Equipment Design and Reliability from Design to Decommissioning

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Equipment Design and Reliability from Design to Decommissioning

- Design Reliable Equipment
- Operational Environment
  - Culture of Safety
  - Human Factors Program
- Design for Operational, Extreme and Survival Loads
- Risks Analysis, Assessment and Management
Designing For Reliability

Everything starts with the design and finishes with a Risk Management.
Designing For Reliability

“If I am an engineer, I better damn well understand what reliability and what failure means, otherwise I am not an engineer...”, Maxime Faget
The History of Safety

- Number & Severity of Injuries
- No Formal Interest
- Reactive Era (Incident Based)
- Preventive Era (Process Based)
- Behavioral Era (Observation Based)
- Creative Era

Time
Incident Prevention Filters

- Leadership
- Principals
- Management System
- Processes and Procedures
- Safety in Design Systems
- Physical Protection
- Human Behaviors
- Equipment and Tool Conditions
- Facility Conditions
- Working Conditions
- Near Miss Incident
- LUCK
- Injury or Worse!
The Integral Model of Safety

SUBJECTIVE

I
D
I
V
I
U
D
A
L
C
O
M
P
A
N
Y

BEHAVIORS
PLANS
ACTIONS
DECISIONS
PERFORMANCE
ACCURACY

SYSTEMS
ORGANIZATIONAL STRUCTURES
WORK PROCESSES
POLICY AND PROCEDURES
SHARED METRICS
CONTRACTS
SEMS
REGULATIONS

INTENTION
VALUES
ATTITUDE
COMMITMENT
RESPONSIBILITY
EXPERIENCE

cULTURE
SHARED VALUES
ETHICS
MORALE
MYTHS AND LEGENDS
JUSTICE
FAIRNESS
COVENANTS
Reliability Based Design Theory

- Load Historical Data
- Tension
- Pressure
- Human Decisions
- Weight
- Automated Interfaces
- Equipment Performance Data
- Yield
- Wall Thickness
- Ovality
- Stress-Strain Curve
- Eccentricity

Reliability Based Design: As outlined in API Spec 5C1 (ISO 10400)
Reliability Based Design

Probability Of Failure

Pf = the area when the load exceeds the capacity

Target Capacity

Target Capacity = weighted Value of the bottom 2 ½%
Design Concept – Load Variability

Design Risk = Probability (Load > Capacity)

LOAD

- Operating Load
- Extreme Load
- Survival Load
- Safety Factor/Design Margin

Probability Density

LOAD Uncertainty

RESISTANCE

- Capacity
- Capacity Uncertainty

Magnitude

Safety Factor (SF) = 1.6

1%
Design Concept - Reliability

Design Risk = Probability (Load > Capacity)

LOAD

RESISTANCE

Probability Density

Operating Load

Load Uncertainty

Capacity

Capacity Uncertainty

Pf = Probability of Failure

SF = Increase Reliability
Design Concept - Human Factor

Design Risk = Probability (Load > Capacity)

LOAD

RESISTANCE

Central Tendency ($\mu$)

Uncertainty ($\sigma$)

Load Uncertainty

Probability Density

Magnitude

SF

Capacity

Pf

Pf = Probability of Failure
Design Concept - Human Factor & Reliability

Design Risk = Probability (Load > Capacity)

LOAD

RESISTANCE

Central Tendency ($\mu$)

Uncertainty ($\sigma$)

Load Uncertainty

Probability Density

Pf = Probability of Failure

SF

Capacity

Increase Reliability

$P_f$ = Probability of Failure
Risks Analysis, Assessment & Management

Risk models have different levels of detail – but most work in a similar manner