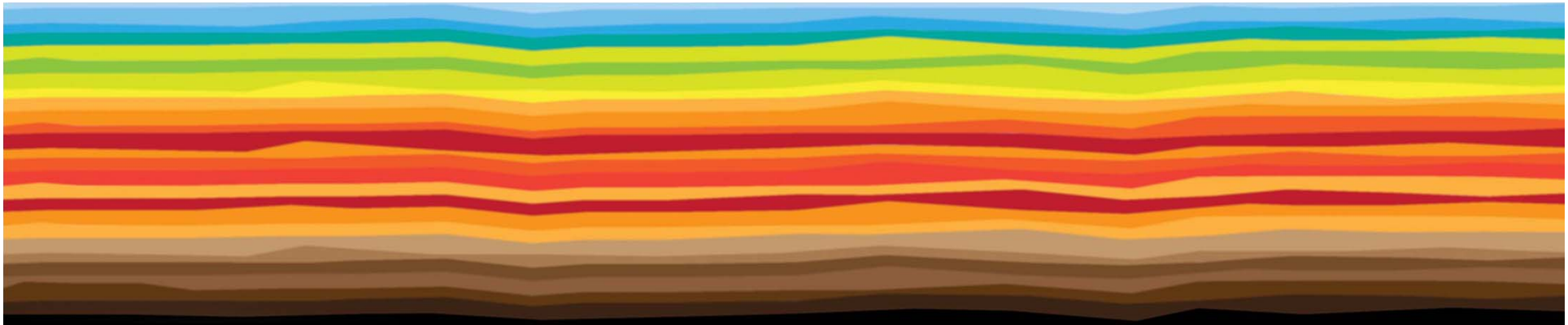

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#SPEWEBEVENTS

About Bill

- 39 years experience
- BS Petroleum Engineering - USL
- MS Systems Management - USC
- ¼ career – Operations
- ¼ career – Technology Centers
- ¼ career - Project support
- 2014 - Formed Bill Capdevielle Enterprises, LLC
  - Innovation & Nanotechnology
- 2014 – Formed Oil Patch Engineering, PLLC
  - Engineering consulting
  - Facility Operability & Operations Support
  - Project Management & Support
  - Field Development Studies

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Facility Operability:
Designing Operable Facilities

SPE Gulf Coast Chapter PF&C Study Group Meeting

18 November, 2014

Bill Capdevielle Enterprises LLC

Innovation and Technology Consulting for the Oil & Gas Industry

www.BillCapdevielle.Enterprises

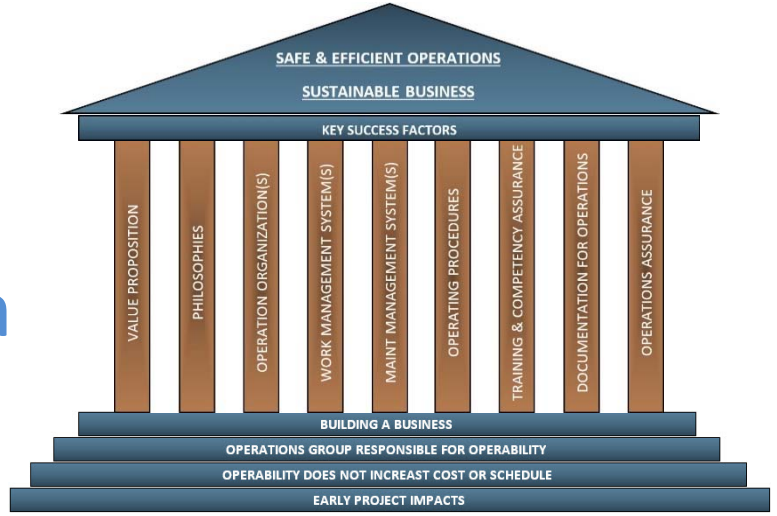
Oil Patch Engineering PLLC

Operations Engineering and Project Operability Consulting

www.OilPatchEngr.com

Facility Operability – Presentation Overview

- Definitions
- Setting the Foundation
- Facility Operability Elements
- Key Success Factors
- Questions & Discussion
- Mechanical Completion
- Commissioning



Facility Operability – Definitions

- **Operability:** those characteristics of facilities which enable them to be operated safely & efficiently

Facility Operability – Definitions

- **Operability:** those characteristics of facilities which enables them to be operated safely & efficiently
- **Production Operations:** the organization charged with the sustainable business performance of the asset
  - Management
  - Administrative
  - Finance & Accounting
  - Engineering
  - Logistics & Warehousing
  - Procurement
  - EHS
  - Facility Operations

Facility Operability – Definitions

- **Operability:** those characteristics of facilities which enables them to be operated safely & efficiently
- **Production Operations:** the organization charged with the sustainable business performance of the asset
- **Facility Operations:** the onsite organization that has care, custody & control of the facility
  - Startup & shutdown systems & equipment
  - Monitor and correct facility operating parameters
  - Issue & rescind work permits
  - Perform energy isolations
  - Enforce SIMOPS
  - Control all activities on the facility
  - Maintain drawings and set point register

Facility Operability – Definitions

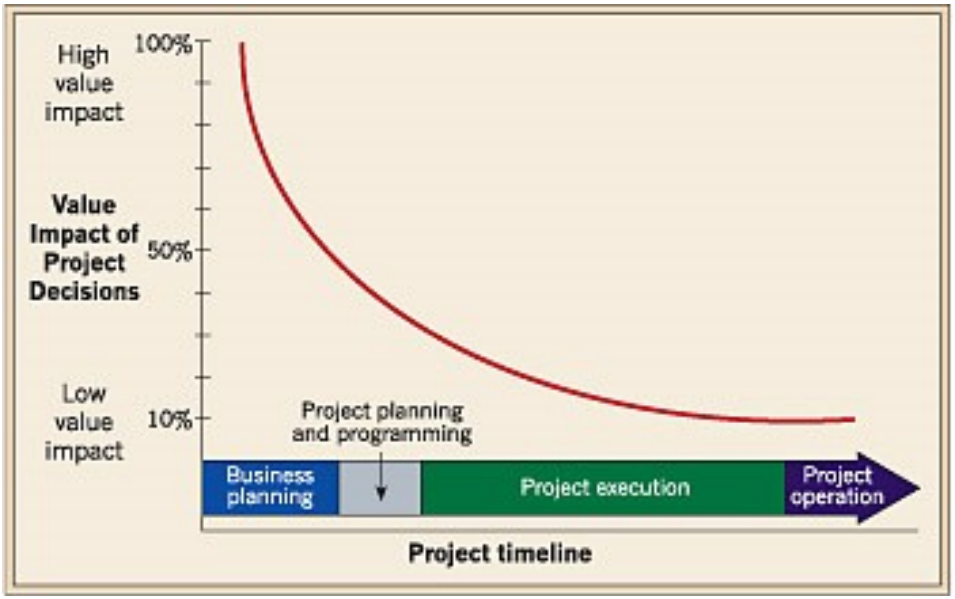
- **Operability:** those characteristics of facilities which enables them to be operated safely & efficiently
- **Production Operations:** the organization charged with the sustainable business performance of the asset
- **Facility Operations:** the onsite organization that has care, custody & control of the facility
- **Facility Maintenance**
- **Facility Logistics**
- **Facility EHS**

Facility Operability

Foundation Concepts

Facility Operability – Foundation Concepts

1. It is far simpler to impact a project early in the project timeline.



The longer you wait to get it right, the more it is going to cost!!

Facility Operability – Foundation Concepts

1. It is far simpler to impact a project early in the project timeline.
2. Done correctly, Facility Operability does not increase project cost, or delay schedule.
   - Facilities with poor operability can experience significant downtime and production loss.
   - Facility Operability eventually be attained.
   - See Rule 1 above.

Facility Operability – Foundation Concepts

1. It is far simpler to impact a project early in the project timeline.
2. Done correctly, Facility Operability does not increase project cost, or delay schedule.
3. Facility Operability is the responsibility of the operating organization.
   - They will “own” the facilities.
   - They will have unique expertise.
   - They can help optimize capital costs vs. operating expense.
   - They will (hopefully) come with time and money.

Facility Operability – Foundation Concepts

1. It is far simpler to impact a project early in the project timeline.
2. Done correctly, Facility Operability does not increase project cost, or delay schedule.
3. Facility Operability is the responsibility of the operating organization.
4. You are not building a facility; you are building a business.
   - Safe
   - Profitable
   - Sustainable

Facility Operability – Foundation Concepts

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Facility Operability

✓ FOUNDATION COMPLETE

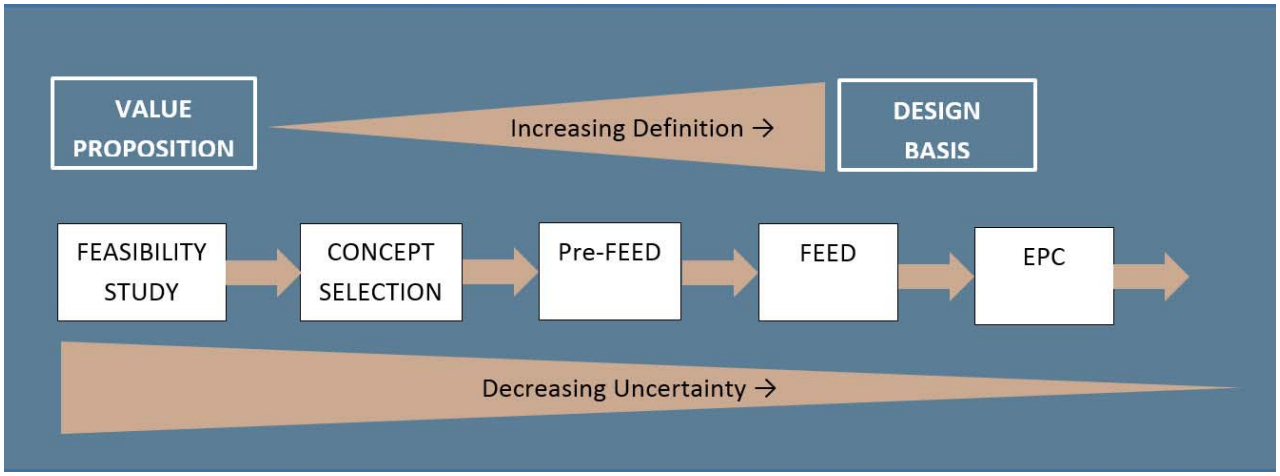
Facility Operability – Elements

Facility Operability Elements

1. Value Proposition

This project will economically develop and produce approximately 4 TCF of gas from the Miocene A reservoir in Block 312 in approximately 1200 feet of water, process the gas to pipeline quality, measure and re-inject condensate into the gas export line, and export product to one of several gas pipelines in the vicinity.

Morphs into Design Basis



Facility Operability Elements

2. Philosophies

Design

- Design Basis Memorandum
- Design Standards
- Cost Basis
- Project Schedule
- Construction Plan
- Contracting Plan
- ESD Philosophy
- Fire & Gas Detection Philosophy
- Process Control Philosophy
- Relief/Flare Philosophy

Operability

- Operating Philosophy
- Isolation Philosophy
- Maintenance Philosophy
- Integrity Philosophy
- Corrosion Philosophy
- Logistics Plan
- Waste Management Philosophy
- Emergency Preparedness Plans

Facility Operability – Elements

3. Developing Operating Organization(s)

- Organizational Functions
- Organization Chart
- Responsibilities & Authorities
- Job Descriptions
- Staffing Plan
- Employee vs. Contractor
- ExPat vs. Indigenous
- Rota & Shift
- Personnel Development Plan
- Cost Profile

Facility Operability – Elements

4. Work Management System(s)

- Safety (EHS) Management System
- Work Control Philosophy
- Permit To Work System
- Energy Isolation System
- Critical Device Override System
- SIMOPS
- Management of Change System
- Assurance System
- Improvement System

Facility Operability – Elements

5. Maintenance Management System(s)

- Computerized Maintenance Management System (CMMS)
- Taxonomy
- Equipment List
- Equipment Criticality Assessments
- Equipment Maintenance Strategies
- Maintenance Procedures
- Facility Integrity Strategies
- Equipment Performance/Failure Tracking
- Inspection Recording System
- Maintenance Reporting System

Facility Operability – Elements

6. Operating Procedures

- Overall Facility Startup/Shutdown Strategies
- System Operating Procedures
- Equipment Operating Procedures

Operating Procedure Requirements

Black Start	Operating Limits
Cold Start	Step-by-step actions
Hot Start	Who performs actions
Normal Shutdown	Reference tag & line numbers
Emergency Shutdown	Human Factors Considerations
Normal Operations	! Warnings ▲Cautions

Facility Operability – Elements

7. Training & Competency Assurance

- Competency Requirements
- Types of Competencies
  - Industry Safety
  - Industry Technical
  - Site Safety
  - Site Technical
- Types of Training (formal, OJT)
- Competency Assurance
- Ongoing Training

Facility Operability – Elements

8. Documentation for Operations

- Facility As-Builts
- Equipment catalogs, drawings, parts lists, repair procedures
- Equipment specifications (POs)
- Final Design Basis
- Engineering studies
- Safety studies
- Operability studies
- QA/QC records

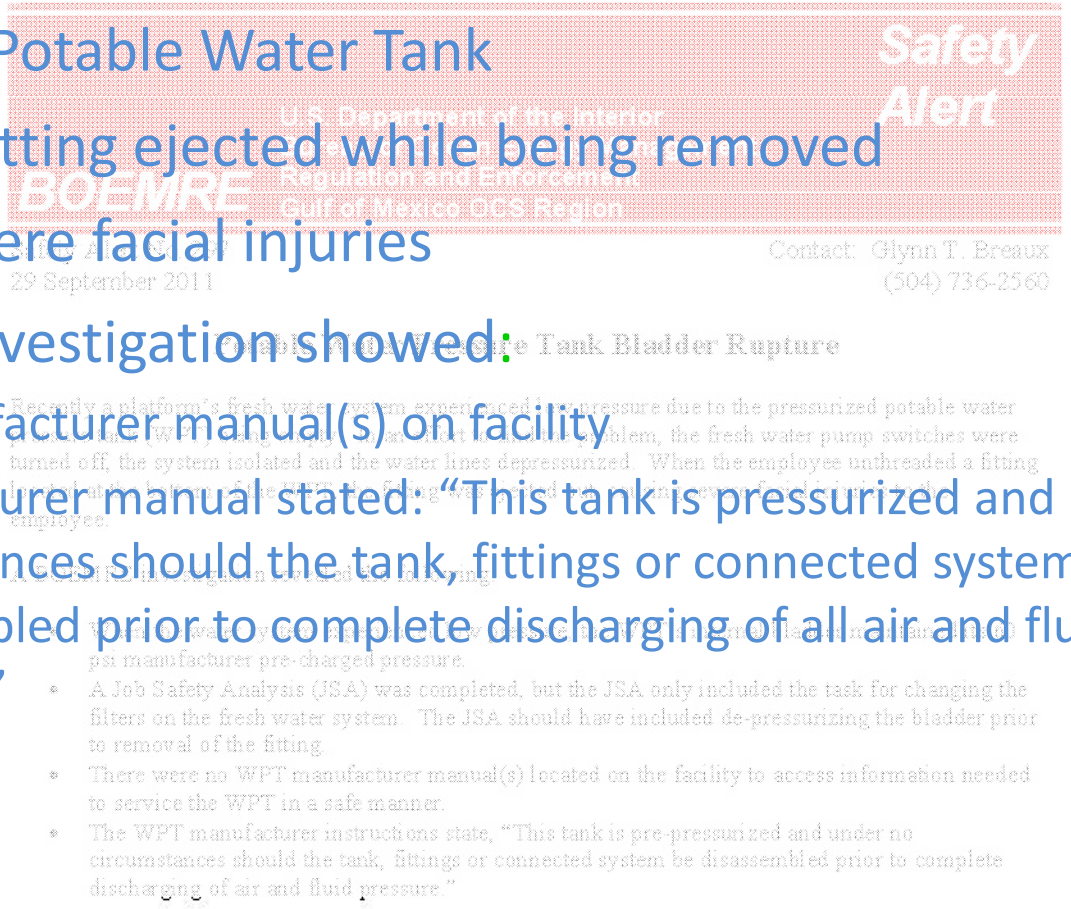
Facility Operability – DFO

Why is Facility Documentation Important?

- Accelerate breakdown diagnostics
- Accelerate repairs
- Validates Operating & Repair Procedures
- Enhances safety

Facility Operability – DFOs

- Repairs on Potable Water Tank
- Threaded fitting ejected while being removed
- Caused severe facial injuries
- BOEMRE Investigation showed:
  - No manufacturer manual(s) on facility
  - Manufacturer manual stated: "This tank is pressurized and under no circumstances should the tank, fittings or connected system be disassembled prior to complete discharging of all air and fluid pressure."



Facility Operability – Elements

9. Operations Assurance

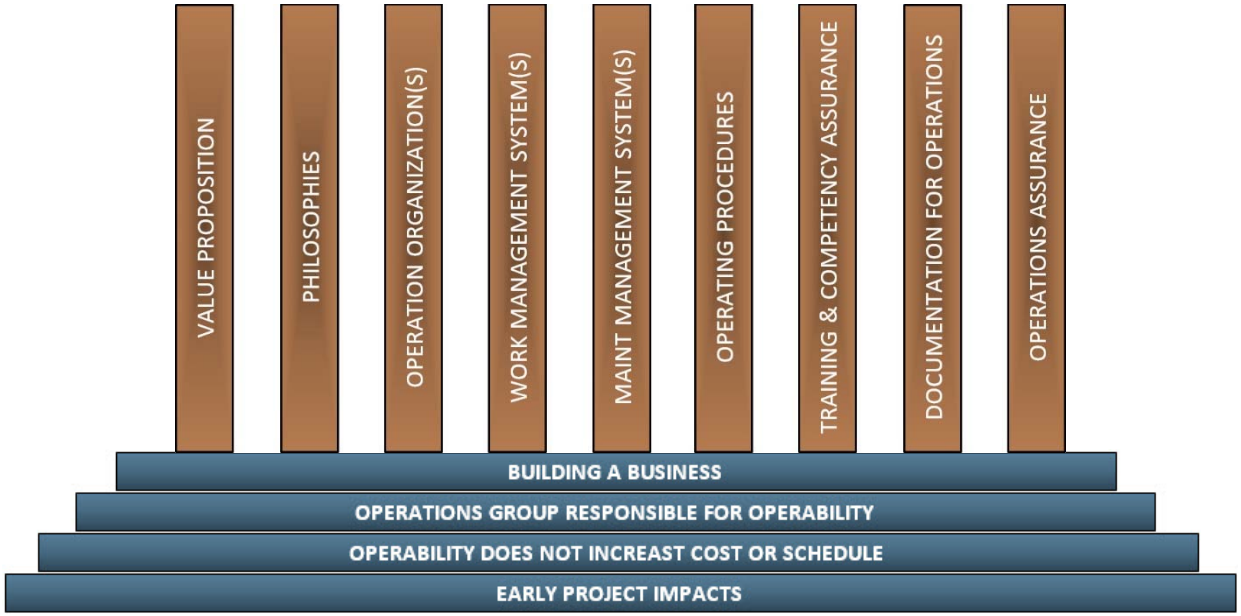
- Operability Audits throughout EPC
  - On schedule
  - On cost
  - Quality of work
  - Any issues
- Operational Readiness Review
  - Operations organization built
  - Sales Contracts in place
  - Vendor contracts in place
  - Emergency Preparedness
  - Daily reporting/production allocation in place
  - Reservoir management plan in place
  - Well surveillance plan in place
- PSSR

Facility Operability – Elements

1. Value Proposition
2. Philosophies
3. Operating Organization(s)
4. Work Management System(s)
5. Maintenance Management System(s)
6. Operating Procedures
7. Training & Competency Assurance
8. Documentation for Operations
9. Operations Assurance

Facility Operability

- ✓ FOUNDATION COMPLETE
- ✓ OPERABILITY ELEMENTS DEFINED



Facility Operability

Key Success Factors

Facility Operability – Key Success Factors

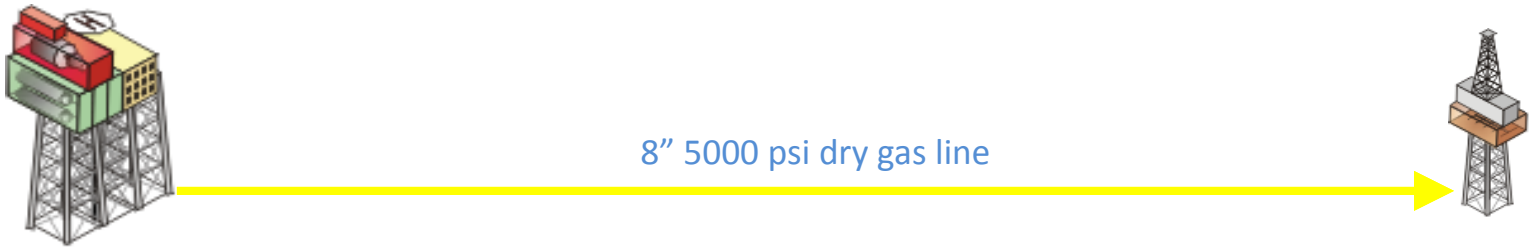
1. Operations Involvement

- Early
- Appropriate
  - Number of operations people
  - Responsibility & authority
  - Knowledge of existing operations
  - Team players, but tenacious
  - People who will operate

Facility Operability – Key Success Factors

Appropriate Operations Involvement Example #1

- Major operator, Offshore West Africa
- High pressure gas system

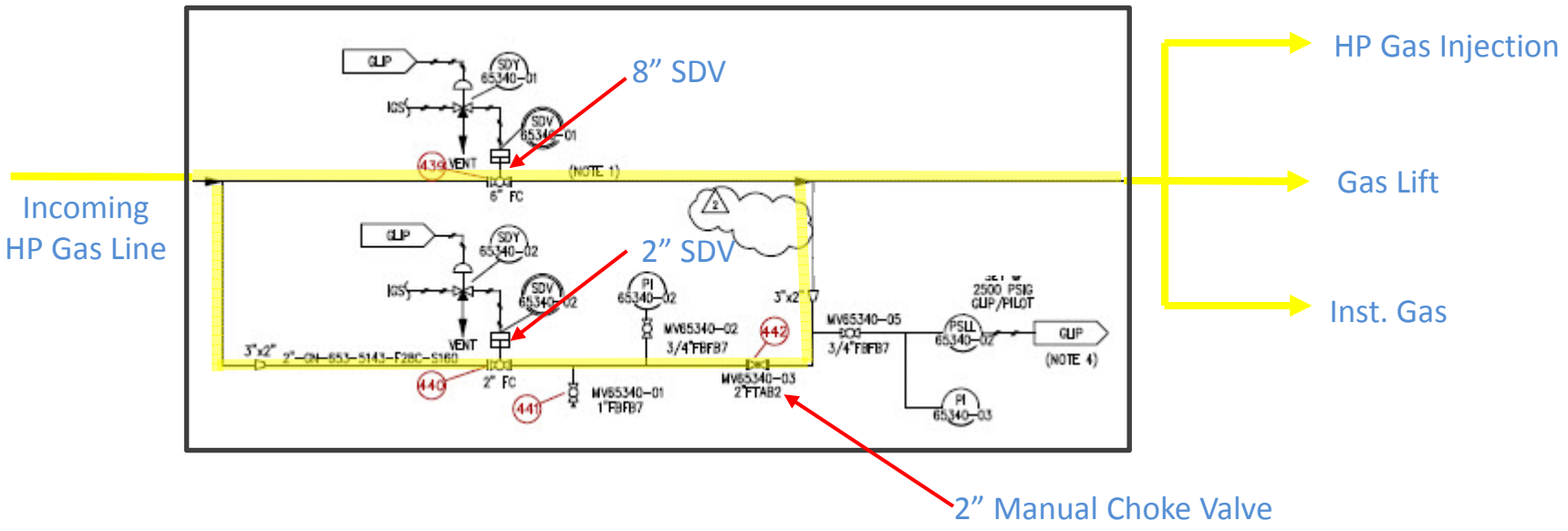


Gas Compression Platform

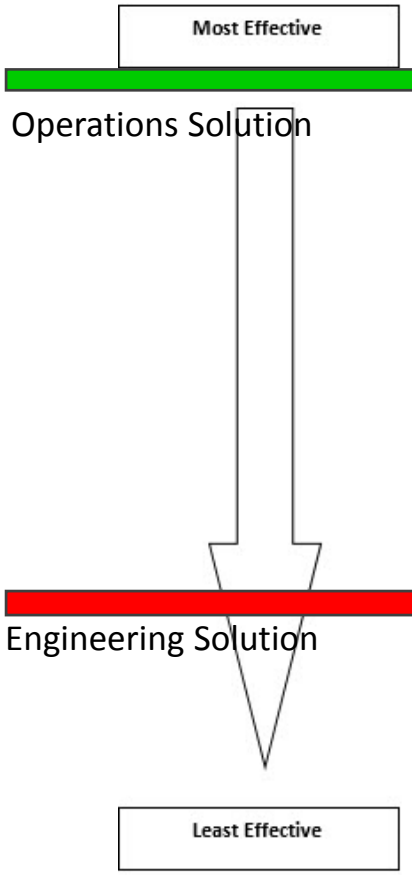
Unmanned Wellhead Platform

Facility Operability – Key Success Factors

Appropriate Operations Involvement Example #1



Facility Operability – Risk Control Hierarchy

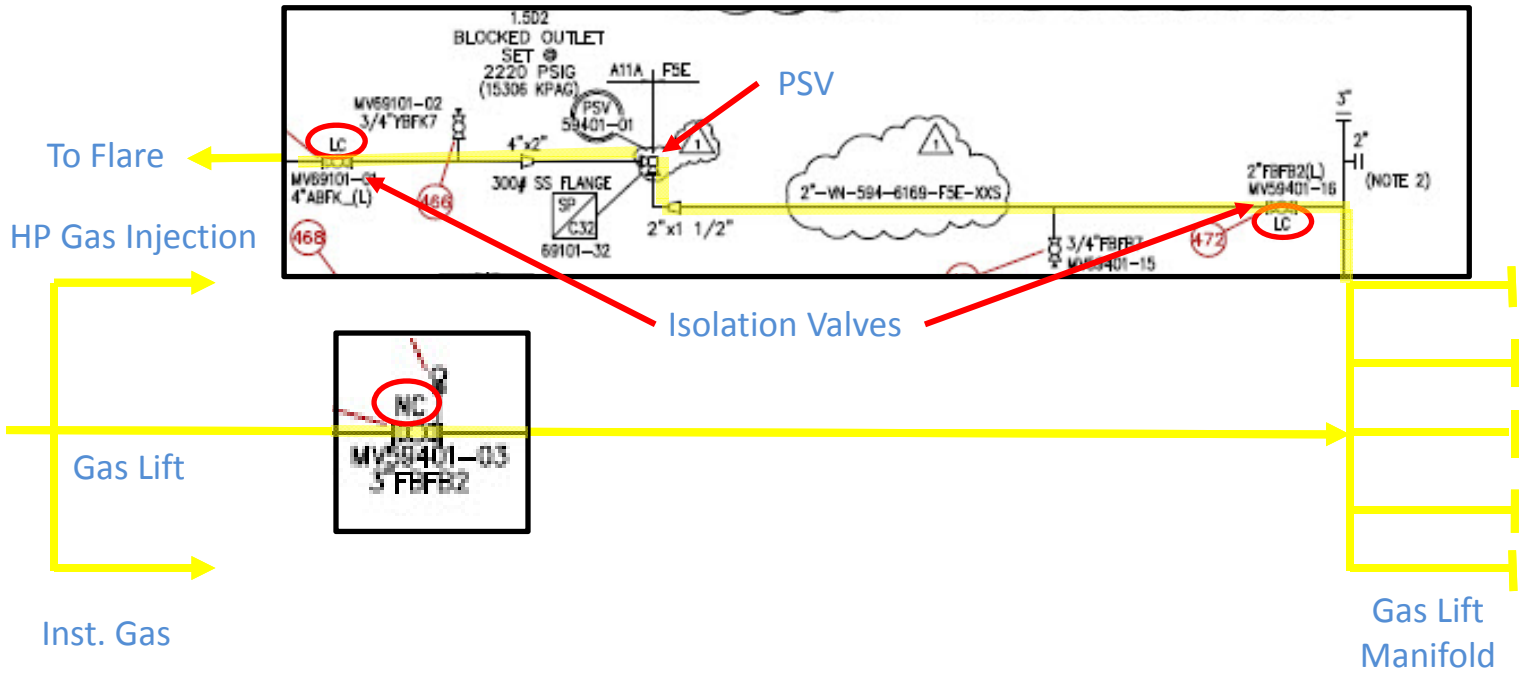


CONTROLS	EXAMPLES
1. Elimination	▪ Design to eliminate hazards, such as falls, hazardous materials, noise, confined spaces, and manual material handling.
2. Substitution	▪ Substitute for less hazardous material ▪ Reduce energy (for example: lower speed, force, amperage, pressure, temperatures, and noise).
3. Engineering Controls	▪ Ventilation systems ▪ Machine guarding ▪ Sound enclosures ▪ Circuit breakers ▪ Access platforms and guard railing ▪ Interlocks ▪ Lifting devices
4. Warnings	▪ Signs ▪ Alarms ▪ Beepers ▪ Horns ▪ Labels
5. Administrative Controls	Procedures: ▪ Safe job procedures ▪ Rotation of workers ▪ Safety equipment and inspections ▪ Changing work schedules Training: ▪ Hazard communication training ▪ Confined space entry
6. Personal Protective Equipment	▪ Safety glasses ▪ Hearing protection ▪ Face shields ▪ Safety harnesses and lanyards ▪ Gloves ▪ Respirators

REFERENCE: ANSI Z10-2005, *American National Standard – Occupational Health and Safety Management Systems*, Section 5.1.1, "Hierarchy of Control"

Facility Operability – Key Success Factors

Appropriate Operations Involvement Example #2



Facility Operability – Key Success Factors

Appropriate Operations Involvement Example #2

- System isolation valve MUST BE Locked Closed(LC)
- Question for Client Operations Superintendent:
  - Is the Management of Change system, as practiced in the field, sufficiently robust such that, when commissioning the Gas Lift system, the Facility Operations personnel will know to LO the PSV isolation valves?

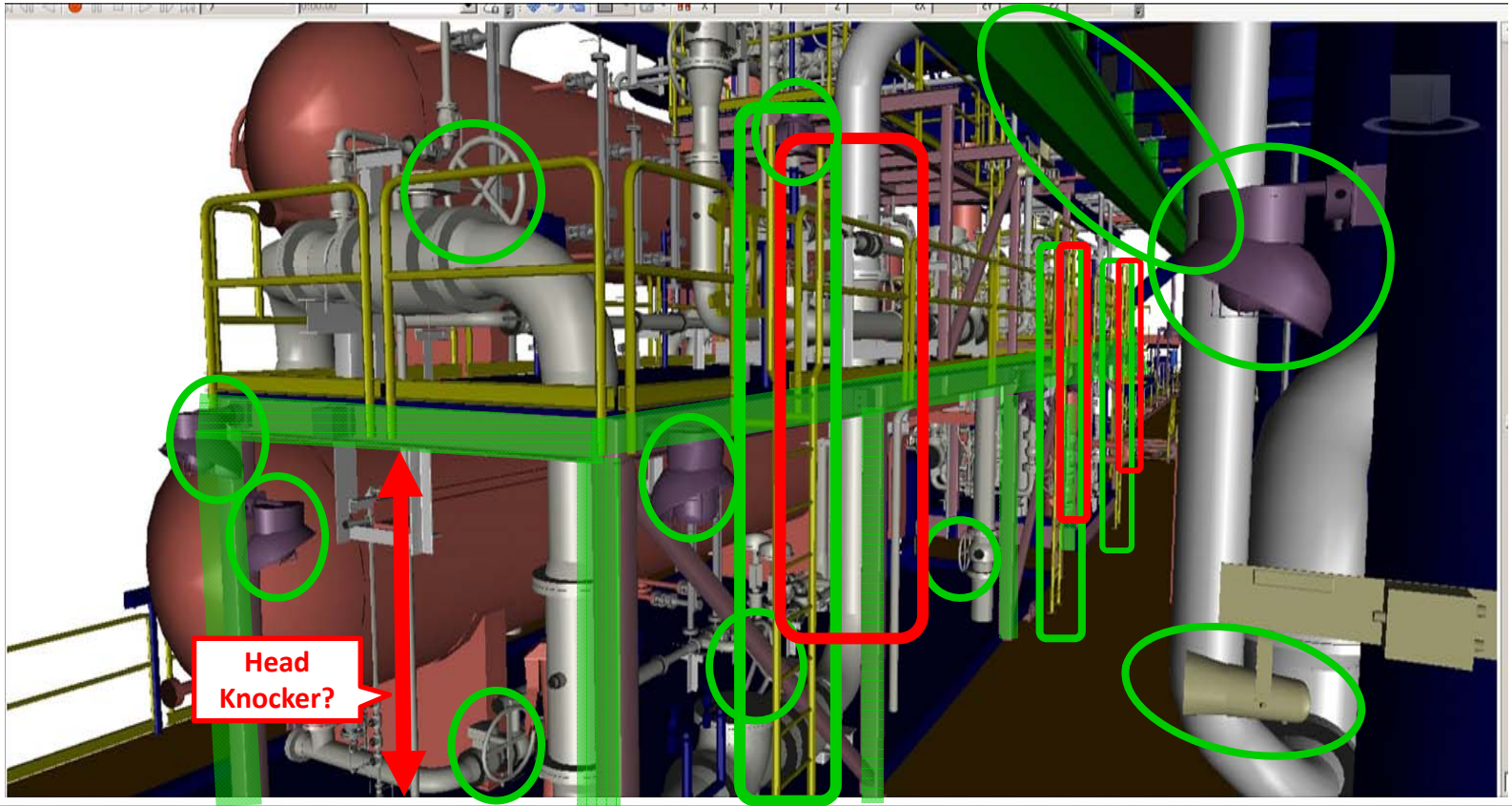
Facility Operability – Key Success Factors

2. 3D Modeling

- Virtual walk-throughs
- Operations activities
- Material handling
- Emergency egress
- Human factors
  - Lighting
  - Indicators
  - Controls

Facility Operability – Key Success Factors

3D Modeling



Facility Operability – Key Success Factors

3. RAM Studies

- Reliability, Availability, Maintainability
- Numerical model of facilities & operations
- Monte Carlo simulation
- Yields % availability (at a given confidence level)
- Shows greatest contributors to lost availability
- Can optimize facility design & operations philosophy

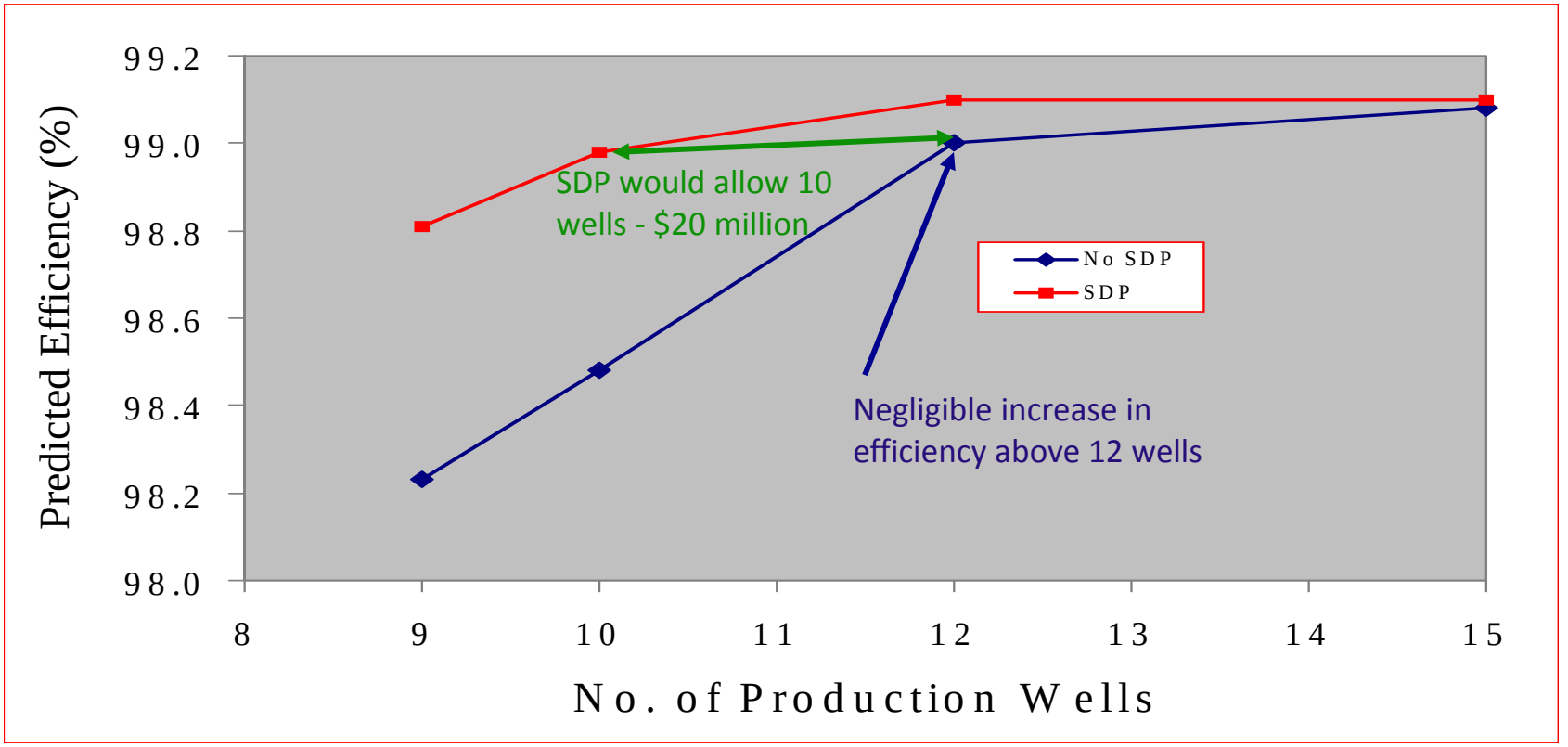
Facility Operability – Key Success Factors

RAM Study Example

- Large LNG Development
- Assessed availability of system
- Split offshore & LNG plant
- LNG Plant: Largest cause of downtime – turbine maintenance
- Offshore: Evaluated reducing 20 wells to 15
- Offshore: Evaluated impact of no SDP

Facility Operability – Key Success Factors

RAM Study Example - Offshore



Facility Operability – Key Success Factors

4. Operations Squad Checks of Engineering

- Engineering Studies
- Safety Studies
- Engineering Drawings
- RFQs & POs
- Internal (Rev A, B, C…..)
- Client (Rev 0, 1, 2 …….)

Facility Operability – Key Success Factors

5. Engineering Squad Checks of Operability

- Operations safety studies
- Operability specifications
- Operations philosophy
- Isolation philosophy
- Operating & Maintenance procedures
- Operability Management Plan

Facility Operability – Key Success Factors

Engineering Checks of Operating Procedures

- Ensure that the procedures conform to the design

TITLE 6. REGULATION OF ENGINEERING, ARCHITECTURE, LAND SURVEYING, AND RELATED PRACTICES
SUBTITLE A. REGULATION OF ENGINEERING AND RELATED PRACTICES

CHAPTER 1001. ENGINEER

SUBCHAPTER A. GENERAL PROVISIONS

§ 1001.003. Practice of Engineering

(c) The practice of engineering includes:

(8) engineering for preparation of an operating or maintenance manual;

Facility Operability – Key Success Factors

Engineering Checks of Operating Procedures

(8) engineering for preparation of an operating or maintenance manual;

For facilities that Texas law requires the design be stamped by a Texas registered PE:

- Operating Manual (operating procedures) MUST be reviewed and stamped by a Texas registered PE.
- The elements of the Maintenance Manual that affects the protection of people, property or the environment MUST be reviewed and stamped by a Texas registered PE.
  - Equipment strategies
  - Repair procedures
  - Preventative maintenance programs
  - Facility integrity programs
  - Fitness for service evaluations
  - Pressure containment, electrical integrity, structural

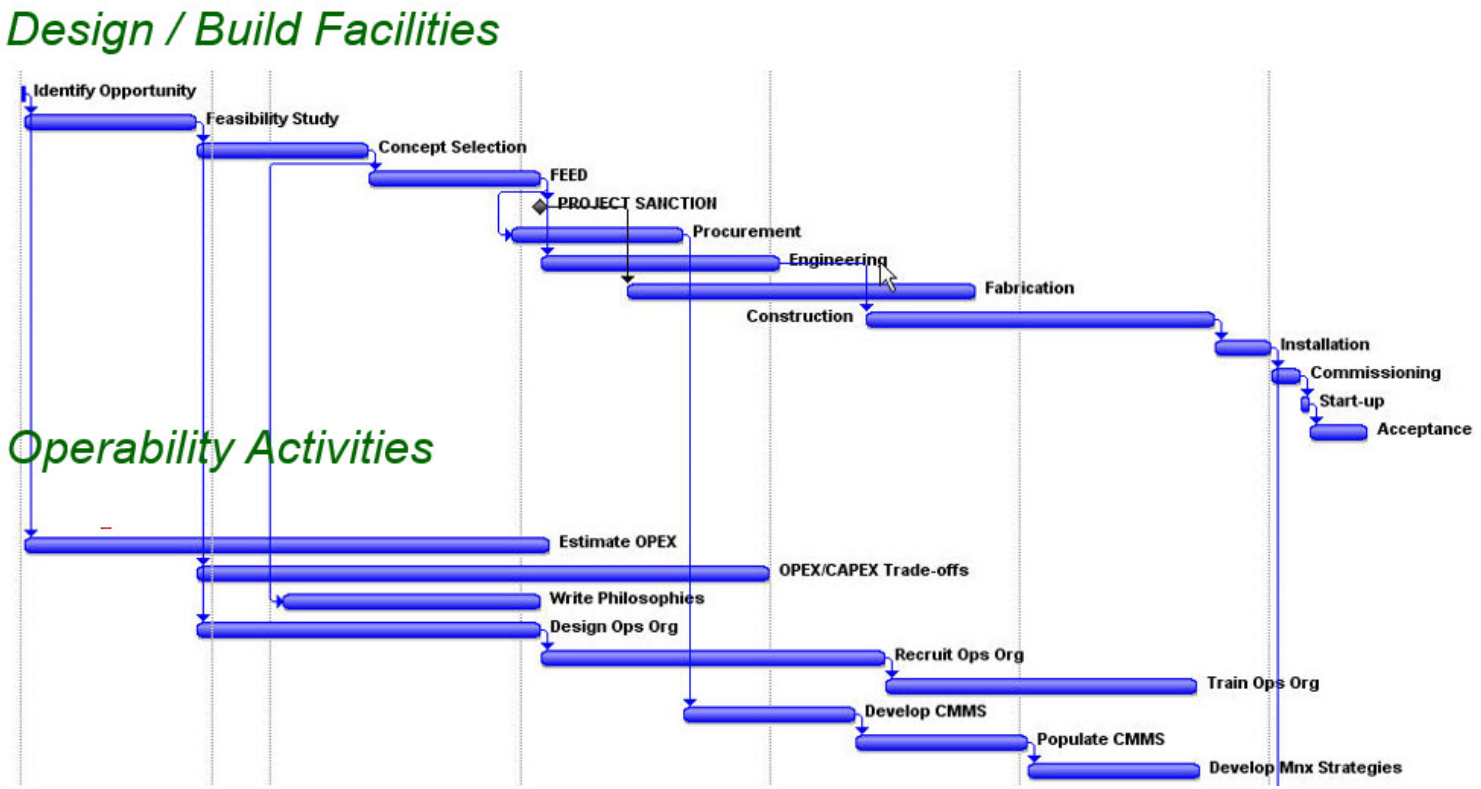
Facility Operability – Key Success Factors

6. Operability Activities in Project Schedule

- Allows planning & tracking of operability activities
- Enables coordination of design & operability activities
- Enables joint resource planning

Facility Operability – Key Success Factors

Operability Activities in Project Schedule



Facility Operability – Key Success Factors

7. Operability Management Plan

- Formalizes:
  - Operability plans
  - Roles & Responsibilities
  - Operability organization
  - Operability Assurance program
  - Interfaces among:
    - Project Team
    - Operations Team
    - Contractors, Fabricators, Vendors
    - Construction/Installation
    - Startup & Commissioning

Facility Operability – Key Success Factors

8. Procurement! Procurement! Procurement!

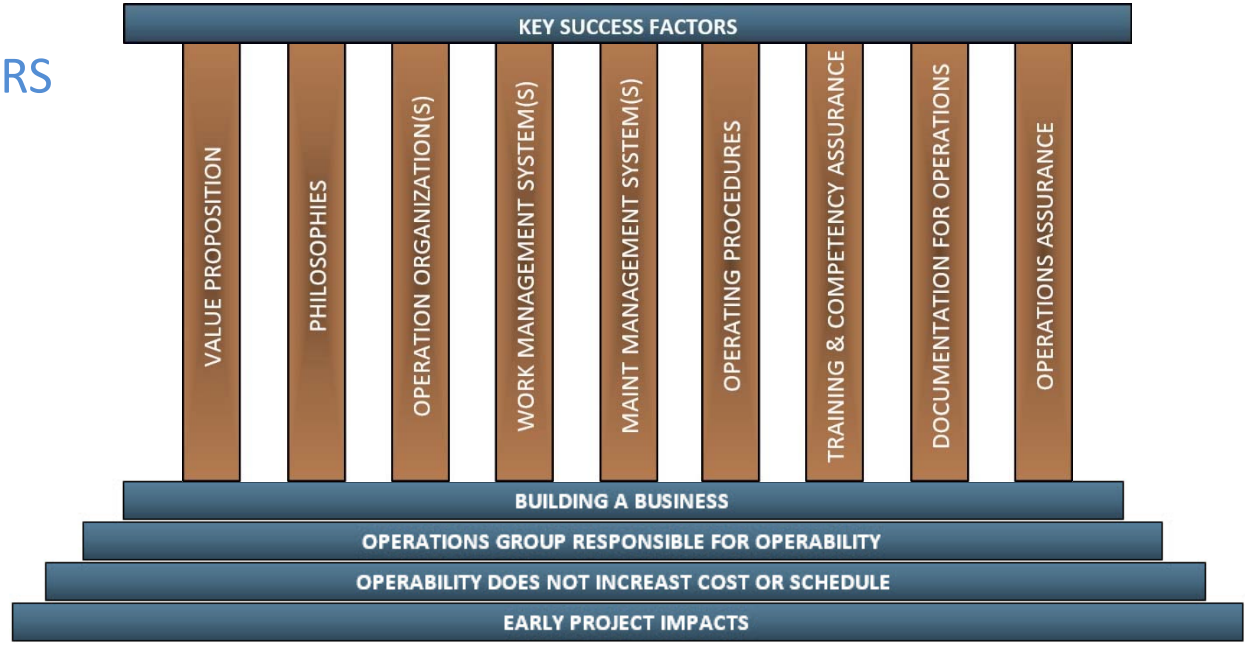
- Procurement may begin early in a project
- NEED to have Operability input into RFQs & POs
  - Documentation requirements
  - Recommended spare parts
  - Full spare parts list
  - Parts commonality
  - Transition to Operations
- VERY COSTLY to add Operability in later

Facility Operability – Key Success Factors

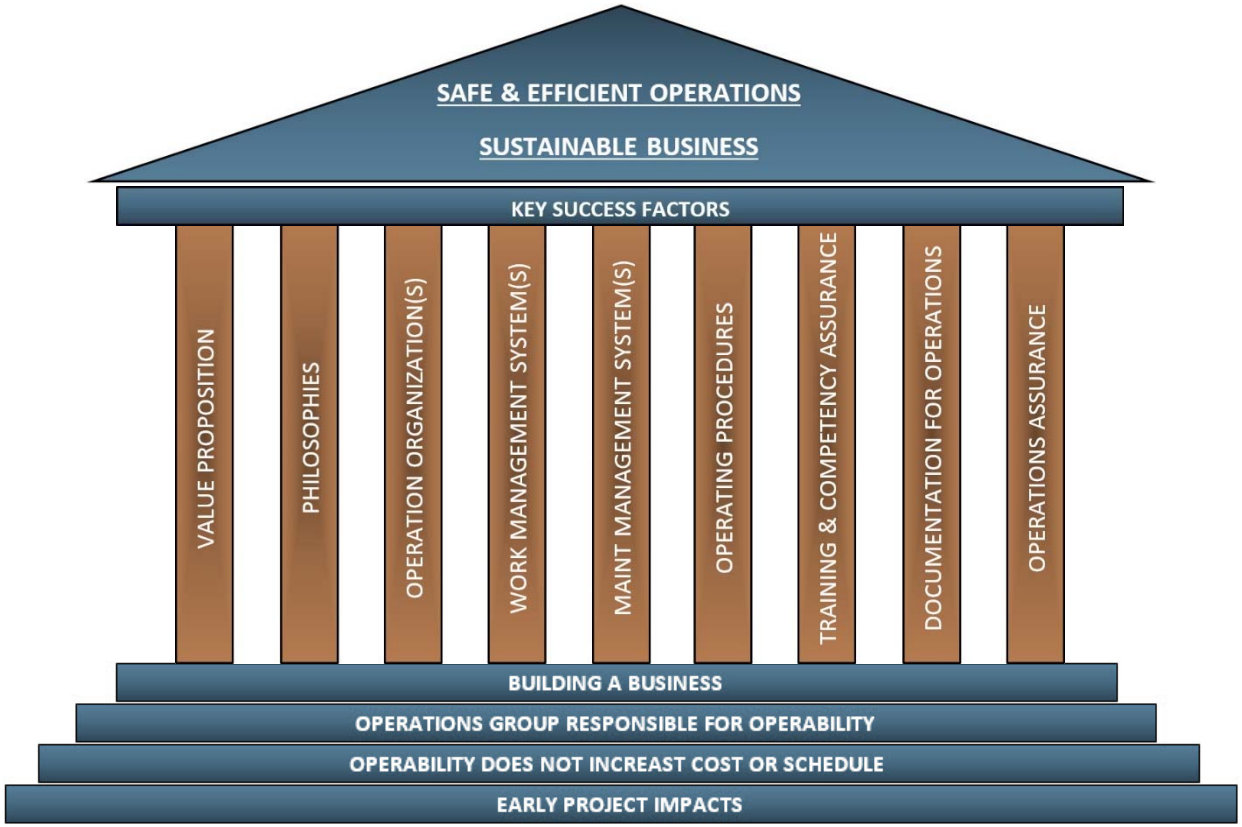
1. Operations Involvement
2. 3D Modeling
3. RAM Studies
4. Operations Squad Checks of Engineering
5. Engineering Squad Checks of Operability
6. Operability Activities in Project Schedule
7. Operability Management Plan
8. Procurement! Procurement! Procurement!

Facility Operability

- ✓ STAGE SETTING COMPLETE
- ✓ OPERABILITY ELEMENTS DEFINED
- ✓ KEY SUCCESS FACTORS



Facility Operability - Completed Model



Questions – Discussion

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