (AIMS) IN PT. CHEVRON PACIFIC INDONESIA

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## Abstract

**Purpose** - This paper is a note of success story of implementation of Asset Integrity Management System in PT. Chevron Pacific Indonesia

**Design/Methodology/Approach** - PT. Chevron Pacific Indonesia (PT. CPI) is subsidiary of Chevron Corporation, 2nd world largest Oil & Gas Company. To support its operation, a major number of equipment and facilities have been operating. After more than 30 years of operation, nowadays PT. CPI was entering mature phase of operation. Risk to keep operating the equipment and facility is growing up rapidly. The risk can affect to worker, environment, company's reputation and profit, etc. Realized that condition, managing the integrity of these aging assets have become a critical attention to lower the risk. Starting in 2007, Chevron Corporate introduces an initiative called Asset Integrity Management System (AIMS) a part of Surface Equipment Reliability & Integrity Program (SERIP). Adopting a well-known "Swiss Cheese" concept, PT. CPI had been working to strengthen the all four basic safeguards concepts to prevent realisation of risk/hazard. Those four concepts are:

1. Prevent,
2. Detect,
3. Control
4. Mitigate

In the early days, most of the efforts still focused on mitigation or curative action to battle common integrity's enemies such as corosions, erosions and mechanical failures. Recently, after few years of journey, the efforts slowly shifting from curative to preventive action along with latest rapid outgrowth of technology in the inspection/detection.

**Findings** - Historical data record shows that by consistently implementing AIMS Chevron successfully reduced incident (oil spill) caused by integrity problems (corosions, erosions and mechanical failures) from 212 events in early 2003 to be 14 events in late 2013. Implementation of AIMS have truly assisted PT. CPI to sustain world class company.

**Research limitations / implications:** Future research could consider benchmarking to other oil & gas companies and may cover a wider range of industry types.

**Original/Value** – This paper presents an original and novel approach of Asset Integrity Management System (AIMS) to manage integrity of asset in Indonesia's biggest oil & gas company PT. Chevron Pacific Indonesia.

**Key words:** Asset Integrity Management System (AIMS), Surface Equipment Reliability & Integrity Program (SERIP).

**Research Type:** Research paper

## 1. Introduction

Asset integrity nowadays is considered as one important element to improve productivity in oil and gas production facilities (production, refining, and distribution). In the development, asset integrity arises from technical issue (maintenance, inspection, engineering assessment) to a higher level of corporate management policy.

### Asset Integrity

Asset Integrity is the ability of an asset to performs its required function effectively and efficiently while protecting health, safety environment, and the asset.

### Asset Integrity Management (AIMS)

Asset Integrity Management System (AIMS) is the systematic implementation of activities such as inspection, tests and maintenance task necessary to ensure that important equipment will be suitable for intended application throughout its service life.

### Asset Integrity Management builds on existing Reliability Efforts

- Focused on high consequence events - consequences of failure are unacceptable.
- Applies a layer of **rigor and governance** to ensure the integrity program is being executed as planned and that variations from the plan are appropriately addressed.

## 2. Historical Background: Lack of Asset Integrity

### 2.1. Flexible Riser Failure

Failure of the flexible riser caused a major fire and resulted in several fatalities. Plugged vent ports located on the topside end of flexible riser led to a buildup in pressure inside the annulus, leading up to rupture to the outer sheath above the high tide water line. Repairs to the riser were performed by an uncertified contractor to repair previous damage. Corrosion of internal and external armor wires in the outer sheath location compromised the load carry capacity of the riser resulting in local bending, torsion loading, and local pipe elongation. Pipe elongation resulted in an increase in armor pitch, unlocking the pressure armor of the riser, followed by rupture of the pressure sheath and subsequent gas release until ignition occurred from an external source.



Figure 1. Flexible Riser Failure Incident

## 2.2. Disaster in the North Sea

The ill-maintained and overloaded North Sea oil rig, Piper Alpha, was destroyed in a fire which also killed scores of workers. Leaking gas on the Occidental Oil drilling platform ignited late in the evening of July 6, 1988, causing a devastating blaze in which 167 of 226 men on board perished. Many of the oil workers jumped 100ft (30m) into the sea to escape the fire and toxic fumes, despite being told their jump would almost certainly be fatal. Total insured loss was about £1.7 billion (US\$3.4 billion). It is still the world's worst-ever offshore oil disaster.

The Cullen Enquiry was set up in November 1988 to establish the cause of the disaster. In November 1990, it concluded that the initial condensate leak was the result of maintenance work being carried out simultaneously on a pump and related safety valve. The enquiry was critical of Piper Alpha's operator, Occidental, which was found guilty of having inadequate maintenance and safety procedures.

There are two (2) condensate pumps. Pump a was in repair (its pressure safety valve). PSVS take out and closed by blind flange – hand tightening). The working hour has ended, as usual the crew change shift, unfortunately communication with next crew was not good enough there is no good hand over. Due to some reason the next crew started the pump with PSV and gas leak from PSV line. Initial explosion caused by leakage of natural gas condensate beneath the platform (due to un perfect work and communication of maintenance team – pump repair and related safety valve). It resulted ignition secondary oil fire and melting of upstream gas pipeline.



Figure 2. Piper Alpha Incident

### 3. Research Methodology

#### 3.1. AIMS Framework

As a management process, AIMS process shall include policy development; organizing; planning and implementation; measuring performance; and audit and review. AIMS elements shall be in accordance to company Quality or HES Policies. Policies based AIMS has already been implemented by several oil and gas operators all over the world.

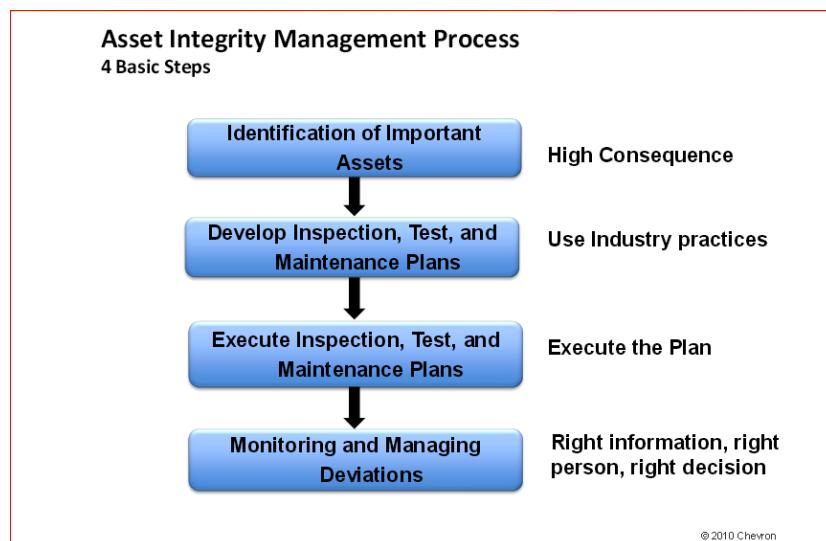


Figure 3. Asset Integrity Management Process

Asset Integrity Toolkit is a guideline to develop AIMS for offshore production facilities. It was published in 2006, developed by a joint industry project between UK Offshore Operators Association (UKOOA), Step Change in Safety, and The Health and Safety Executive UK.

Asset Integrity Toolkit is also a health and safety based AIMS which is more comprehensive and measurable by several performance indicators that already known well in oil and gas industry. Asset Integrity Toolkit can be proposed as the basis for asset integrity audit for pre-development of asset integrity management system. Asset Integrity Toolkit defines 32 elements of AIMS into 6 six groups as follows:

## **1. Assurance and Verification;**

Facility Owner shall define safety critical element (SCE) within the facility. SCE is a term in Safety Case (UK Offshore Installation Safety Regulations SI 2005 No 3117) to refer to:

- Parts of an installation and such of its plant or any part thereof, the failure of which could cause or contribute substantially to a major accident; or
- A purpose of which is to prevent or limit the effect of a major accident.

The assurance process is the duty holders responsibility to set out an assurance scheme that defines and manages the activities which ensure required performance standards of SCE are sustainable. While the verification process is the duty holders responsibility to develop verification scheme that provides the evidence to demonstrate the assurance scheme is operating effectively. Independent reports and comments shall be able to define clearly SCE list, assurance activities applied to SCE, and any failures and or anomalies are in communication with the duty holders

## **2. Assessment/Control and Monitoring**

The process of assessment/control and monitoring should include the following key elements:

- Rigorous risk assessment of potential major hazards and threats from plant equipment and operations to the personnel, the environment, and the asset;
- Identification necessary mitigation and controls in order to lower each of the risks to a level which is As Low As Reasonably Practical (ALARP);
- Recognition of which of these controls takes the form of SCE and assurance that the associated performance standards are continually maintained. Main issue in this element is engineering integrity. The duty holders should develop strategy to maintain the integrity of plant equipment against mechanical failure, fatigue, corrosion, throughout asset lifecycle.

Activities ruled under this AIMS element are: Asset register (asset information system); Risk Assessment (risk based inspection); Mitigation Plan (repair, replace, re-engineering); Inspection and monitoring (NDT, vibration analysis); and Integrity assessment (fitness for service, defect assessment).

## **3. Competence**

Personnel with the required levels of competence should be supported by commitment of senior management. Duty holders should develop competence system that should: be able to verifiable by audit of training, recruitment process, formal assessment, provides demonstrable capability within their pre-defined and agreed job description, be in accordance with national or equivalent standards, cover third party contractors.

## **4. Planning**

AIMS should be comprehensively planned for successful implementation. The planning and implementation of an Integrity Management System should includes:

- Processes definition required to manage the integrity of asset;
- Resources and Responsibility Allocation;
- Identification performance against the plan;
- Identification SCE should be included;

- Identification business element should be included; and
- Effective prioritization of activities

## 5. Maintenance Management System

Maintenance Management System (MMS) provides the process for managed and control of maintenance program including set of maintenance task and their schedules. Target object of MMS include the following:

- Maintaining the condition, functionality, operability of equipments;
- Reducing failure incidence or mean time between failures, downtime after failures or mean time to repair;
- Reducing critical incidents or near miss accidents;

## 6. Quality and Audit

Quality management and audit should be integrated and aligned in every process embedded in every aspects of asset integrity management through out six lifecycle stages. Quality and audit system as to senior management framework to guide organization toward performance improvement can encompass the four C's of control (defined roles and responsibilities), communication (clear reporting and record keeping), competence (training and supervision), and co-operation (interface management).

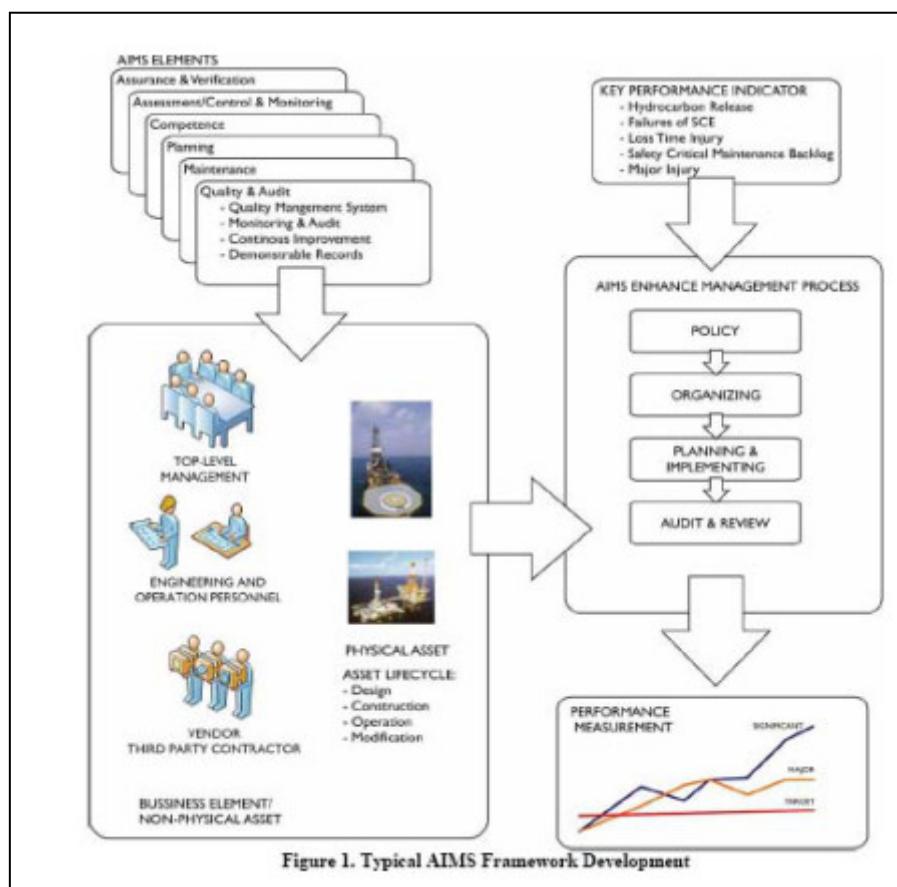


Figure 4. AIMS Framework

### 3.2. Asset Integrity Principles - Swiss Cheese Model

Asset Integrity principles adopt the well-known “Swiss Cheese Model”. With some layers of protection, it is expected that we can prevent the incident happened. Each layer represents a safeguard. Several layers of protection must align or fail at the same time to permit a subsequent, severe or catastrophic incident.

Consistent with the concept of putting ‘first things first’, Asset Integrity Management provides a level of focus and rigor on the most critical equipment. The ‘Barrier Model’ introduces the concept of ‘layers of protection’ to prevent, detect, mitigate & control, and response & recovery to the impact of failures of assets. This approach requires that various processes and systems be in place to protect people, assets, and the environment from a known hazard.

These “barriers” consist of 6 elements as follows: design, construction, and start-up processes; procedures, training and qualifications; process containment and functionality; warning devices; engineered safety devices; and safety equipment.

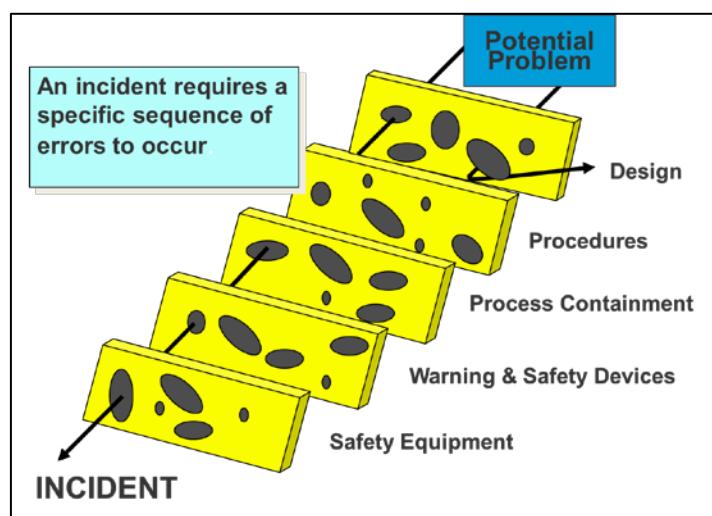


Figure 5. AIMS Principle-Swiss Cheese Model

Example Component of each barriers element are as follows:

Design	Standards, quality control, PSSR
Procedure Training Qualification	SOP, Safe work Practice, safety training
Process Containment	Equipment, structure, machinery, I & C system
Warning devices	Alarm,
Engineered Safety Devices	PSV, ESD, Interlock.
Safety Equipment	Personal Protective Equipment (PPE)

### 3.3. Intercorrelation AIMS to Other Corporate Process

#### 3.3.1. AIMS related to OE

Correlation AIMS with Corporate Process called Operational Excellence Management System (OEMS) start from quote of Element 5, Reliability Expectations 5.1 – 5.7, which states: Organizations are expected to “Operate and maintain wells and facilities to ensure asset integrity and prevent incidents.”

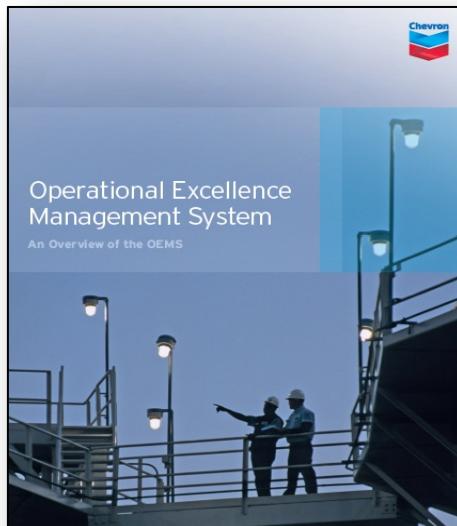


Figure 6. Chevron OEMS

#### 3.3.2. AIMS related to SERIP

In PT. CPI, AIMS is a sub process of another bigger Chevron's Process called Surface Equipment Reliability and Integrity Process (SERIP). AIMS is covered in Stages 3, 4 and 5. Until now, most Business Units are in SERIP stage 1 or 2.



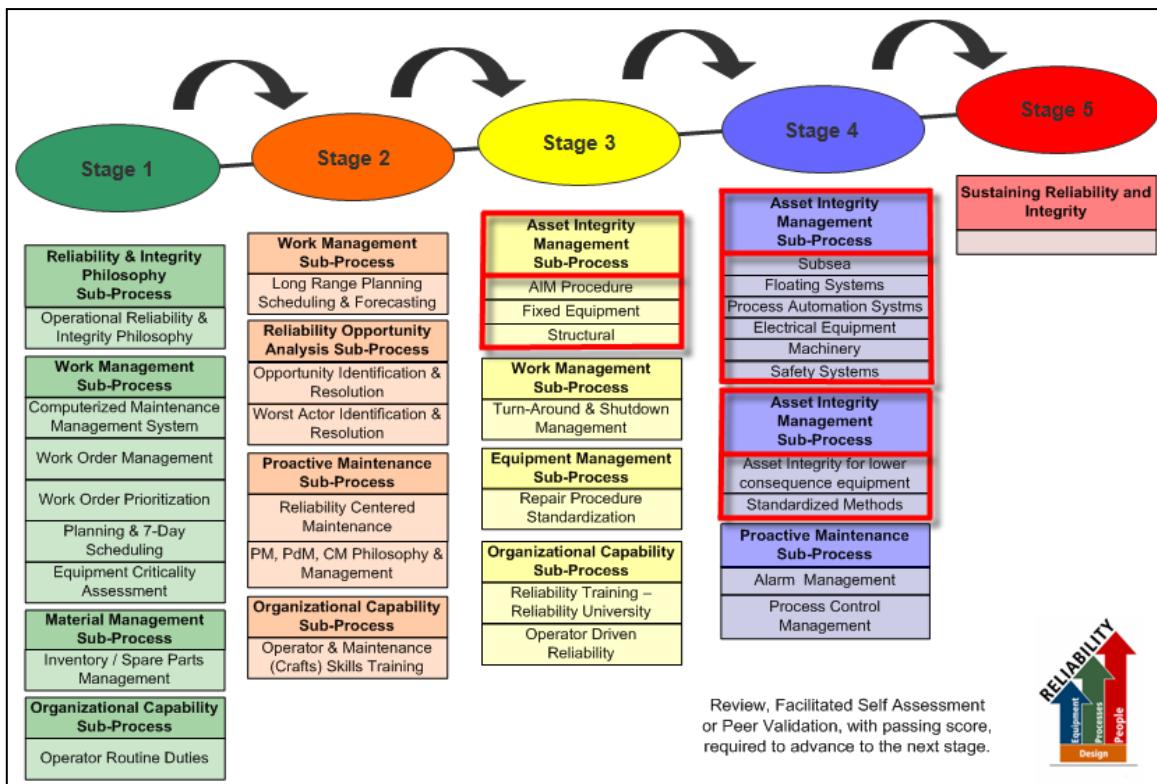


Figure 7. Chevron SERIP

The SERIP Asset Integrity Process only focuses on the last three (3) element barriers (i.e., process containment and functionality; warning devices; engineered safety devices; and safety equipment). The first two (2) barriers (i.e., design, construction, and start-up processes; and procedures, training and qualification) are included in different process called Chevron Project Development and Execution Process (CPDEP). CPDEP process is out of scope in this paper.

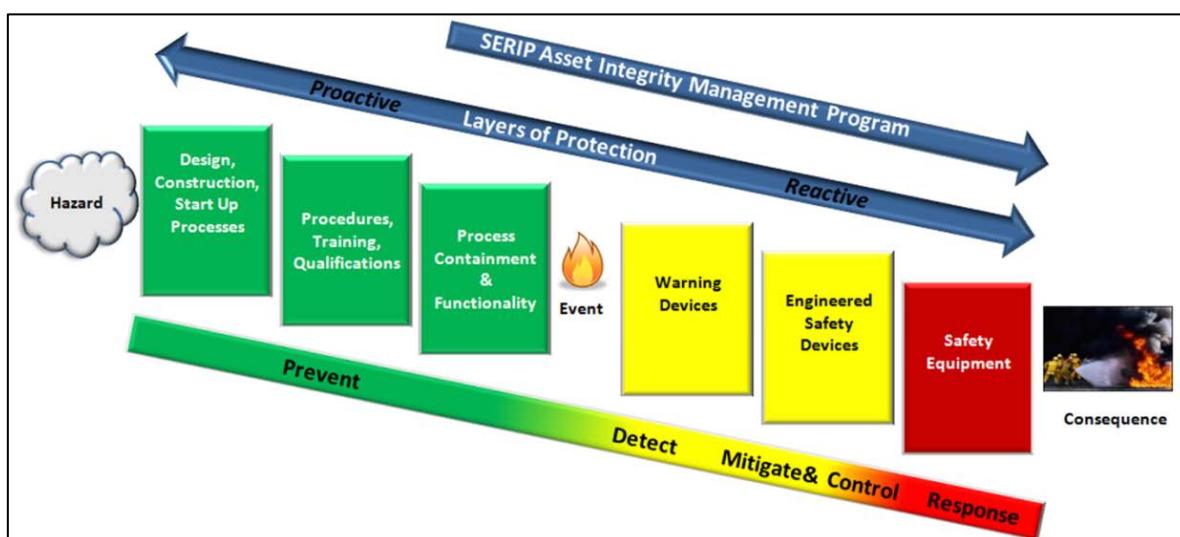


Figure 8. SERIP Process

### 3.3.3. AIMS related to Corporate Required Standard for Asset Integrity

The Corporate Required Standard for Asset Integrity was issued in 2010 along with three other Corporate Standards (Operating Procedures, Codes & Standards, and Process Safety Information) to improve the definition of minimum corporate requirements and strengthen overall. AIMS tied also to corporate required standard of AI.

Chevron Corporate Required Standard for Asset Integrity Issued January 2010 intened to be the correlation bridge and gaps filler, between AIMS and several Chevron process.

Chevron Corporate Required Standard for Asset Integrity Issued January 2010 contains 6 major areas as follows:

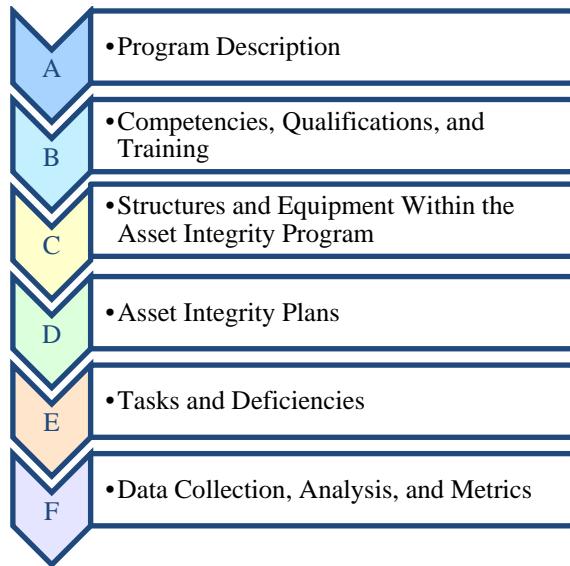


Figure.9. Major Areas of Corporate Required Standard for Asset Integrity

### 3.3.4. AIMS related to Tenets

AIMS also tied to tenet operation. Some tenets that align with AIM are highlighted with the red color: there are 6 tenets related with AIMS

- The Tenets of Operation are based on two key principles:
  1. **Do it safely or not at all.**
  2. **There is always time to do it right.**
- Tenets of Operation:
  1. **Always operate within design and environmental limits.**
  2. **Always operate in a safe and controlled condition.**
  3. **Always ensure safety devices are in place and functioning.**
  4. Always follow safe work practices and procedures.
  5. Always meet or exceed customer's requirements.
  6. **Always maintain integrity of dedicated systems.**
  7. Always comply with all applicable rules and regulations.
  8. **Always address abnormal conditions.**
  9. Always follow written procedures for high-risk or unusual situations.
  10. **Always involve the right people in decisions that affect procedures and equipment.**

### 3.3.5. Diagram of AIMS related to All Chevron Process

As per described above, AIMS has strong correlation with all other Chevron Process (**OEMS**, **SERIP**, **Tenets**, **Corporate Required Standard for Asset Integrity** . The correlation of can be figured out in a diagram as follows:

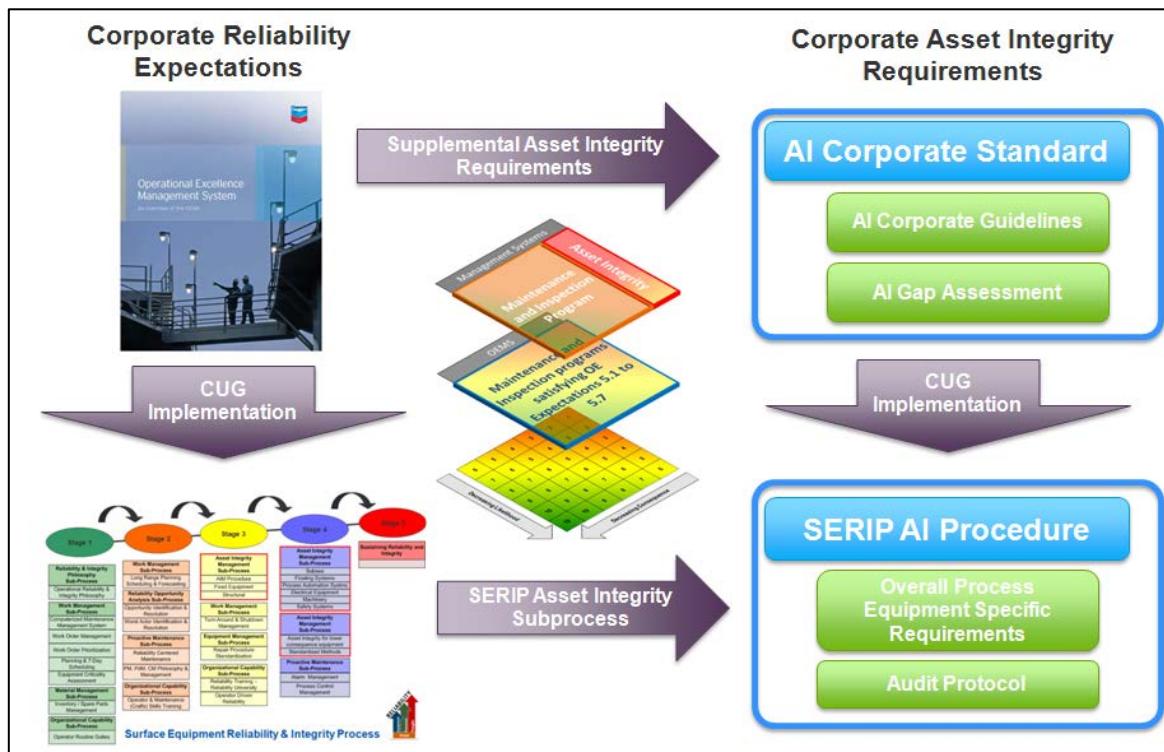


Figure 10. Correlation AIMS with All other Chevron Process

## 4. Research Finding in PT. CPI

### 4.1 Chevron AIMS Shaping Plan

#### - SERIP Stage 3 - AIM Phase 1 (2011-2013)

Baseline procedures are applicable to the entire Asset Integrity Management System (AIMS). Specific procedures applicable to **fixed equipment and critical structures**. Focus on equipment that prevents Health, Safety, Environment, or Asset consequences of 1 or 2 from being realized.

#### - SERIP Stage 4 - AIM Phase 2 (2013-2015)

Specific procedures applicable to **machinery, electrical equipment and power systems, instrumentation and control systems, safety systems including fire fighting and fire suppression, subsea systems/equipment, and floating systems** . Focus on equipment that prevents Health, Safety, Environment, or Asset consequences of 1 or 2 from being realized.

#### - SERIP Stage 5 –AIM Phase 3 (2015+)

Expanding the focus to **all** equipment, defining Technical Authorities, standardize methods, and establish mature Communities of Practice (COP). Escalation/Governance only applies equipment that prevents Health, Safety, Environment, or Asset consequences of 1 or 2 from being realized.

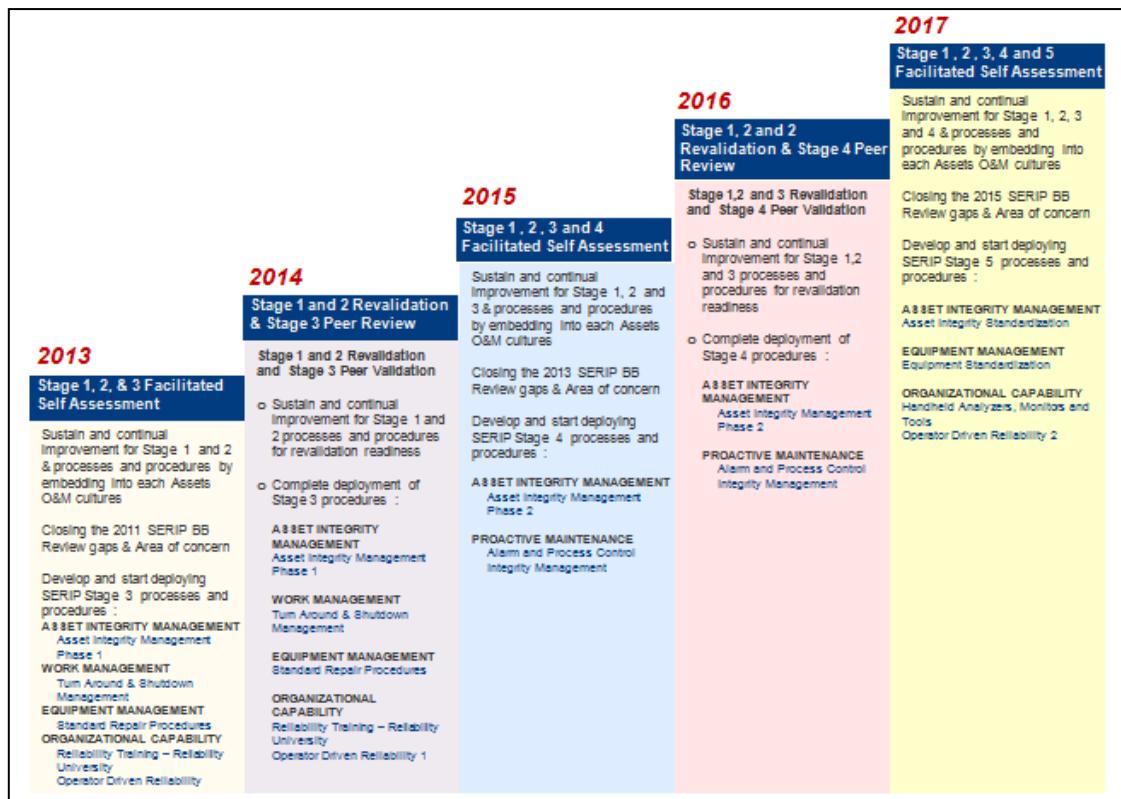


Figure 11. AIMS Roadmap

## 4.2 Measuring AIMS Implementation in PT. CPI

Measurement of AIMS implementation in PT. CPI is divided into two (2) metric types, as follows:

### 1. Implementation Metrics

- Percent of initial integrity analysis completed
- Number of Integrity Critical Assets Identified
- Percent of Integrity Critical Assets identified that have integrity plans in place

### 2. Execution Metrics

- Integrity Plan compliance – monthly metric
  - ✓ Percent compliance - Number of Integrity Critical tasks completed in a calendar month / number of Integrity Critical Tasks that were due in that month
  - ✓ Number of Integrity Critical Tasks that are past the due dates the Escalation process is required and average numbers of days the tasks are overdue.
- Number of non-conformances opened in the month.
- Average age of work orders generated against integrity critical tasks (validate we fix what we find in a timely manner).
- Number of temporary repairs in place and average age of open temporary repairs.
- Number of open items on the Integrity Issue Log.
- Number of reported incidents on Integrity Critical Assets (monthly reporting with an annual total).



**SLS - Asset Integrity Management Metric 2013**



No.	Measures	Asset Month	SLS											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Implementation Metric	Percent of initial integrity analysis completed	94%	94%	94%	94%	94%	100%						
2		Number of Integrity Critical Assets Identified	68	68	68	68	68	68						
3		Percent of Integrity Critical Assets identified that have integrity plans in place	100%	100%	100%	100%	100%	100%						
4	Execution Metric - Integrity Plan	Integrity Plan compliance - Monthly Metric												
4A		Percent of Compliance - Number of Integrity Critical tasks completed in a calendar month / number of Integrity Critical Tasks that were due in that month	95%	95%	95%	95%	98%	100%						
4B		Number of Integrity Critical Tasks that are past the due dates the Escalation process is required and average numbers of days the tasks are overdue.	0	0	1	0	0	0						
4C		Number of nonconformances opened in the month.	1	0	1	0	0	0						
5	Execution Metric - Managing Integrity	Average age of work orders generated against integrity critical tasks	5	2	2	3	8	6						
6		Number of temporary repairs in place and average age of open temporary repairs	5	2	1	2	0	1						
7		Number of open items on the Integrity Issue Log	0	1	1	0	0	0						
8		Number of reported incidents on Integrity Critical Assets	0	0	0	0	0	0						
9	Other Metric	Certification Compliance	82%	82%	82%	82%	82%	82%						

Figure 12. AIMS Metrics

Above metric was measured through highlight activities as follows::

- Established IBU AIM Procedure Development with IBU Task Force Team
- Complete initial integrity analysis for fixed equipment & Structure
- Complete Integrity Plan (ITPM Planning & Scheduling) for Integrity Critical Equipment (IC1/IC2 Equipment)
- Centralized Integrity Database Management system into AIM Software Visions Metegrity (IC1-2)
- Implement Non Conformance Process for managing any deviation from Integrity Plans
- Complete Integrity task procedures on ITPM Plan & define acceptance criteria
- Tracking, Update, Monitoring & Evaluate AIM Program into SLS AIM Metrics for item below:
  - Integrity Plan compliance
  - NCR management & Integrity issue
  - Temporary repair monitoring
  - Inspection & Certification Program Monitoring
  - Inspection finding follow up monitoring

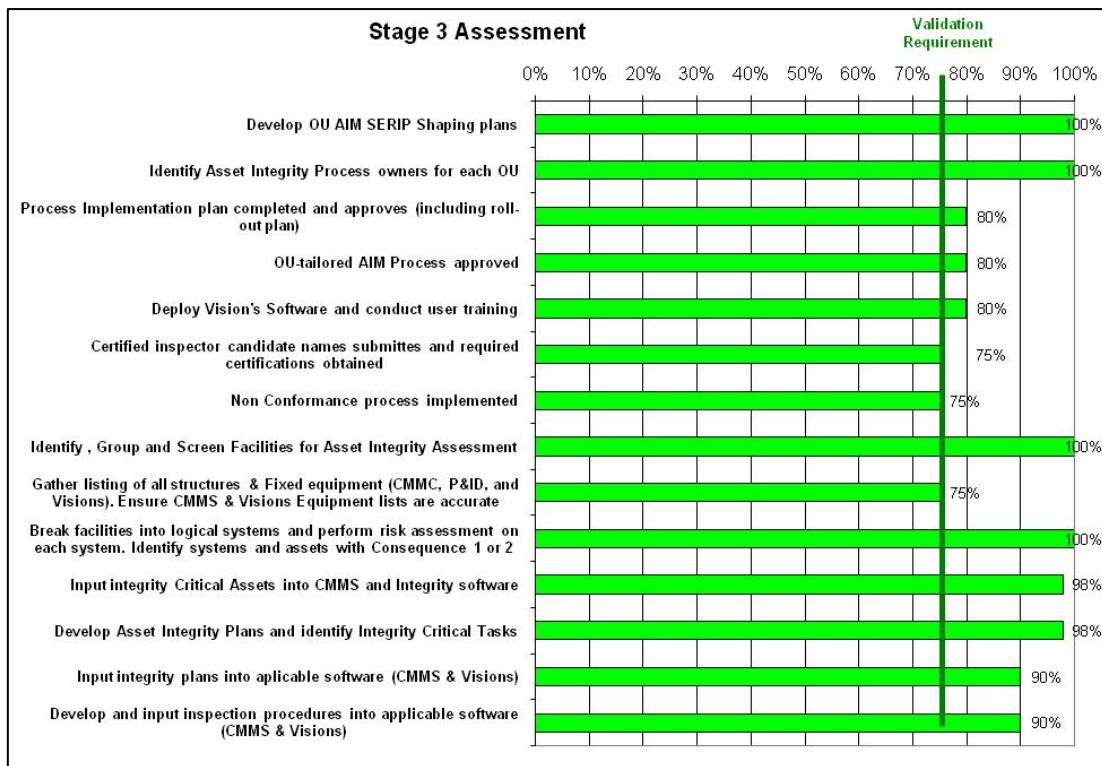


Figure 13. AIMS Detail Stage 3 Metric

PT. CPI has successfully developed a comprehensive pipeline inspection dataset for its asset as shown in the figure below, consists of red category that indicates most criticality integrity, yellow indicates medium criticality integrity and green indicates acceptable integrity condition, as follows:

- 4,127 anomaly spots indicate red category
- 21,983 anomaly spots indicate yellow category
- 140,080 anomaly spots indicate green category

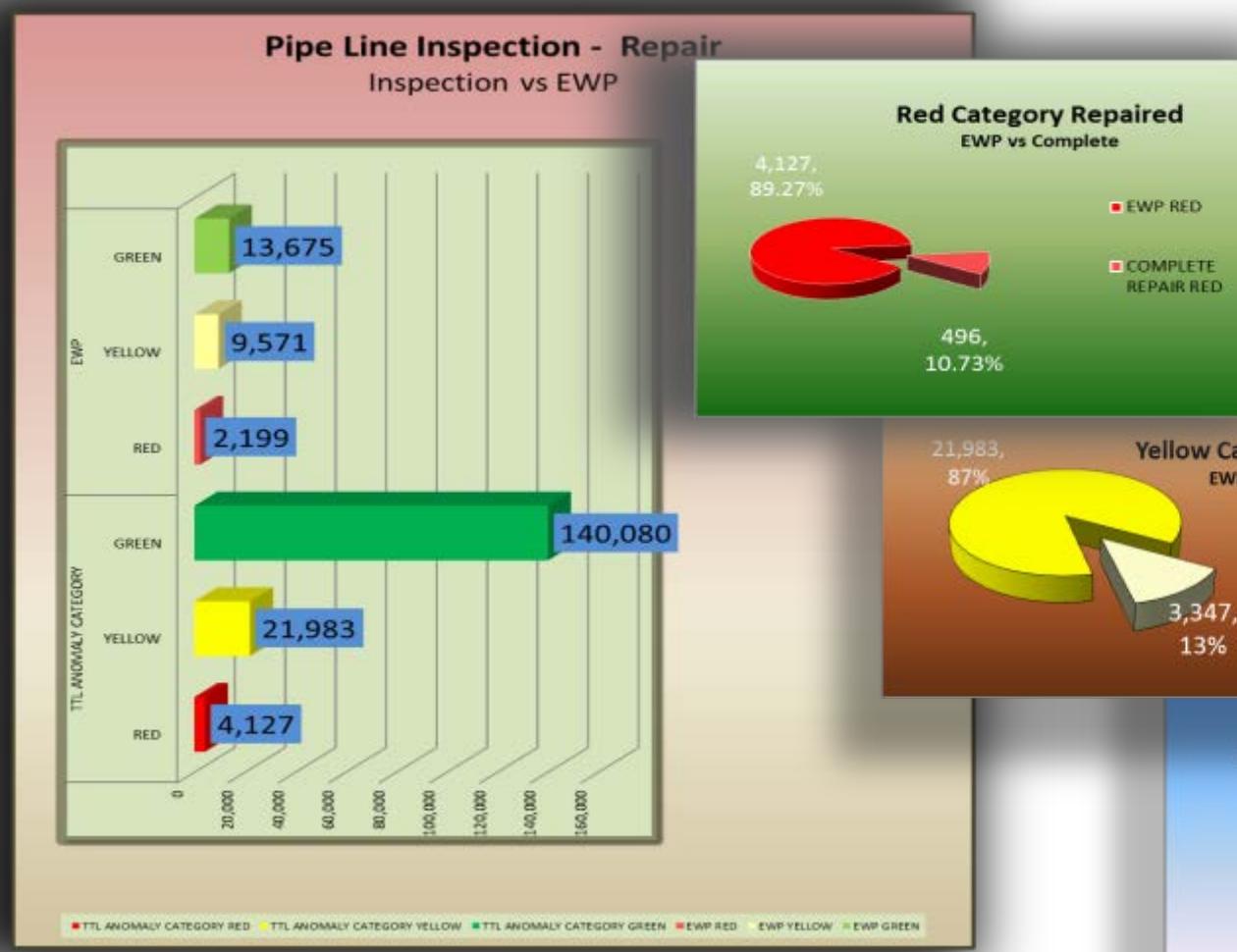


Figure 14. Pipeline Inspection Database

Historical data record shows that by consistently implementing AIMS, PT. CPI successfully reduced incident (oil spill) caused by integrity problems (corrosions, erosions and mechanical failures) from 212 events in early 2003 to be 14 events in late 2013.

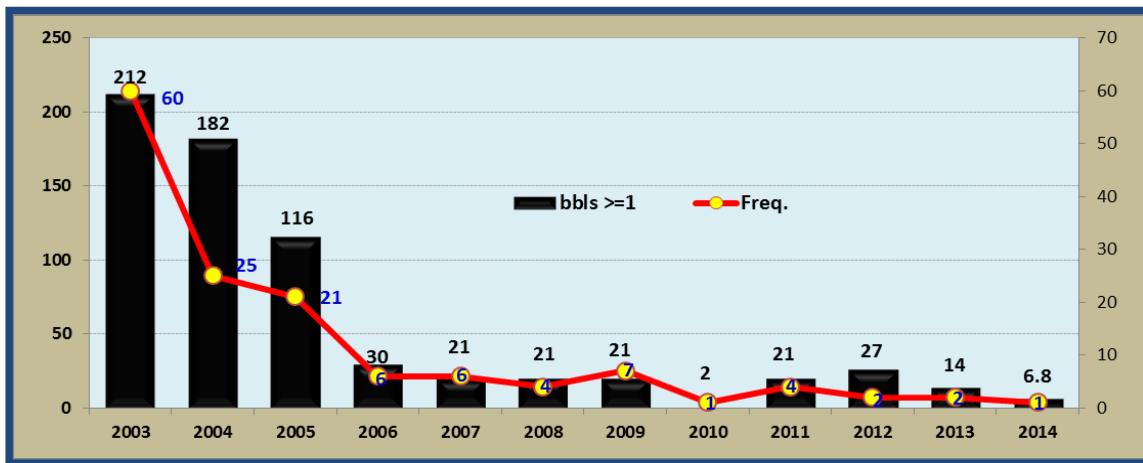


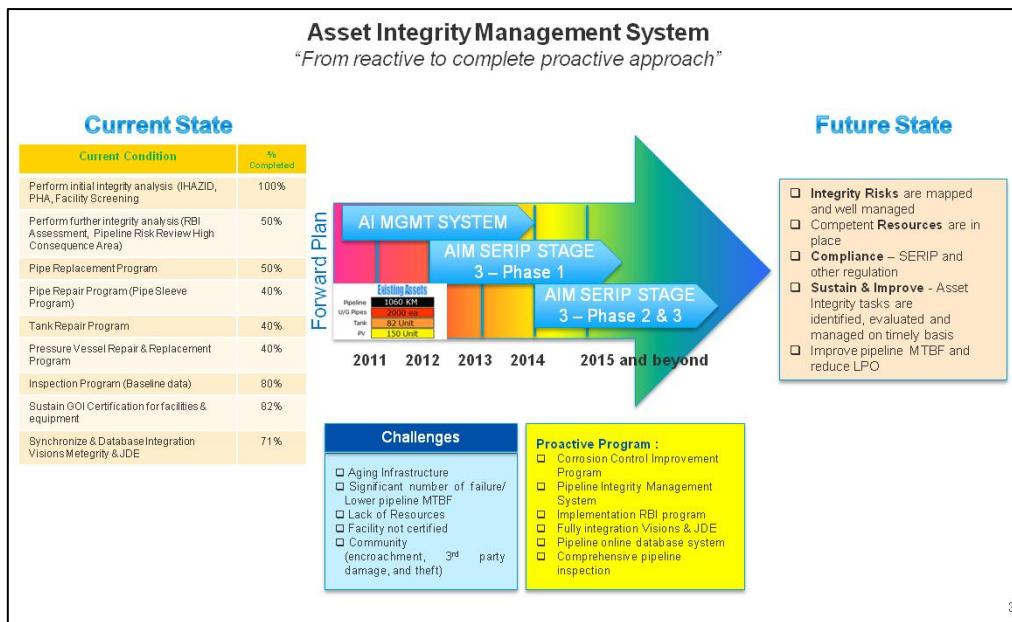
Figure 15. Data tumpahan minyak (oil spill record) lebih dari 1 bbls

## 5. Conclusions

The key features of the AIMS program in PT. CPI are the detailed failure history, design reappraisal, practically balanced risk prioritization, focused inspection and extended verification. The methodology could if used as intended, provide the concerted effort to make a major difference in supporting deepwater developments, in particular where hazop, safety, environmental and financial margins are tight.

The methodology will ensure that corrosion prevention and control is well addressed, and that practical fit for purpose solutions are planned, and less reactive further down the line. The AIMS process can be constructively applied to structures, pipelines, subsea developments, topsides facilities, specific equipment or can be directed at selective failure investigations or mechanisms.

The principles apply to new and existing facilities, the strategy and matrix generation should focus attention to urgent and high risk areas of safety critical items only, thus streamlining effort. Close adherence to the loop will ensure that practical, theoretical and empirical judgments tend to converge with re-iteration. Ultimately sanctioning the target of zero corrosion surprises. Consistently implementation of AIMS have support PT. CPI to sustain its world class performance.



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Figure 16. Asset Integrity State

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