Shell Global Solutions

Aging, Overworked, Debottlenecked Refineries

An Increased Risk to the Insurance Industry?

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- Risk Management
- Risk Based Inspection
- Managing Effects of Aging
- Management of Debottlenecking
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In the context of corrosion and pressure vessel integrity assurance

Challenges in the Refining Industry

CURRENT BUSINESS ENVIRONMENT (inside & outside Shell)

- Tighter margins
- Higher profile, therefore need to be a “good citizen”
- HSE legislation becoming stricter
- Reduced CAPEX with tighter constraints
- Aging workforces for many industrial facilities

Hard Challenges

- Provide Availability as Required by the Business
- Risk Elimination/Reduction
- HSE Compliance
- Integrity Assurance
- Effectiveness (Optimum Work Volume)
- Efficiency (Planning)
- Contracting and Procurement
- Performance Measurement and Improvement

opportunity

community

cost

Modern Asset Management Requires:

- a “systems thinking” approach (as opposed to reliance upon an individual or individuals)
- cross functional business processes and teamwork
- roles, responsibilities, accountabilities and competency assurance
- limits of the asset’s capability clearly defined and widely understood
- utilisation of risk management (NOT risk taking) techniques for setting priorities, making decisions, utilising resources and eliminating risk
- performance measurement and improvement (closing the loop)
- high standards

Risk Management

RISK = PROBABILITY x CONSEQUENCE x EXPOSURE

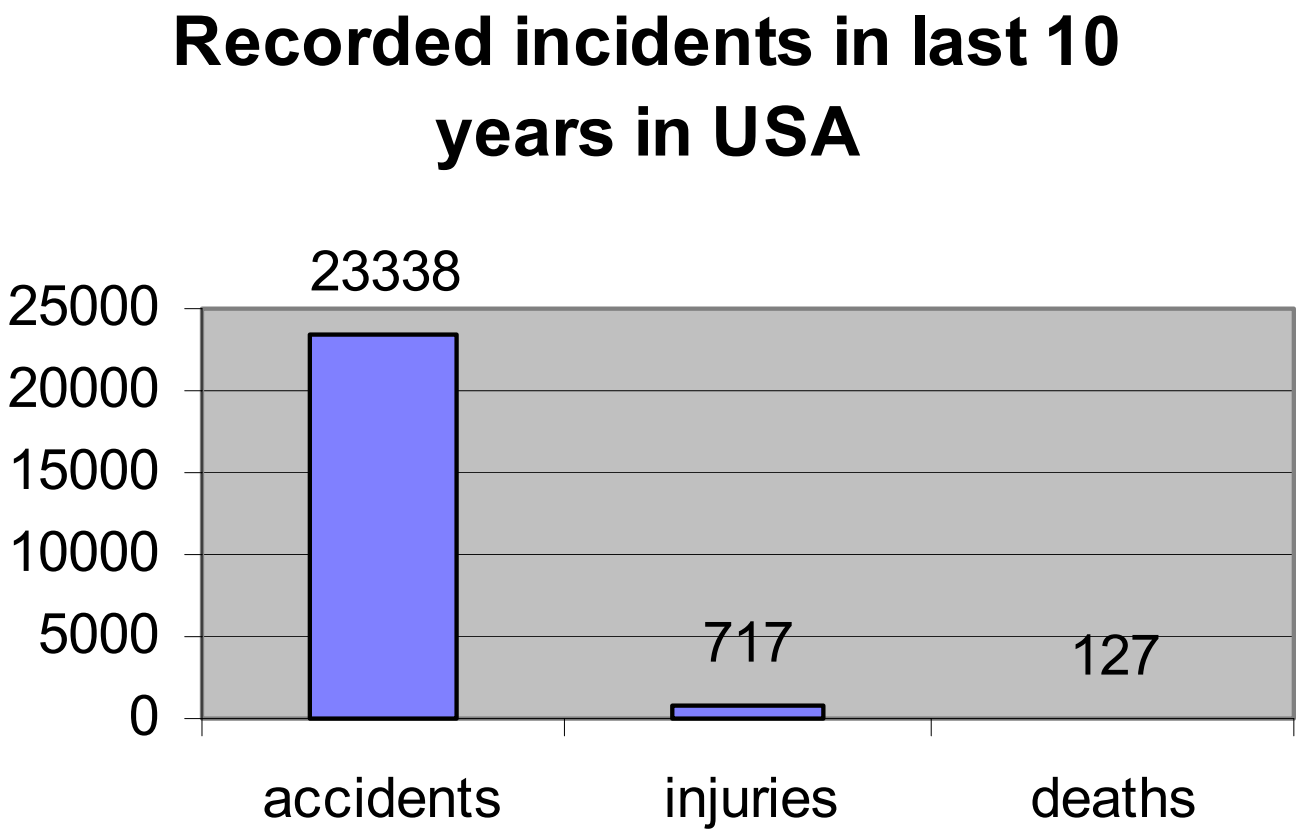
- Consequence mitigation:
  - Design (leak before rupture)
  - Response procedures (readiness)
- Exposure reduction:
  - Location of new plant (remote areas)
  - Process automation (DCS)
  - Control room design (blast proof)
  - Personal Protection Equipment (fire retardant)
- Probability reduction:
  - Inspect and maintain

Risk Management

- Risk can be assessed for hazardous scenarios.

- For instance, probability for injury to personnel requires the following chain of events to be analysed:
  - Susceptibility to corrosion ← Integrity Management
    - Likelihood of a large hole
      - Probability of vapour cloud explosion
        - Exposure to people in the area

Incident Statistics



Source: National Board of Boiler and Pressure Vessel Inspectors

Why Apply Risk Based Inspection

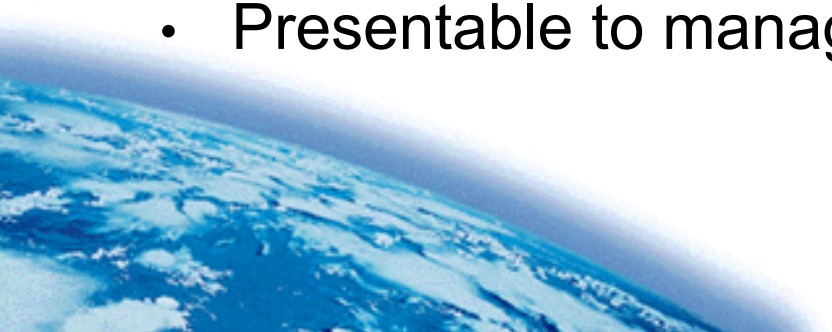
- To move away from time based inspection governed by minimum compliance with rules, regulations and standards for
inspection.
- To apply a strategy of doing what is needed for safeguarding integrity and improving reliability and availability of the unit by planning and executing those inspections that are needed.
- Risk Based Inspection provides economic benefits: less inspection, shorter shut down, longer run length, no unplanned shut down.
- Risk Based Inspection safeguards integrity.

Why apply Shell-RBI

Knowledge transfer is the basis for S-RBI; putting expertise on site is an investment in the future of the site. Leading to further improvements on existing plant and much reduced cost in developing maintenance programmes for new plants

“Do It Yourself” Route offered by Shell Global Solutions

- Recognition of expertise / knowledge of local staff
- Ownership / commitment of local staff
- Structured approach (manual and software tool)
- Compliance with API RP 580
- Facilitation
    - training in methodology
    - guidance / challenge during analysis
    - link to operational experience from similar units
    - link to knowledge database of Shell
- Focus on inspection plan (not only on risk)
- Presentable to management and regulators



S-RBI in Comparison With API Standards

API 510 Pressure Vessel Inspection code
API 570 Piping Inspection code
API RP 580 Risk Based Inspection

S-RBI FULLY IN LINE WITH API REQUIREMENTS:

- involve various part of organisation
- incorporate likelihood and consequence of failure
- include HSE consequences
- assess all potential degradation mechanisms
- evaluate effectiveness of inspection methods
- re-assessment after process change
- consider design relative to operating conditions
- RBI assessment should be properly documented

S-RBI in Comparison With API Standards

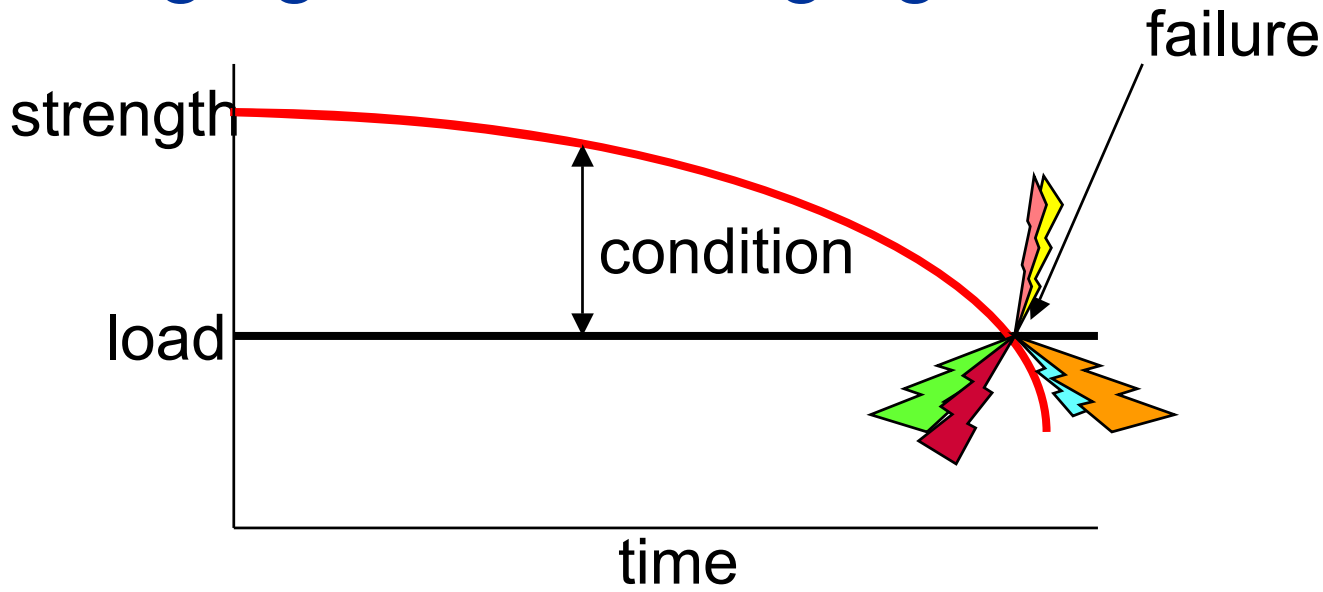
ADDITIONAL ADVANTAGES OF S-RBI

- Team effort is pre-requisite
- Approach is very practical, easy to apply and transparent
- Auditable consideration to assure integrity and define inspection plan
- Corrosion loop concept streamlines the analysis and adds clarity
- Definition of (integrity) operating window
- Comprehensive but concise report
- S-RBI based on long lasting experience and applied within Shell worldwide

How S-RBI achieves risk reduction

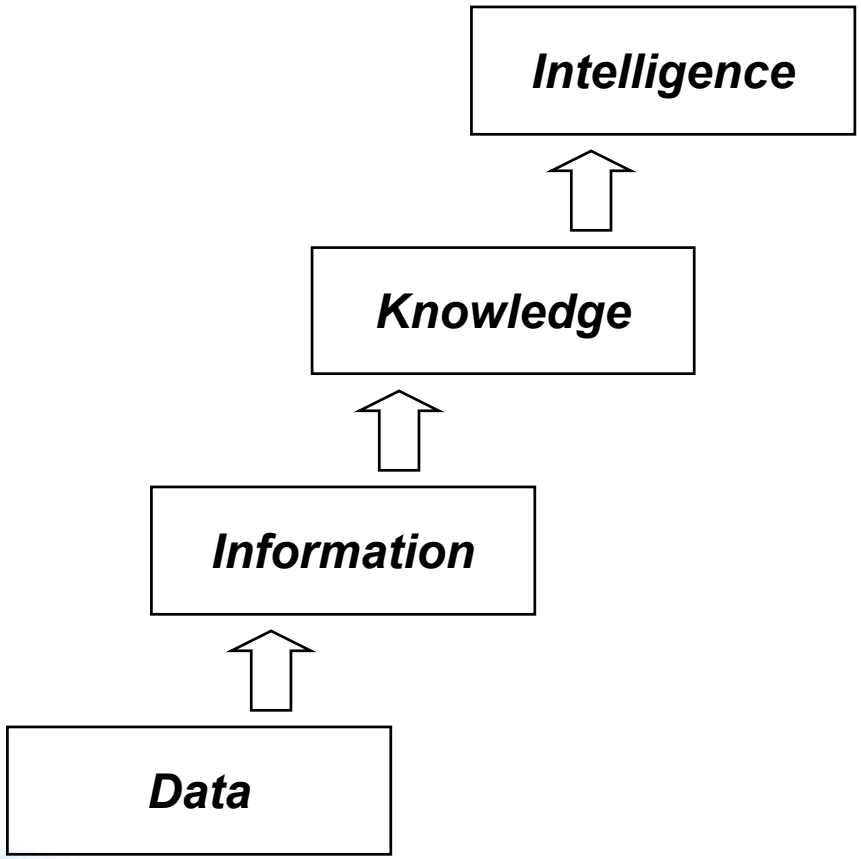
- Better understanding how equipment can fail
  - (inventory of all failure modes and susceptibilities)
- Better understanding of how process and upset conditions affect degradation of the pressure envelope
- Better interpretation of past inspection results and more insight in true equipment condition
- Results of S-RBI studies are “moderate steps out” of frequency
  - (on average an interval extension of 2 years)
- Results of S-RBI are significant changes of inspection strategy
  - (how, how much and where)

Managing Effects of Aging

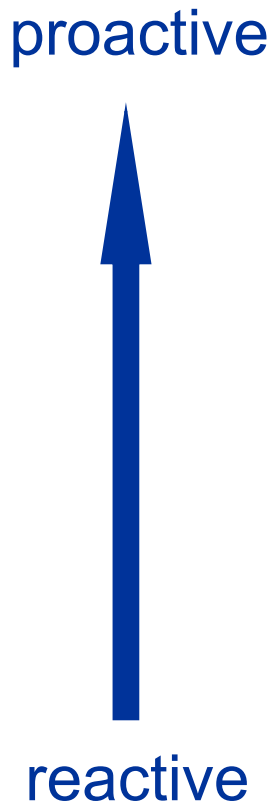


- The objective of inspection is to reduce the probability of failure
- What Inspection mainly achieves, is improved confidence in knowledge of true vessel condition with respect to pressure integrity

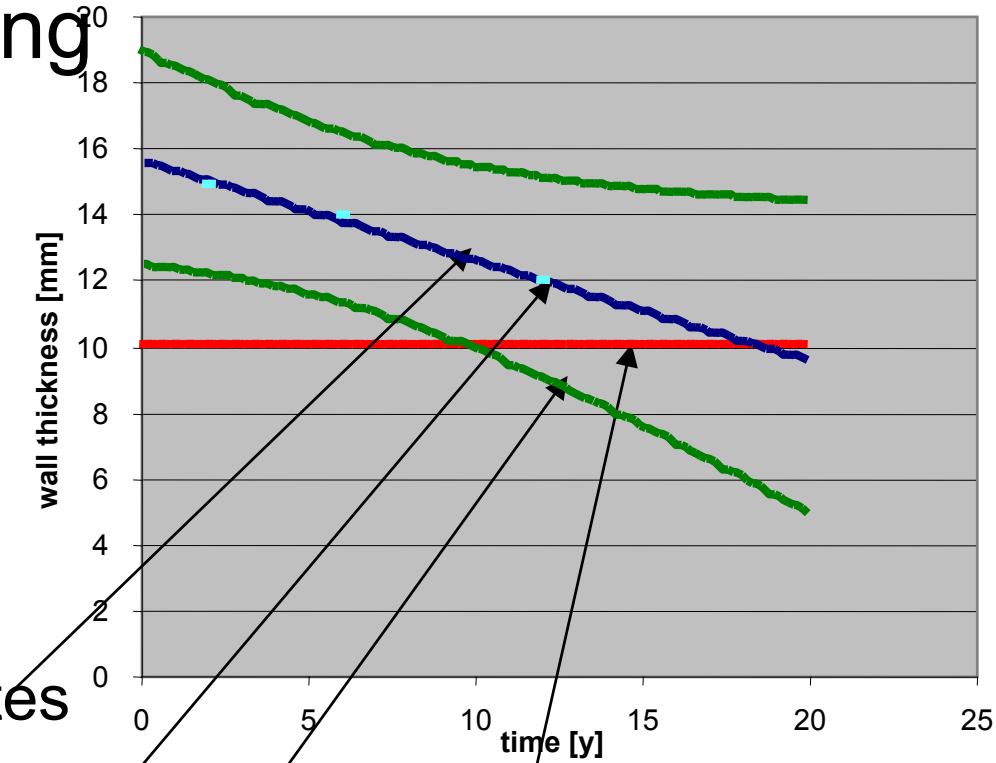
Managing Effects of Aging



- Influence the Future Risk
- Ability to predict future Condition
- Recognise Parameters that affect susceptibility to failure
- Recording Last Condition after Inspection



Managing Effects of Aging



Tools to establish corrosion rates

Tools to establish technical condition

Tools to establish prediction confidence

Tools to establish minimum required wall thickness

Tools to establish minimum required wall thickness

- Escalation of effort based on the probability to undercut:
  - Design Corrosion Allowance
    - Typical design load at 2/3 of yield
  - Trend analysis of past NDT wall thickness measurements
  - Recalculation, using real strength and load values
    - Materials certificate strength
    - Lowering SRV set pressure
  - Fitness For Service analysis
    - API 579
    - BS 7910

Tools to establish technical condition

- Work out active degradation mechanisms
  - Materials and Corrosion expertise
- On-stream inspections
  - Appropriate techniques (i.e. for high temperatures)
  - Quantified results
- Visual internal inspections
  - Often qualitative results
  - Improved reporting with help of digital cameras

Tools to establish corrosion rates

- From inspection history (experience)
- From other equipment in same Corrosion Loop
    - With same materials of construction
    - Subjected to same operating severity
    - Part of same Operating Window control
- From Corrosion Models
- From expertise of Materials and Corrosion Engineers

Tools to establish prediction confidence

- Inspection effectiveness and accuracy
- Integrity Operating Windows (pH, temp, partial pressures)
- Condition Monitoring and reporting of Plant Upsets

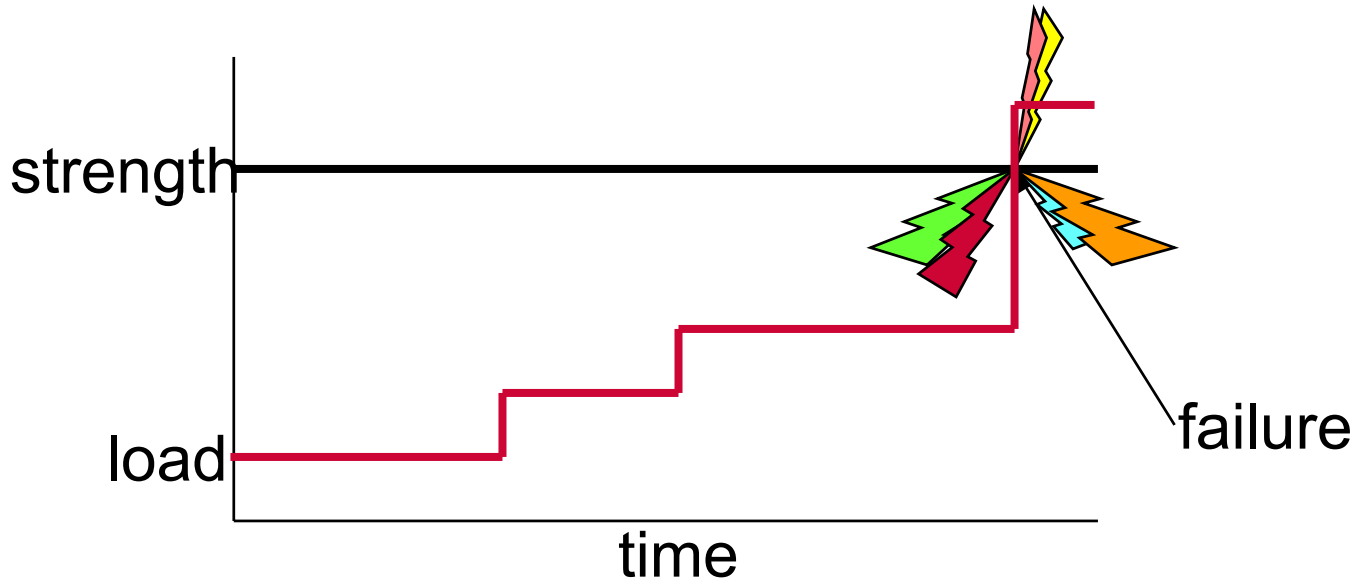
Reaction of Authorities to S-RBI (Examples)

- **NETHERLANDS**
  - Changed rules from time based to flexible interval between 4-8 yrs
  - S-RBI first method accepted to determine interval, after extensive presentation of method and results (audible considerations / analysis)
- **GERMANY**
  - time based, 5 yr interval for intrusive inspection
  - S-RBI results accepted on individual basis to define "replacement" inspection (exemption rule), i.e. every other 5 yr onstream / external inspection

Reaction of Authorities to S-RBI (Examples)

- **MALAYSIA**
  - time based, but acceptance of S-RBI results on a case-by-case basis
- **JAPAN**
  - time based, but gradual increase from 1 to 4 yrs
  - S-RBI results used to convince users (and authorities) of sustained integrity at longer intervals
- **UNITED KINGDOM**
  - self regulating, maximum interval 12 yrs
  - S-RBI results used to discuss intervals above 12 yrs

Management of Debottlenecking



- Management of Change

Plant Change Management

The management of changes to the existing situation is an integral part of Asset Management

TO ENSURE

That there is no detrimental effect on Integrity, Reliability and Safety.

And that the change/modification is cost effective and in line with business premises.

What is a Plant Change / Modification

- Any variation or modification that changes the plant from one state or form to another
- Concerning hardware, operational design window or process conditions
  - Independent of money involved
  - Independent of party executing

Plantchanges

- Small but numerous
- As complex as full scale projects
- Continuous effort
- Understanding and managing of the process is essential

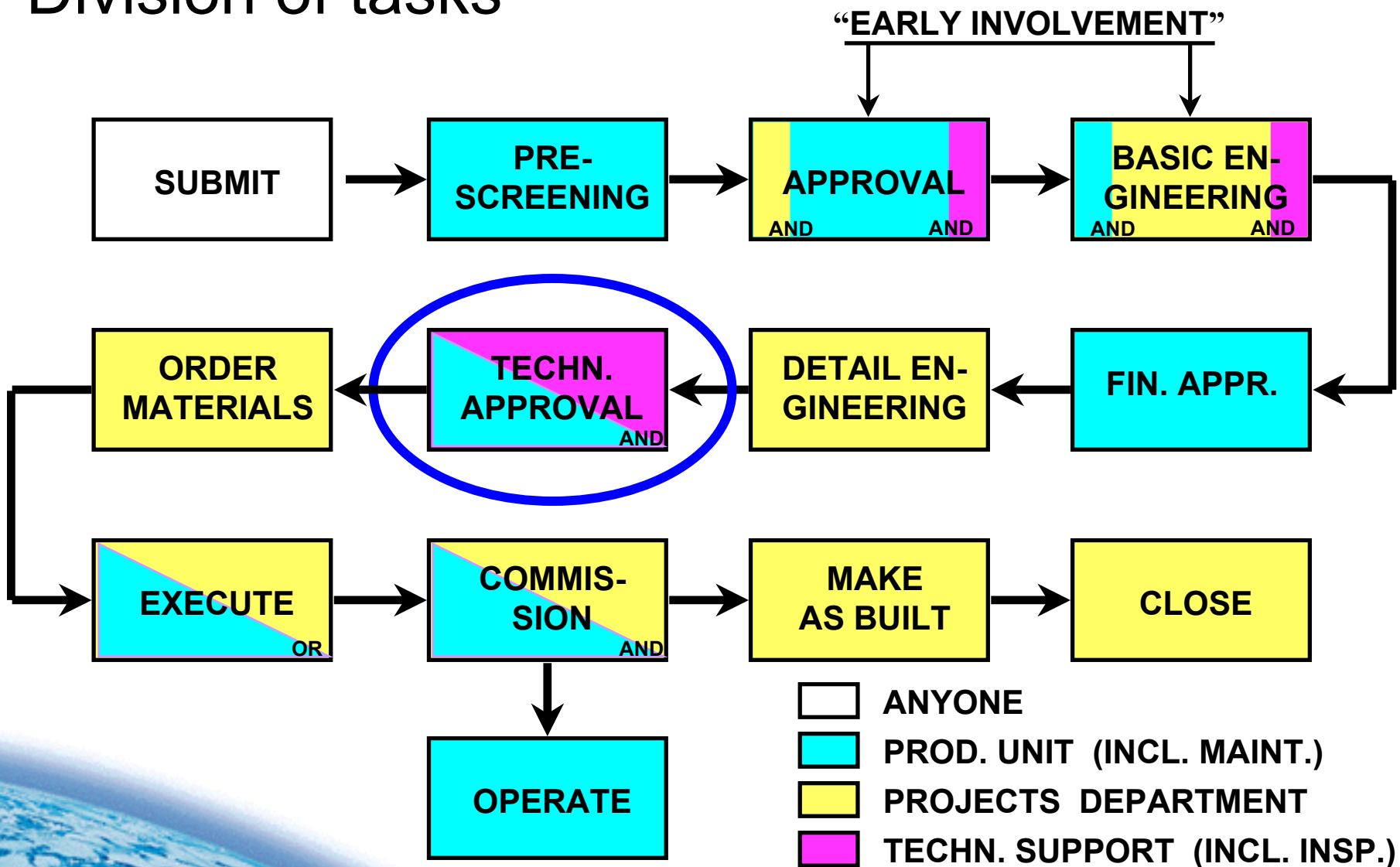
Families of Plantchanges

- Process and Process Operation
- Engineering
- Temporary Changes

Management System Requirements

- Standard Registration Form/System
- Traceable System
- Roles
- Responsibilities
    - Safety assessment checklist
    - Technical Approval
- Competencies
- Part of Quality System (Auditable)

Division of tasks



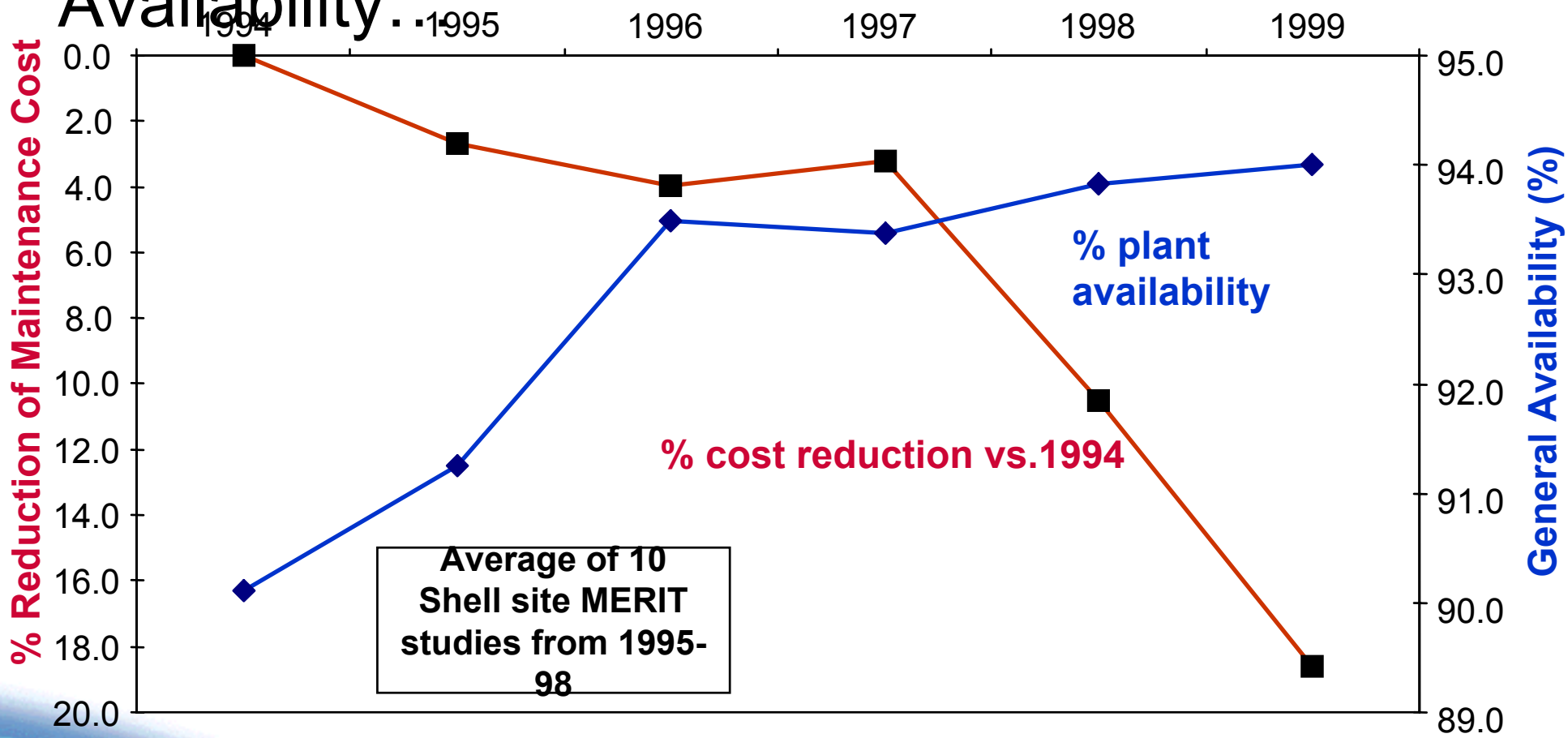
Workload Management

- Too much work
  - Fragmented/unfocussed initiatives
  - criticalities and priorities undefined
- Not feeling in control
  - Too many schedule upsets
  - Fire-fighting
  - Low execution compliance with plans
- Too much waste
  - Non-value-adding activities
  - Poor planning and scheduling
  - Internal competition, silos, lack of trust

Soft issues

- HR and Relationship Management
- Business process based management
- Must manage and utilise large quantities of data
- Must be a change manager
- Competency Assurance
- Managing rather than solving technical problems
- Leadership as opposed to management
- Status quo = continuous change
- Competency mapping

Achieved Maintenance Cost & Plant Availability…



…Without Compromising Safety