



**ORS**

# FUNCTIONAL SAFETY / “SIL” IN PROCESS INDUSTRIES

***BARIS ARSLAN***

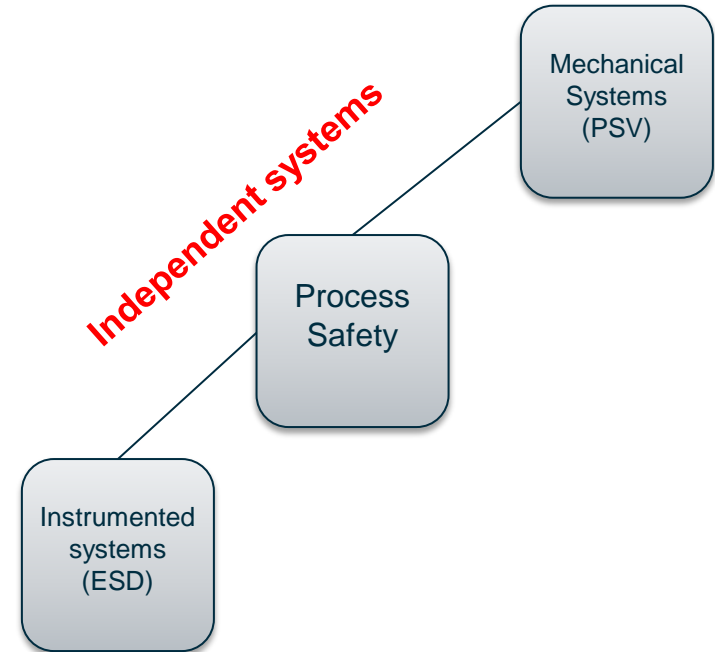
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THE 10<sup>TH</sup> TANK & REFINERY CONFERENCE, COPENHAGEN, DEC 2017

# PROCESS SAFETY IN PETROLEUM- OCH PETROCHEMICAL INDUSTRIES

- Control and mitigation of fires & explosions in the process industries – **main concern!**
- As a part of traditional process design, two different protection layers are installed to avoid accidents
- Typically, it is achieved by
  - An electrical system (instrumented), such as Emergency shutdown system (ESD)
  - A mechanical system – such as Pressure Safety Valve (PSV) or similar
- These systems are called primary and secondary
- Primary and secondary systems are independent of each other!





Sensor



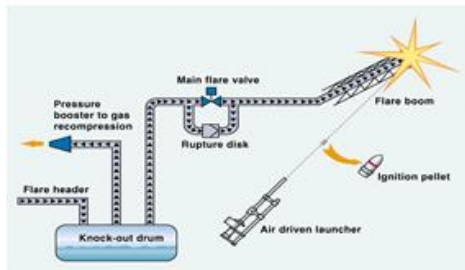
Logic



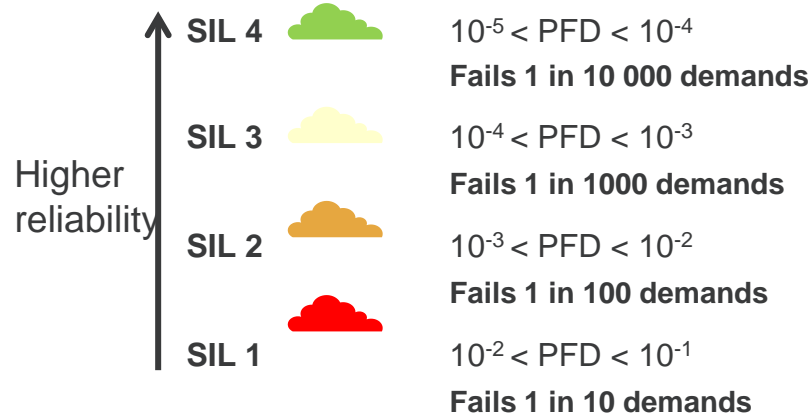
Final

Vad vet du om Nobelpristagaren i litteratur?

<p>Kjell Mäki, Haparanda. - Jag känner igen namnet, - Jag är definitivt. Men jag kommer inte på något att säga om honom.</p>	<p>Robert Jäcobsson, Umeå. - Ha ha... In- dett jota. Vad hette han? Harold Pinter?</p>	<p>Gunvor Jönsson, Storuman. - Ingen aning. Har aldrig hört namnet förut.</p>	<p>Moa Malm, Skellefteå. - Jag kommer från Skellefteå så jag vet inte någonting.</p>	<p>Inger Forsberg, Bygdeå. - Ingenting. Har aldrig hört namnet.</p>	<p>Lisbeth Brogren, Lund. - En dramatik- er? Som fått författar- priset? Jät- teintressant. Har aldrig hört namnet.</p>



Maximum one (1) system failure in 500 Times?



**SIL Requirement:**  
**Functions+Integrity+Condition**

# CONTAINMENT OF FLAMMABLE/EXPLOSIVE INVENTORIES IN PROCESS

**IEC 61511**

Safety Instrumented Systems for the  
Process Industry

**IEC 61508**

Functional Safety of Electrical/Electronic  
and programmable electronic safety related  
systems

ISO 13702 Control and mitigation of fires  
and explosions

ISO 10418 Basic Surface Process Safety  
Systems

API 14 C  
(Process Safety)

API 521  
(Depressurization, Pressure-relief)



PROTECTION LAYERS



PROBABILITY OF FAILURE

## FUNCTIONAL SAFETY FROM A LIFECYCLE PERSPECTIVE

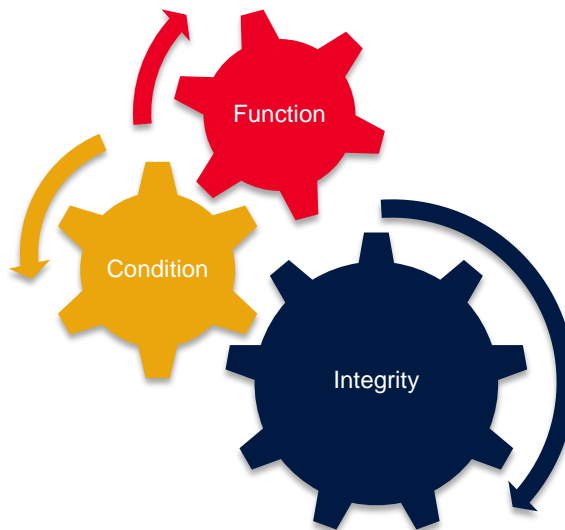
- IEC61511 provides a complete framework for management of functional safety from a lifecycle perspectives.
- Different roles as:
  - Supplier / Vendor
  - Design Realization (Engineering)
  - System Integrator (typically the Operator)
- **INVOLVEMENT OF ASSET OPERATIONS IN SIS DESIGN PHASE IS CRITICAL FOR SUCCESS**

Planning / Verification / Validation / Competence

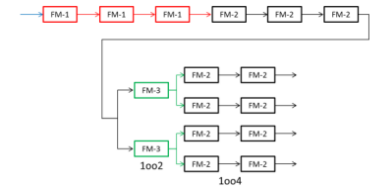
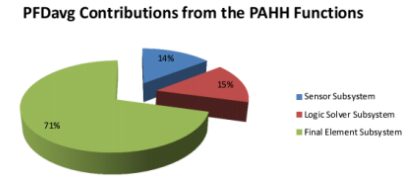
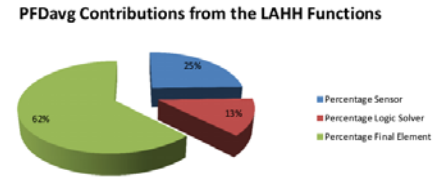
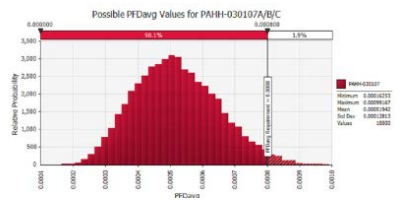
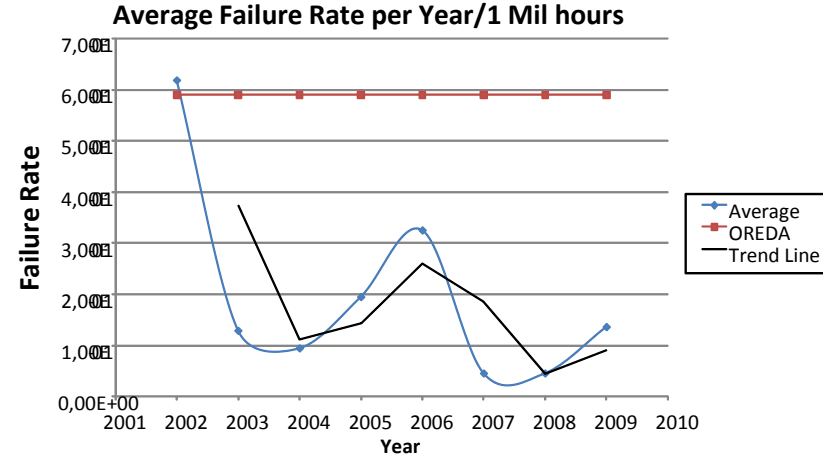
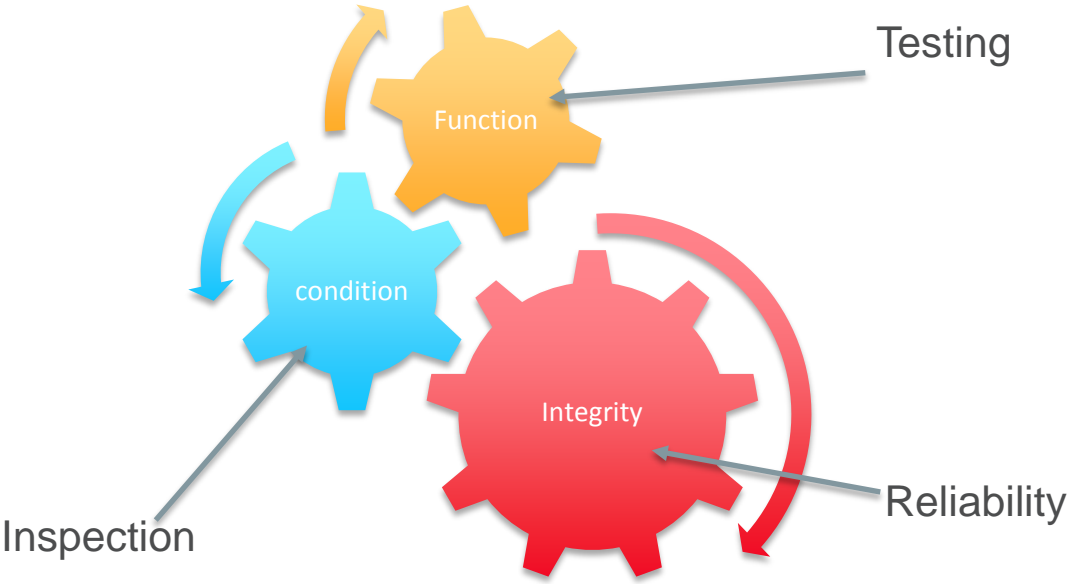


## SIS OPERATIONS PERFORMANCE MONITORING

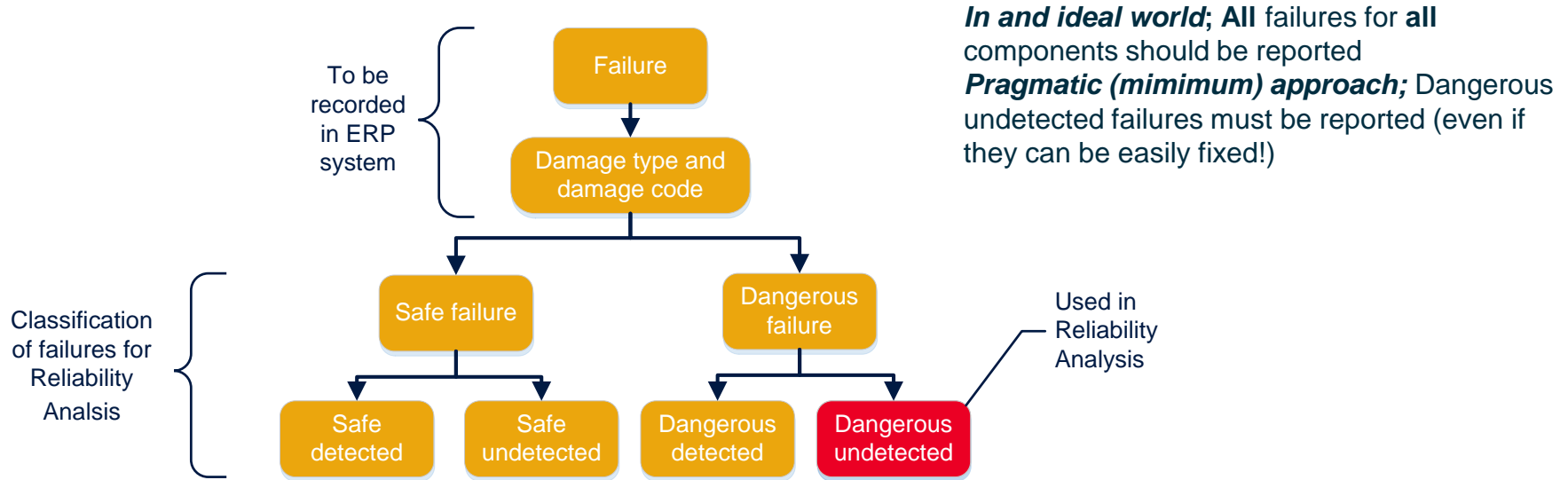
- Functional requirements
- Failure rates (collection and categorization of failure rates)
- Type and number of Demands
- Spurious failures
- Independent protection layers
- Overall PFD/reliability monitoring
- Other issues (systematic failures, Common cause)
- Lifetime monitoring

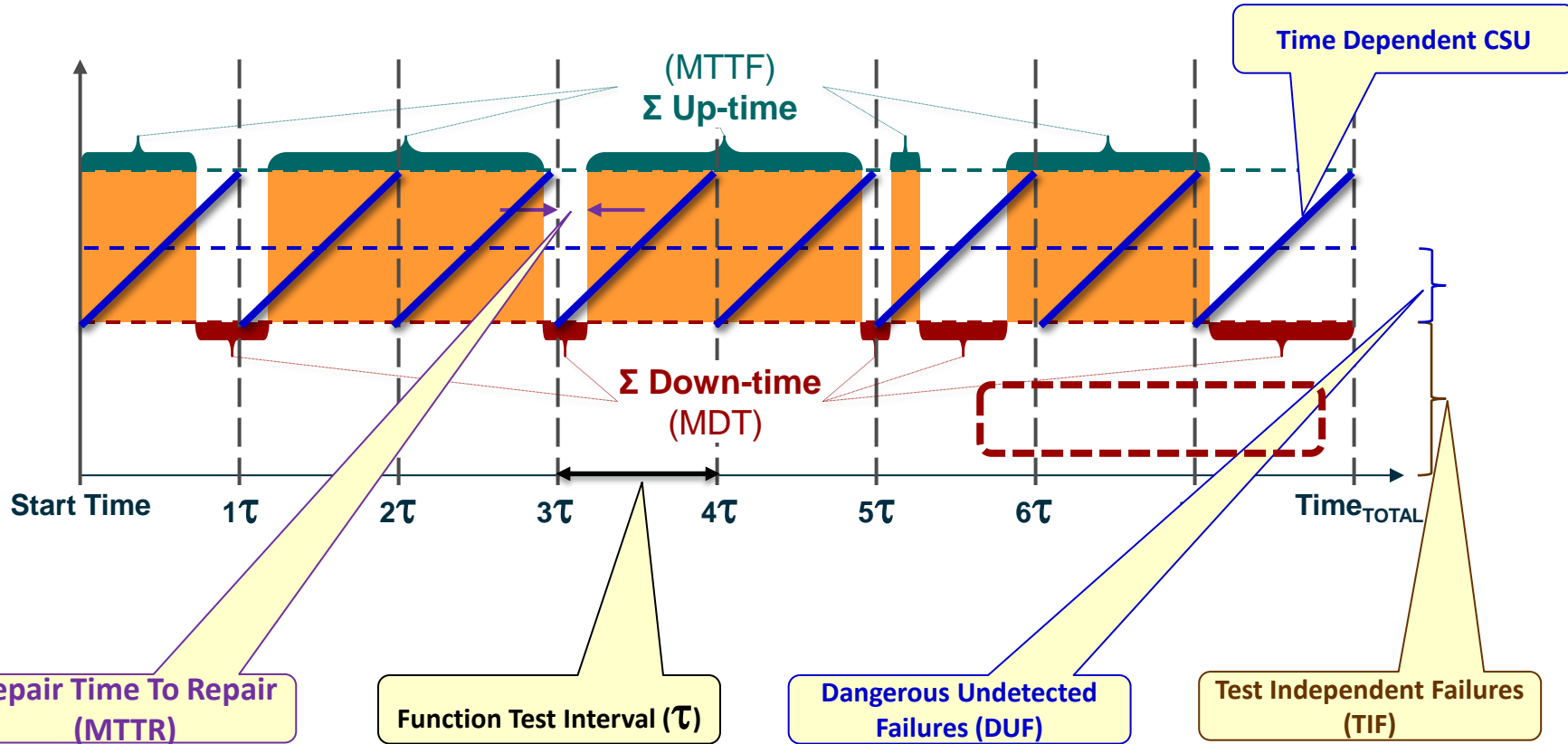


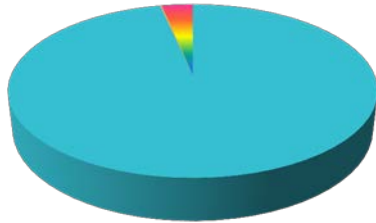




# FAILURE REPORTING – KEEP IT SIMPLE

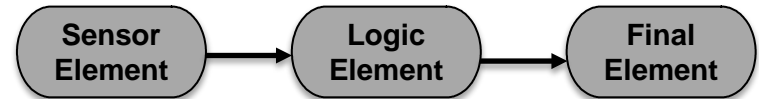






Subsystem	PFD		TIF	CSU
	Common Cause	Random		
Pressure Transmitter	8,86E-6	1,09E-6	2E-6	1,19E-5
Hardwired Logic Solver	-	2,22E-4	1E-7	2,22E-4
HIPPS Valve incl. actuator	-	2,67E-3	2E-6	2,67E-3
Solenoid Valve	-	2,42E-3	2E-6	2,43E-3
<b>Total</b>	8,86E-6	5,32E-3	6,1E-06	<b>5,33E-3</b>

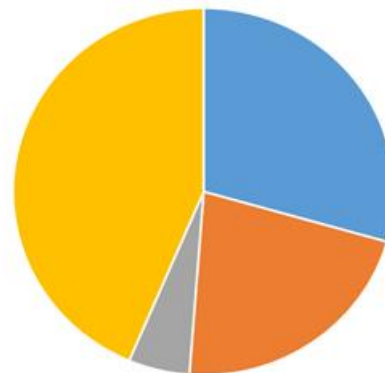
CSU



SIL 2?

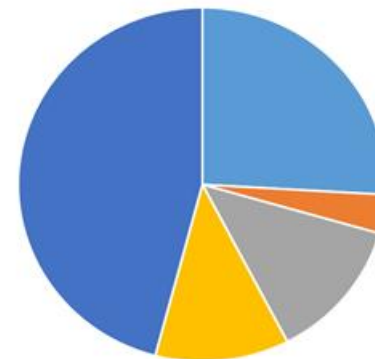
<b>Probability of Detection</b>	Undetected	<b>Our Concern!</b>
	Detected	
		<b>Consequence of Failure</b>
	Safe	Dangerous

FAILURES IN VALVE INVENTORY  
(Topside Equipment; OREDA-2009)



- Valve
- Control and monitoring
- Actuator
- Miscellaneous

FAILURES IN VALVE ITEMS  
(Topside Equipment; OREDA-2009)



- Valve body w/internals - Bonnet
- Flange
- Seat rings - packing - seals
- Closure member (Ball/gate/disc/etc.)
- Other valve components

- **Useful Life-time: Constant failure rate.**

- Not fully true! It is only an assumption - up to 8-10 years.

- **Useful Life-time, Extended: Progressive failure rate!**

- Assumption of constant failure rate invalid
- Not allowed to use constant failure rate.

