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Risk Based Verification (RBV) and its role in Asset Integrity Management

MINISTRY OF ENERGY
AND ENERGY INDUSTRIES

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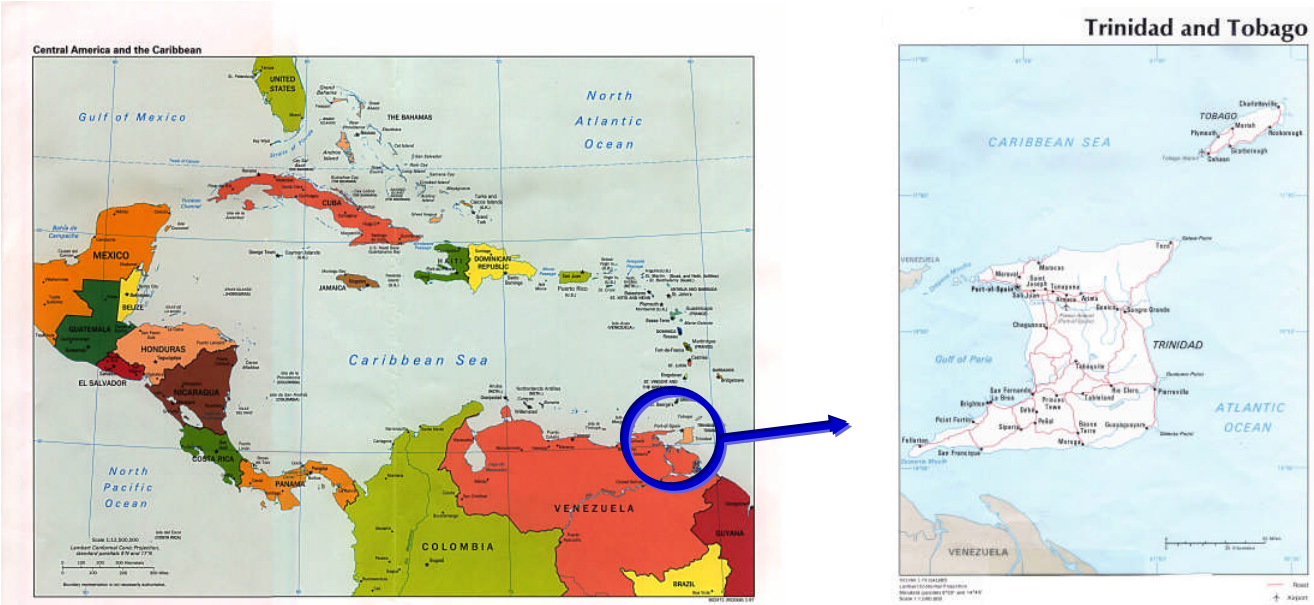
OBJECTIVE

- **Review how Trinidad and Tobago is applying Verification Scheme as a HSE asset integrity management tool for establishing "Fit-for-Purpose" assurances on offshore oil and gas assets.**

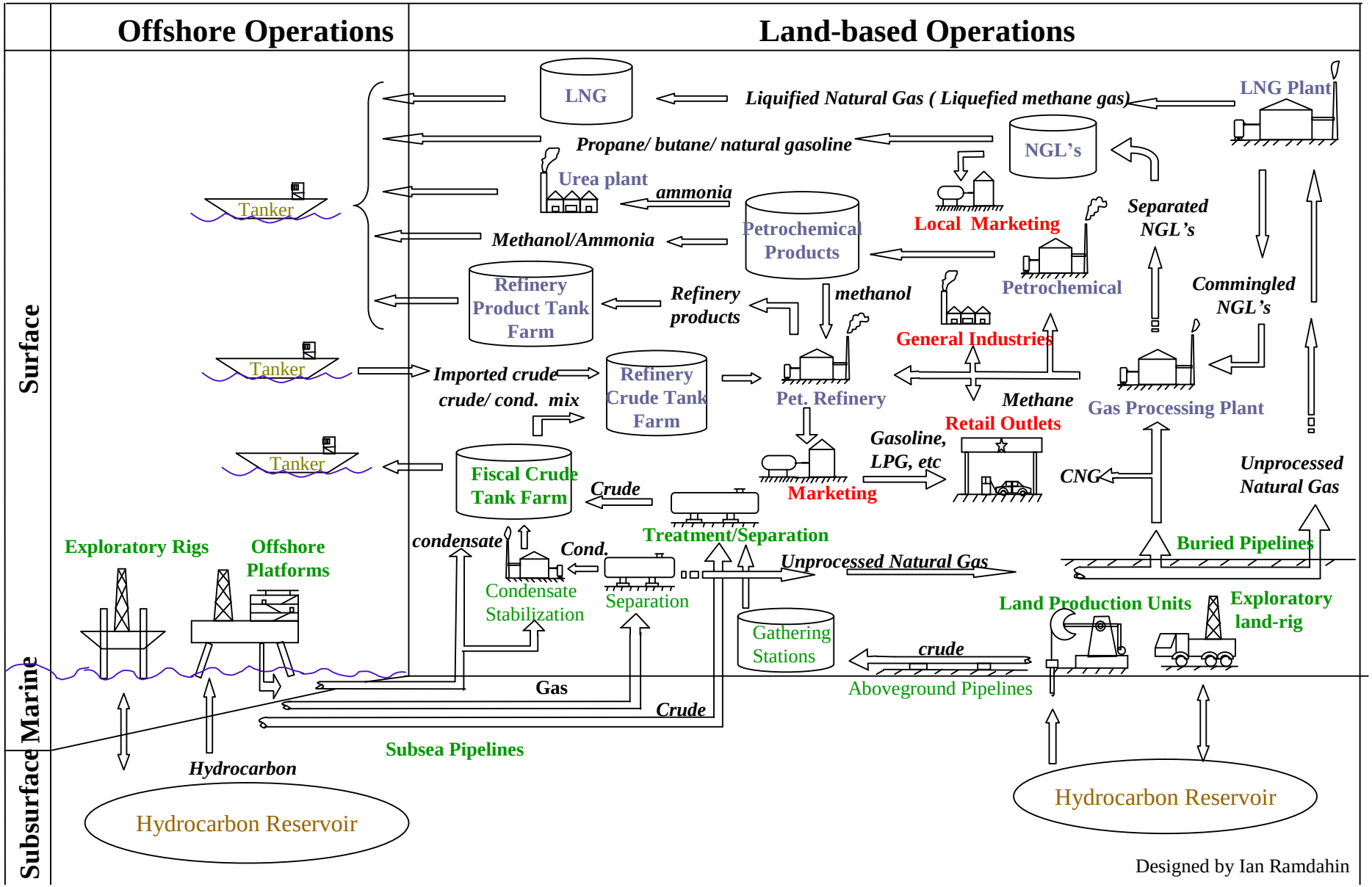
Disclaimer: ***Sample photos shown on asset integrity are purely for illustration purposes for this conference only and does not depict the general status of offshore structures in Trinidad and Tobago.***

TRINIDAD AND TOBAGO



- **Trinidad and Tobago (T&T) is located at the lower end of the Caribbean chain of islands, with a combined population of approx 1.3 million people.**
- **Energy sector of T&T**
  - **over 100 yrs old (crude production started in 1908 and 1st refinery established in 1912)**
  - **accounts for more than 45% of GDP**
  - **critical to the economic stability and prosperity of T&T**

STRUCTURE OF THE ENERGY INDUSTRY OF TRINIDAD AND TOBAGO



Designed by Ian Ramdahin

ASSETS THAT MAKE UP THE ENERGY SECTOR OF TRINIDAD &TOBAGO

Exploration & Production:

- Drilling Rigs
- Wells
- Oil and Gas Production Facilities (onshore, offshore and sub-sea)

Transportation Network:

- Pipelines
- Road Tank Wagons
- Shuttle Tankers

Mid Stream Processing/Refining :

- Crude Oil Refineries
- Gas Treatment and Conditioning

End Stream Manufacturing:

- Petrochemicals
- Gas liquefaction

Retail & Marketing:

- LPG Bottling
- Service Stations
- Bunkering

ASSET INTEGRITY - T&T EXPERIENCE

Historically, Trinidad has inherited a legacy of pollution problems from early onshore oil and gas practices, much of which can be attributed to Asset Integrity problems such as:

- **improper planning and design,**
- **inappropriate materials of construction,**
- **lack of adequate maintenance programmes**
- **inaction to rectify deficiencies in a timely manner,**



ASSET INTEGRITY - T&T EXPERIENCE

- continuous operations of systems without proper checks for degradation over time
- not adjusting the operating envelope of systems that have udergone degradation
- Selective approach towards maintaining integrity of certain assets (bias towards operability while HSE loss prevention/control equipment ignored).
- Inadequate document management - records, design drawings, etc
- Inadequate capital to undertake necessary repairs, surveillance and m'tce
- Absence of performance benchmarks for providing guidance on when to take action or suspend operations of the asset
- Reuse of components affected by fire
- Contracted equipment kept in poor state
- Risk Assessment practices generally lacking
- etc.

PRESENT DAY SITUATION

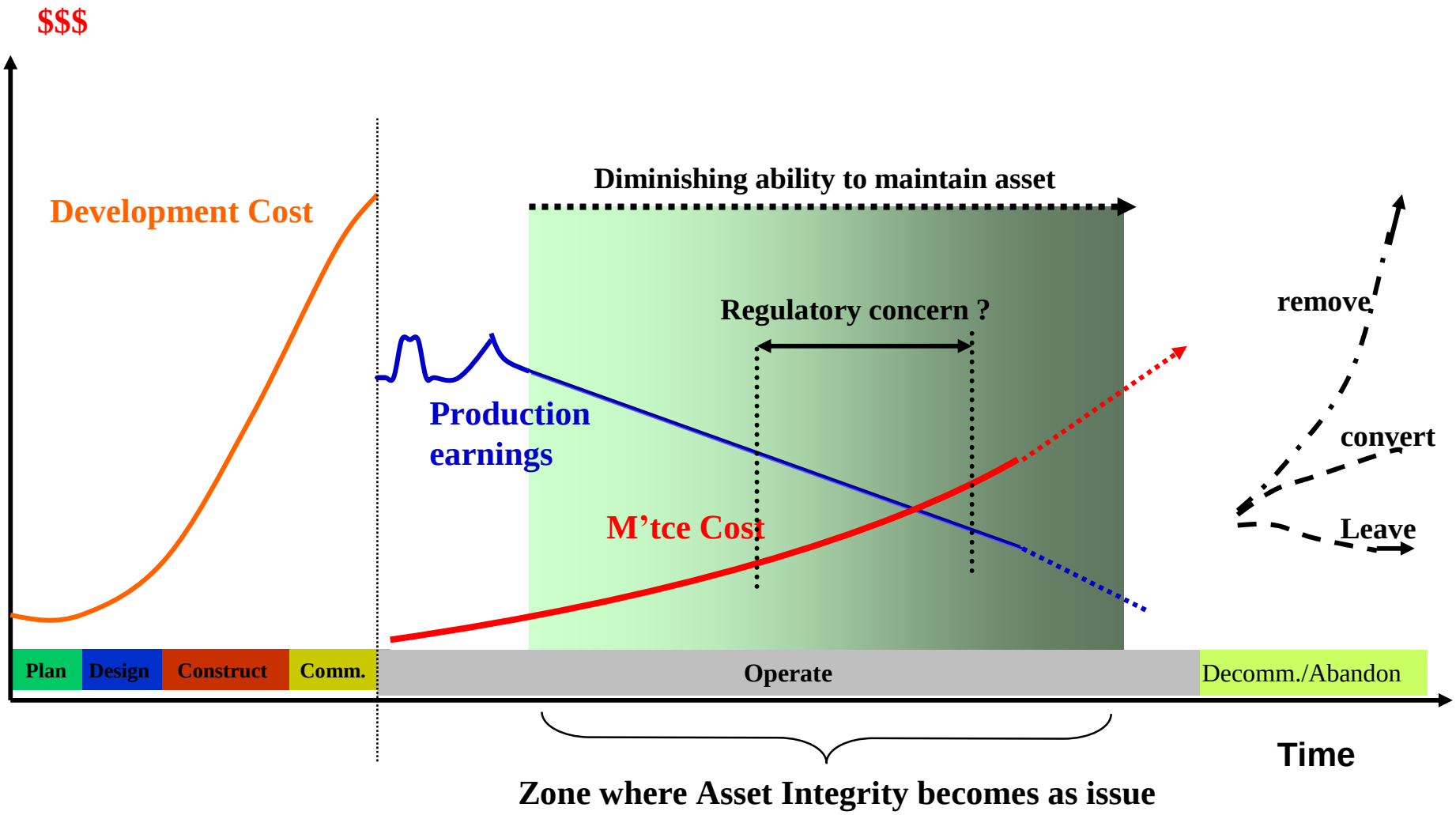
- **Asset integrity problems are not restricted to the past**

- **Same problems keep reappearing in recent times**

- **Questions to be answered**
  - **Why have the integrity management programmes of companies lapsed?**
  - **Effectiveness of regulatory controls?**

ASSET INTEGRITY

- AVAILABILITY OF FINANCIAL RESOURCES



ASSET INTEGRITY

– ENGINEERING OVERSIGHTS

- **Tank wagon made contact with pump emergency shutdown while reversing.**
  - **oversight in not stalling barriers**

- **Coastal bunkering facility, foundation settlement of recaimed and backfilled land causing the bundwalls to crack.**

ASSET INTEGRITY

– ENGINEERING OVERSIGHTS

- Engineering oversight in site selection, concern with slope failure of adjacent hill
- External environment influencing the fate of asset integrity

ASSET INTEGRITY

– RESULTS WHEN NOT PROPERLY MANAGED

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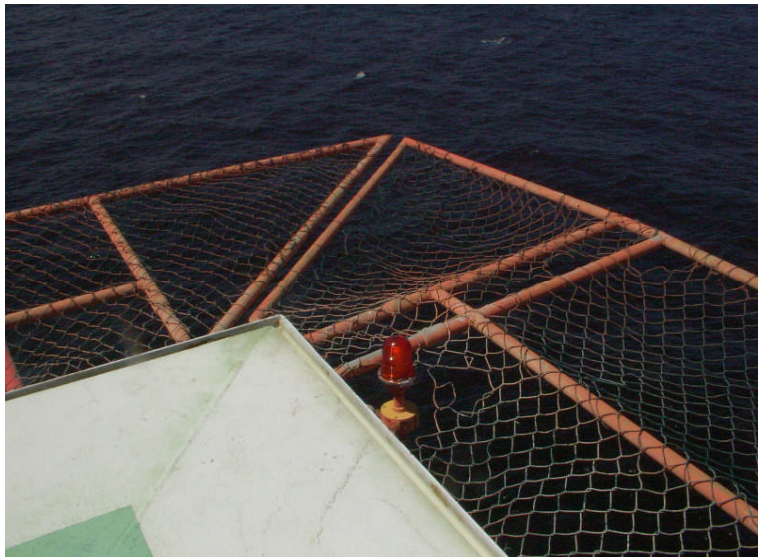


WHEN ASSET IS NOT RIGHT FOR THE TYPE OF SERVICE

Failure of 'illegal' CNG storage cylinder – body of cylinder became an airborne projectile

ASSET INTEGRITY

-LOCALIZED FAILURE

Relatively new pipeline (6 yr of service) failing at HDD section due to damages sustained to coating during HDD pull and subsequent localized corrosion.

ASSET INTEGRITY

- THIRD PARTY ACTIVITIES

- **New pipeline project undermining the foundation of a neighbouring pipeline and places it at risk due to potential of it to be pulled apart should slope slippage occur.**

ASSET INTEGRITY

- CONTRACTED SERVICES

Fire engulfing a contracted Road Tank Wagon transporting condensate

ASSET INTEGRITY – OFFSHORE SECTOR

- **Today, the oil and gas offshore sector of T&T has over taken the onshore sector, and given its importance to the national economy it means that every effort has to be made to prevent the recurrence of asset integrity problems of the past.**

- **This is easier said than done because management of asset integrity is still an ongoing problem, as evident from:**
  - **inspection/audits findings**
  - **accidents and incidents**

- **Failure to manage the intergity of oil and gas assets introduce risks that can cause**
  - **Harm to people**
  - **Damage to property**
  - **Pollution and other deletrious effects on the environment**
  - **Disruption to business continuity and productivity loss**
  - **Wastage of energy resources**

ASSET INTEGRITY – T&T's CHALLENGE

- **Legal framework give MEEI the responsibility to determine whether on not to "suspend or terminate" the operations of assets in the energy sector of T&T, based on concerns over deteriorated integrity.**

- **Making such a judgement is not an easy task – political, socio-economic implications,etc.**

- **Some offshore assets in question are operating beyond the original intended design life and are still producing hydrocarbons for the economic wellbeing of the State.**

- **Some challenges faced :**
  - **Uncertainty on how to properly address the shortcomings in management of asset integrity.**
  - **Varying asset integrity management practices among operators**
  - **Process to determine when to take action against assets with suspect or deterioated integrity.**
  - **Knowing how long an aged infrastructure should be allowed to operate i.e. life extension**

ASSET INTEGRITY – T&T's CHALLENGE

- **In addressing these challenges,**
  - **it has been recognized that proper baseline assessment on asset integrity is required to prove that an asset or facility acceptable for use.**
  - **technical assurances required (*Company to demonstrate vs. Acquired by CVA / ICB for the State*)**

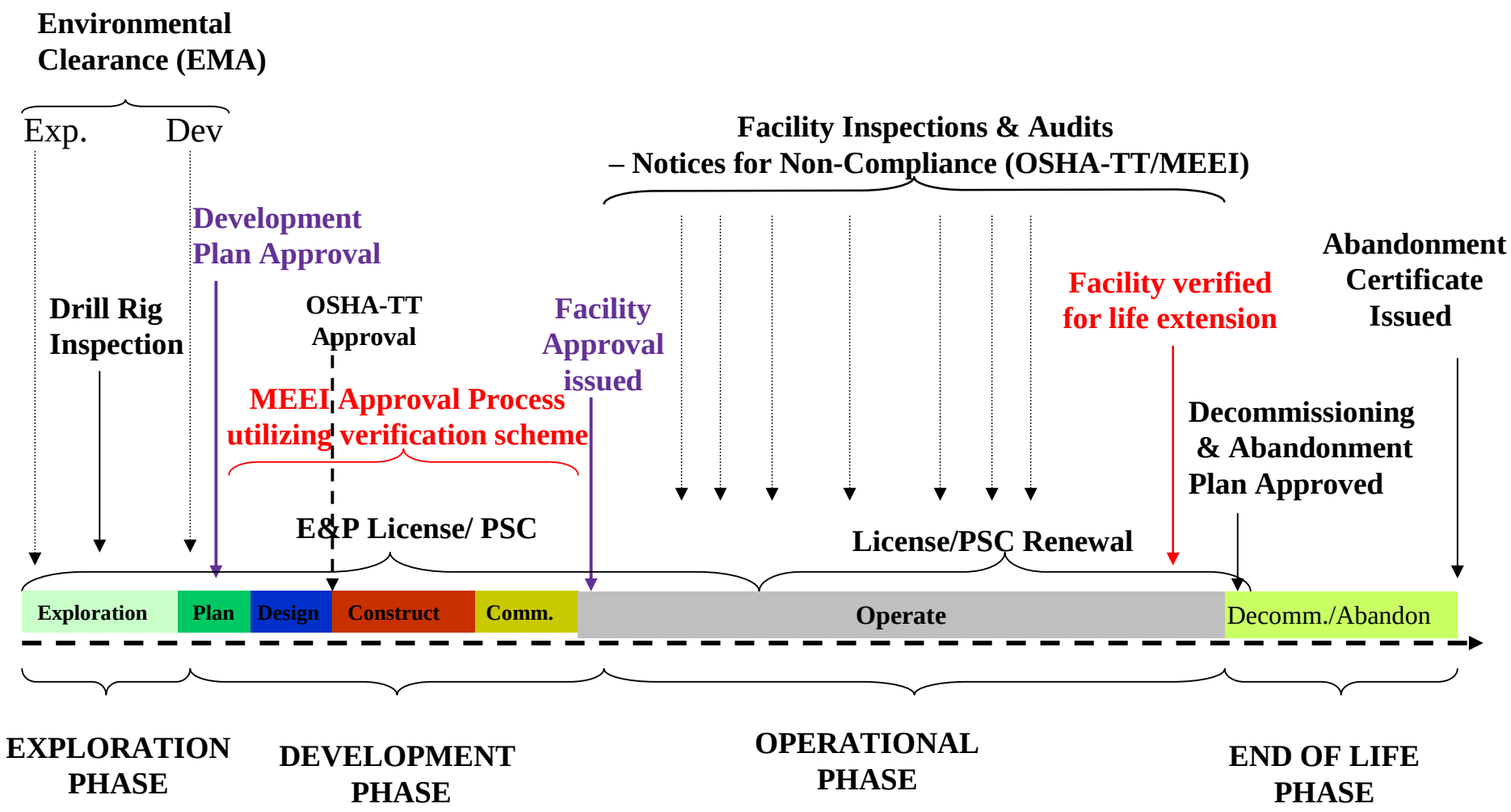
- **"Verification Schemes" utilized to acquire the technical assurances on asset integrity.**

  i.e. **use of independent and competent agents to conduct studies and assessments of assets to determine:**
    - **Ftiness-for-Purpose**
    - **Fitness-for-Continuous Service**

- **TT's legislation empowers MEEI with authority for "supervision and control"**
  - **technical assurances on asset integrity have to be acquired by the State**
  - **However, because the State has inadequate manpower resources, outsourcing of services of Certified Verification Agent (CVA).**

T&T COMPLIANCE FRAMEWORK

– MEEI, EMA, OSHA-TT



REGULATORY CONTROLS OVER THE LIFECYCLE OF A FACILITY

VERIFICATION SCHEMES IN T&T

- **Early 1980's, MEEI was first introduced to the concept of Verification Scheme**
  - **US Geological Survey OCS Order No 8 (MMS)**
  - **Specified requirement for Certified Verification Agent (CVA)**
- **Mid 1990's, first application of verification scheme process in T&T.**
  - **Driven by need to confirm the load bearing capabilities of offshore structural platform**
  - **MEEI did not have structural engineers to do the evaluation**
  - **Services of CVAs utilized**
- **April 2003, verification scheme became a requirement for Onshore and Offshore Pipeline projects.**
  - **applied to onshore 56" cross country gas transmission pipeline system**

VERIFICATION SCHEMES IN T&T

- **April 2005, verification scheme requirements for Hydrocarbon Production and Processing Facilities**

  - **applied to an onshore slugcatcher facility built at location that encountered problems during the construction phase**

- **In 2006, verification scheme revised based on lessons learned and the DNV's publicly available verification standards.**

INFORMATION FOR SETTING UP A VERIFICATION SCHEME

MEEI's Approval Regime

- **Guide to the MEEI Approval Regime, GD 01**
- **Role of the Certified Verification Agent (CVA) in MEEI's Approval Regime, GD 02**
- **Verification Scheme for Offshore Structures, GD 03**
- **Verification Scheme for Pipeline Systems, GD 04**
- **Verification Scheme for Hydrocarbon Production and Processing Facilities, GD 05**

DNV's Verification Standards (publicly available)
– concept of verification plan adopted by MEEI

- **Risk Based Verification, OSS-300**
- **Hydrocarbon Production Plant, OS-E201**
- **Certification and Verification of Pipelines, OSS-301**
- **Verification of Process Facilities**
- **Verification of Subsea Facilities**
- **Verification, Certification and Classification of Gas Export and Receiving Terminals**

UNDERSTANDING VERIFICATION SCHEMES

- DEFINITIONS

■**BS 4778 Part 2**

Certification – The authoritative act of documenting compliance with requirements.

■**EN 45011**

Certificate of conformity - action by a third party, demonstrating that adequate confidence is provided that a duly identified product, process or service is in conformity with a specified standard or other normative document.

■**BS 8402 1994**

Verification - Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled.

■**DNV**

Verification - An examination to confirm that an activity, a product or a service is in accordance with specified requirements.

■**IEC 61511-1, Section 3.2.92**

Verification - Activity of demonstrating for each phase of the relevant safety life cycle by analysis and/or tests, that, for specific inputs, the outputs meet in all respects the objectives and requirement set for the specific phase.

UNDERSTANDING VERIFICATION SCHEMES

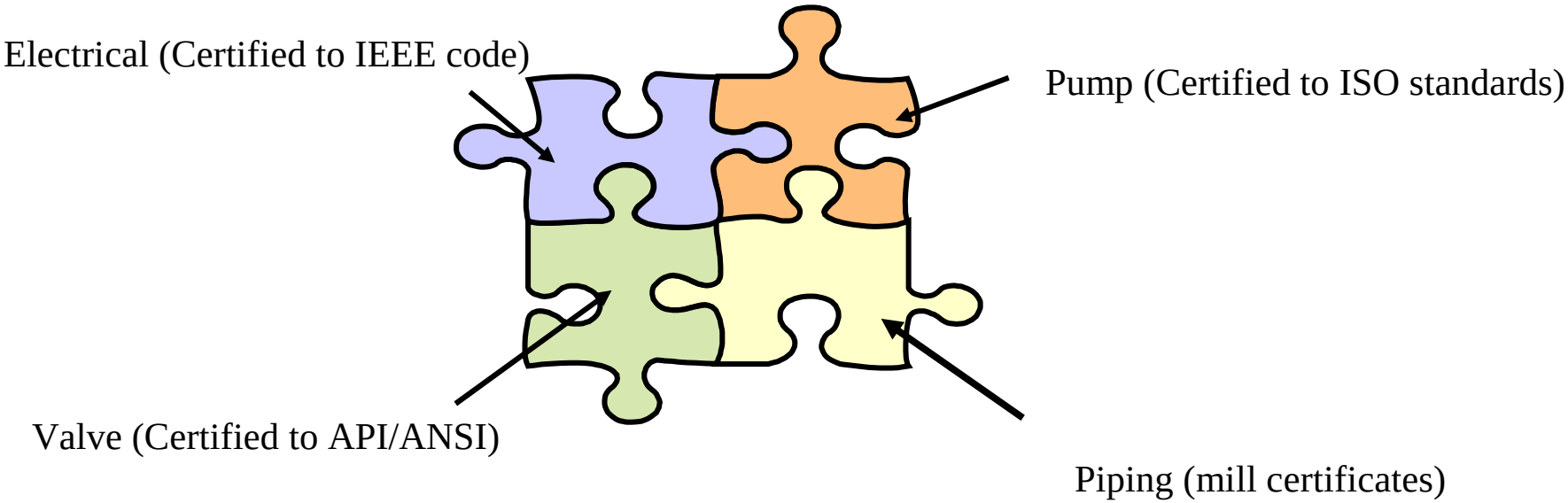
- CERTIFICATION vs VERIFICATION

- **Nearly every component of a facility comes with some form of certification**

- **However, certification by itself is not enough to prove that the asset will be "Fit-for-Purpose"**

- **Certification does not fully address all risk management issues**

- **Integration of certified components can result in many different configurations– verification is utilized to determine which configurations are acceptable.**

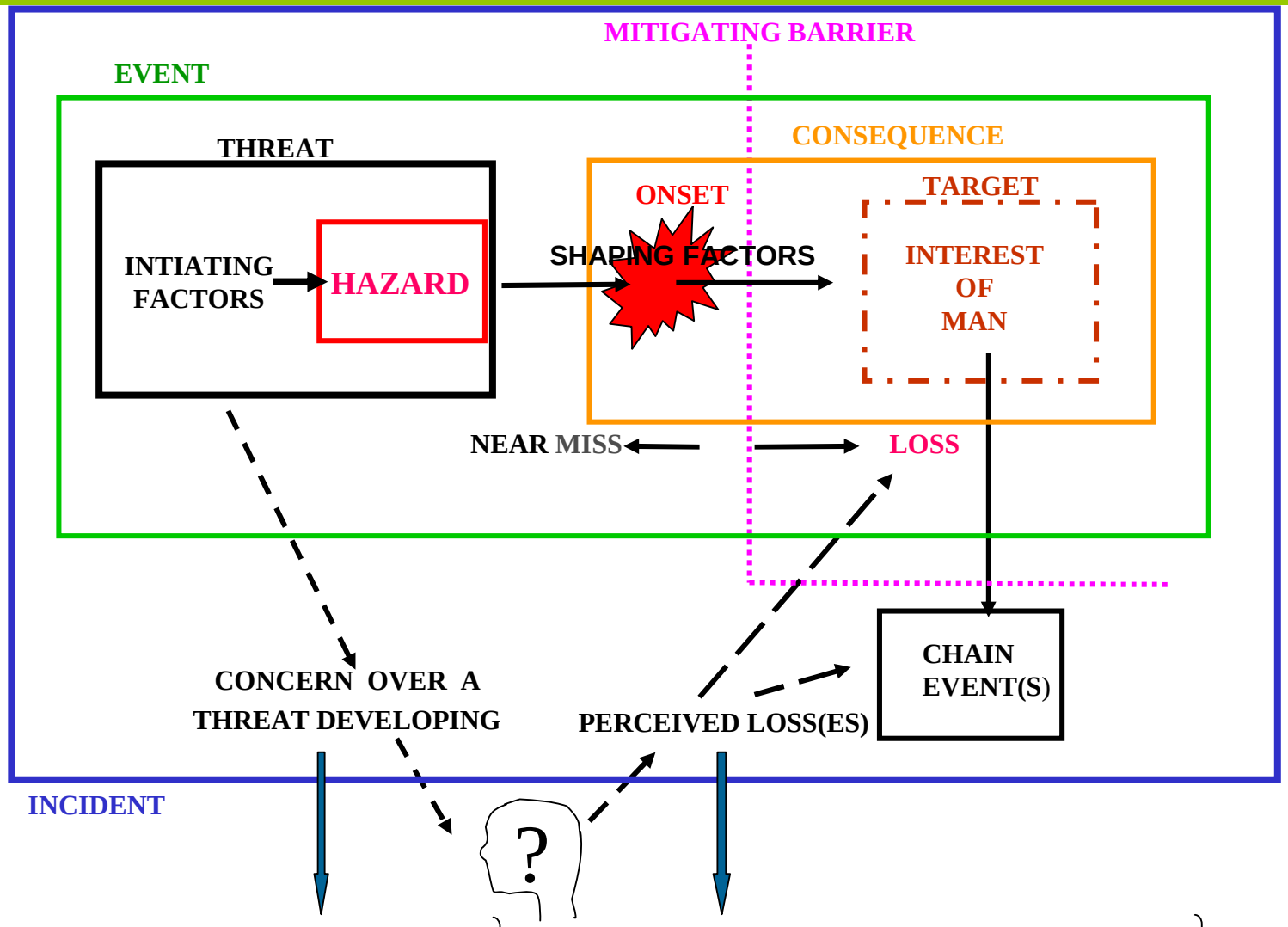


MECHANICS OF RISK

Initiating Factors:
- Natural/external
- Unintentional Human Influence
- Intentional Human Influence

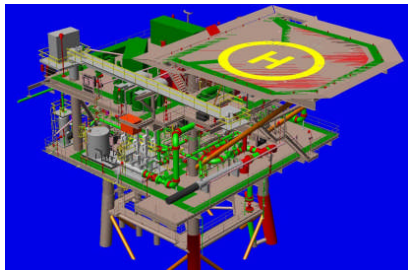
Shaping Factors:
- Wind direction
- Topogaphy
- Sea state
- Etc.

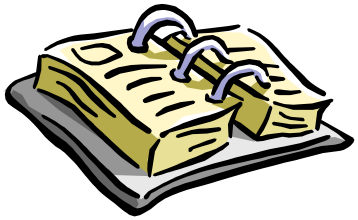
Interest of Man:
- People
- Property
- Environment
- Business



{ LIKELIHOOD OF LOSS EVENT DEVELOPING FROM A HAZARD } X { CHANCES OF SURVIVAL OR RECOVERY BASED ON MAGNITUDE OF CONSEQUENCE } = RISK

RISK – UNINTENTIONAL HUMAN INFLUENCES





Technical | Managerial | Behavioural

Risk

high

meduim

ALARP

low

Compliance with Engineering Performance Standards

Adherence to Procedural Management System

Safety culture

Risk aspects

RISK – NATURAL/ENVIRONMENTAL INFLUENCES

Physical environment affected e.g. Climate change

Environment:

Dealing with hazards generated by natural or anthropogenic (human influenced) factors that carry the risk or causing internal and external harm to people, property and natural ecosystems as well as disrupting social and economic means by which people survives

Extreme events: Flooding, landslides, earthquakes,etc

Imbalance with ecosystems e.g. certain micro organisms thrive better than others

Safety :

Dealing hazards that carry a risk of causing external harm to people and property.

e.g. explosions, fire, drop objects, etc

Health:

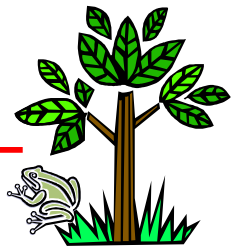
Dealing with hazards that carry a risk of causing internal harm to a person's mental and physical well being.

e.g. exposure to toxic gases, biological pathogens, heat stress etc

Waste products from a human activities

natural biodiversity impacted

less food to eat / exposure to pollutants



People's livelihood for survival compromised

Security:

Dealing with hazards associated with Social disorder

Self Preservation

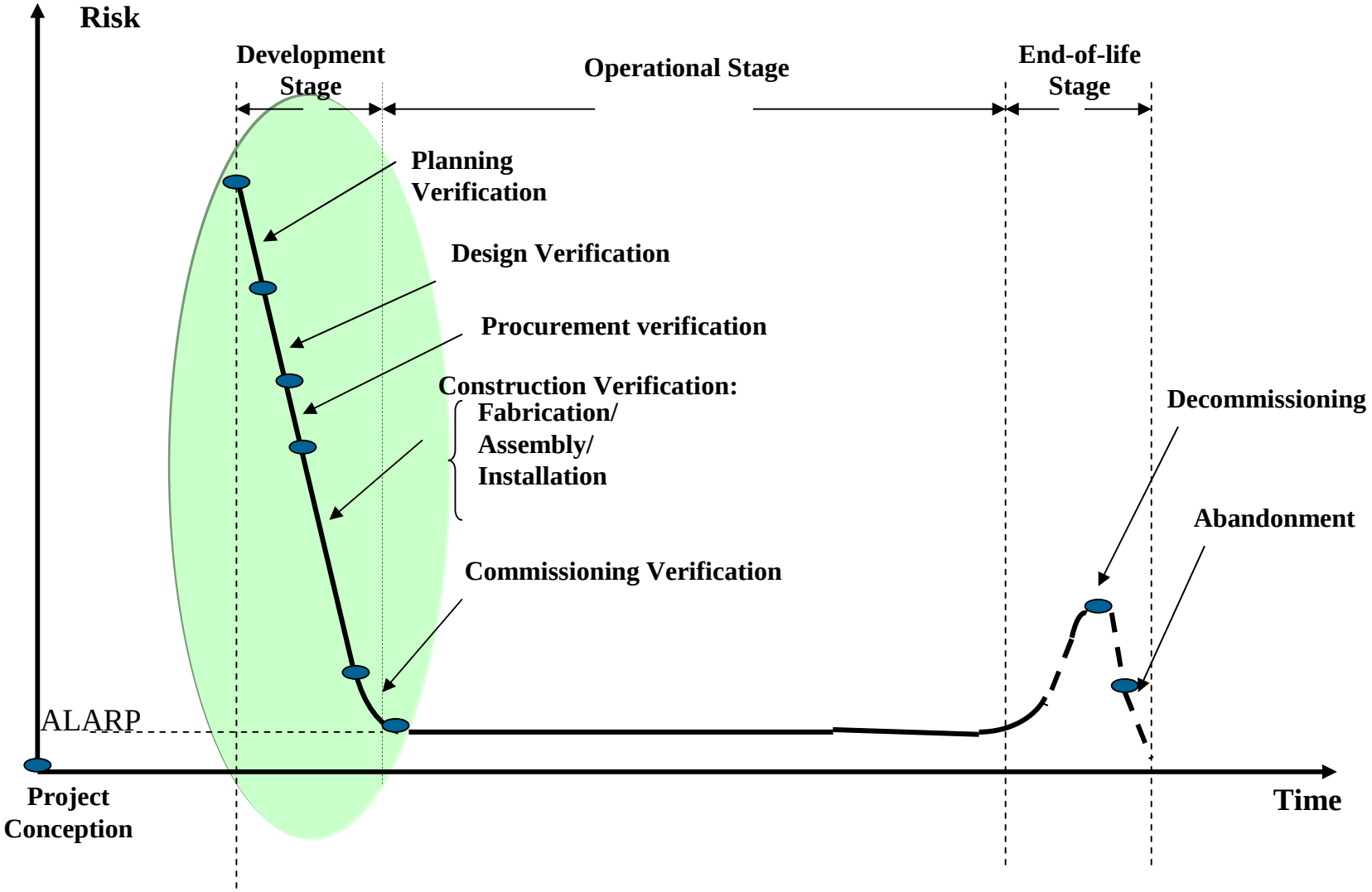
Person at Risk

Facility

RISK BASED VERIFICATION SCHEMES

- **Managerial and Behavioural aspects of risks depends heavily on the Technical aspect of the facility involved i.e. having a properly engineered facility.**
- **Risk Based Verification Schemes focus on the technical aspects of the facility for acquiring technical assurances on integrated components and provisions.**
- **In essence, a Risk Based Verification Scheme is equilivent to a peer review process which additional controls e.g.**
  - **Focused on areas where HSE risks matters (high to medium)**
  - **Experts in various fields utilized**
  - **Verification Plan - structured work programme to monitor CVA**
  - **Clear lines of accountability and reporting**
  - **Etc.**

RISK BASED VERIFICATION SCHEME



ALARP = Fit-for-Purpose + Operational Preparedness + Appropriate Safety Culture

PLANNING VERIFICATION

Check made for planning oversights:

- **Review of FEED studies, QRA and other pertinent reports that guided the selection of preferred technology, location of site, equipment capacity sizing and inventories, etc.**
- **Environmental parameters – review appropriateness of data on anticipated forces due to extreme events, seasonal patterns, effects of climate change, etc.**
- **Geotechnical Analysis – seismic zoning; faults; hydrology; terrain stability; check soil properties load bearing capacity (dry season vs. wet seasons) , acidity, electrical conductivity, permeability, etc.**
- **Spatial Analysis – data from site visits pertaining to setback distances from existing and future neighbouring establishments, prevailing wind direction, access and egress, fire break, future neighbouring development, etc**
- **Choice of technology – proven, historical problems, reliability performance records, parts supply problems**
- **Layout analysis – segregation of equipment, placement of human relative to high and medium potential risks, muster points for emergencies, escape routes, future equipment, movement of equipment, spacing between tanks, etc.**

DESIGN VERIFICATION

Assessment conducted on the civil, structural, electrical, process, mechanical or marine aspects of a facility and includes review of design data, P&ID drawings, flow diagrams, engineering analyses and calculations, HAZOP studies, modeling, …… etc; that went into the determination of:

- **electrical classification,**
- **equipment power loads,**
- **pressure containment capacity of vessels and piping,**
- **sizing and rating of process components, pumps, valves,…**
- **distributions of structural loads,**
- **configuration of ESD system to be utilized on the facility,**
- **fixed firefighting equipment**
- **materials of construction**
- **materials of equipment**
- **bund capacity**
- **drainage**
- **relief and blowdown system, etc.**

MANUFACTURING/PROCUREMENT VERIFICATION

Focus is on quality of ordered materials, plant equipment and supporting appurtenances supplied.

- **Assessment can be made on the manufacturing processes used to produce the pressure vessels, piping and other pertinent equipment.**
- **Ordered equipment and machinery must be made of material that are compatible with fluids or substances they are coming in contact with.**
- **Ensure materials of construction are acceptable to deliver desired performance.**
- **The manner in which equipment and material are handled, stored and transshipped will also be assessed to ensure that no damages are sustained.**
- **Operators must have appropriate assurances that they can reuse damaged or repaired equipment or supplied products.**

CONSTRUCTION VERIFICATION

Intent here is to ensure that the facility is completed as per agreed and approved plans

- **Validate acceptability of foundation - compaction, stabilization, piling, etc**
- **Validate that electrical, process, mechanical equipment and civil structures are properly**
  - **located**
  - **oriented**
  - **aligned – free of stresses**
  - **integrated – no loose connections, missing parts,**
  - **secured or bolted down**
  - **examined/tested for defects – welding cracks, stress concentration, etc.**

- **Assessment made on deviations from approved plans and any sustained damages to ensure that they have been appropriately addressed.**

COMMISSIONING VERIFICATION

Intent here is to ensure that facilities can perform as intended.

- **Validate that each equipment has been satisfactorily functioned tested**
- **Commissioning punch list will be checked for completeness**
- **Hydro test of vessels, tanks, pipe works will be evaluated to ensure no leaks and proper repairs executed for detected leaks.**
- **Control system will be checked – level, temperature, pressure and flow control sensors and instrumentation**
- **Functionality of alarms, ESD and safe failure modes will be validated**
- **Emphasis will also be placed on equipment that fail to meet performance specifications to ensure that shortcomings are addressed.**
- **Facility may be monitored after first hydrocarbon for a stipulated period (e.g. one month) before final approval is issued**.

ASSET LIFE EXTENSION

- **There is a need for determining the remaining life of facilities that have passed their original design life.**

- **Certain facilities built in the 1970's that are currently undergoing modifications and upgrade works are being assessed by the CVA with a modified verification scheme.**

- **Future- application of Verification Scheme a tool for determining life extension?**
  - **Worthy of consideration.**

THE END

Thank you for your attention.

QUESTIONS & ANSWERS?