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SUBSEA PRODUCTION AND PROCESSING

3.12 Optimizing Condition Monitoring For Dynamic Health And Risk Management

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Agenda

- ESREL (2018) - Conference Paper

✓ Research question (targeted)

✓ Methodology

✓ Simulations & Results

✓ Future work

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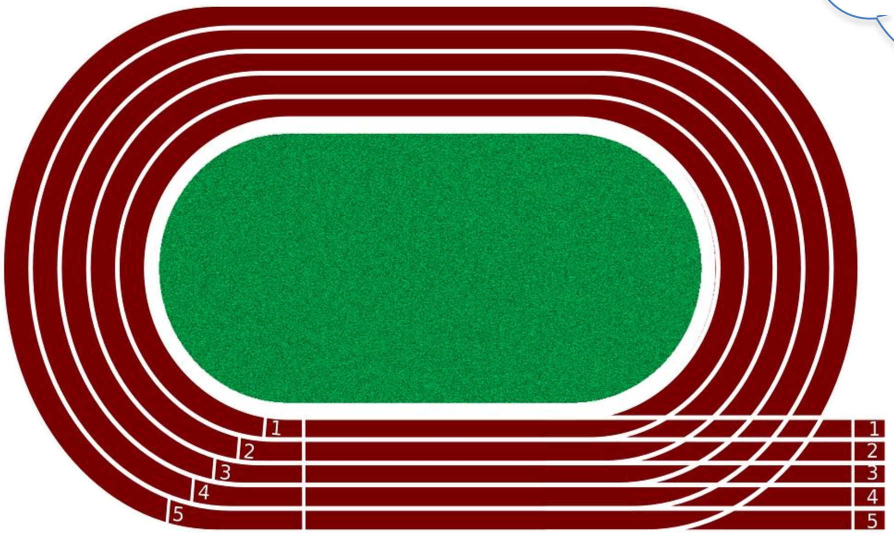
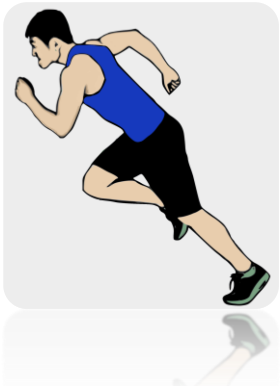
Optimization of Periodic Inspection time of SIS subject to a regular Proof Testing

Authors : Srivastav Himanshu, de Azevedo Vale Guilherme, Barros Anne, Lundteigen Mary Ann, Pedersen Frank Børre , Hafver Andreas, Oliveira Luiz Fernando

1. Research Question - Example





1. Research Question

- Safety Instrumented Systems (SIS)

✓ Passive (activated on demand)

✓ Not continuously monitored

✓ Periodic proof testing is required to gain information about its status

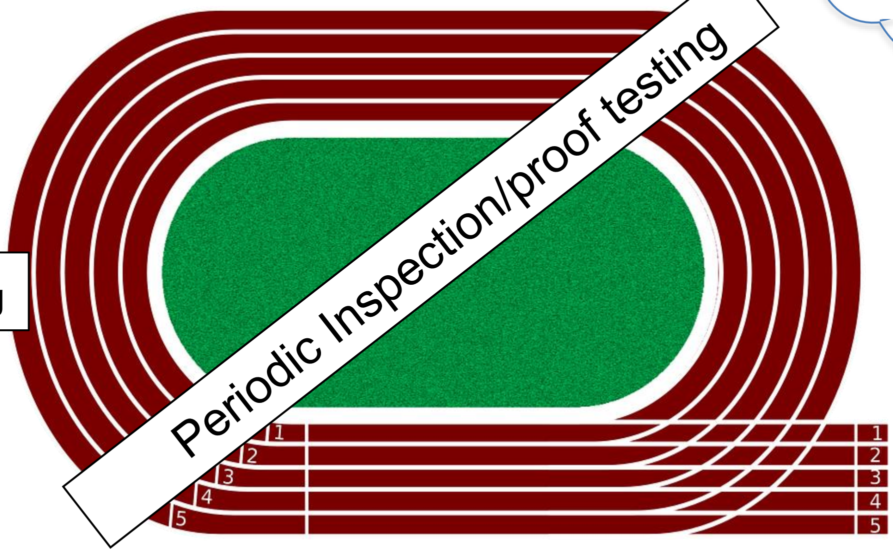
✓ But …..Proof test induces "negative effect" (some cases) – makes SIS more prone to failures increases "Unavailability"

✓ Measure of "Unavailability" considered is PFD_{avg} (governed by SIL(safety integrity levels))

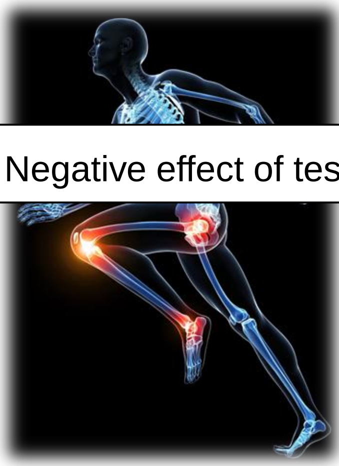
1. Research Question

Availability (PFD_avg)

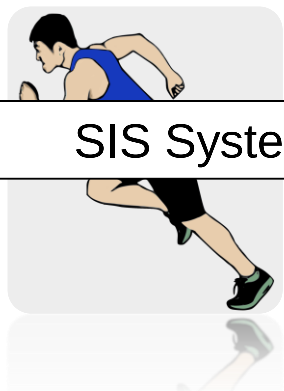
Safety requirements (SIL)



Periodic Inspection/proof testing



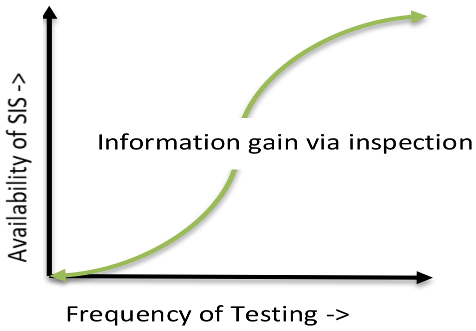
Negative effect of testing

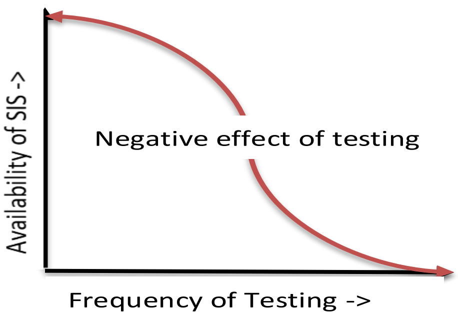


SIS System

1. Research Question

- Study the potential **negative effects** of testing on a system operating in **low demand mode**
- Determine a **trade-off** between frequency of **gaining information** (e.g. tests/inspections) versus **its negative impact**





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2. Methodology

- Multiphase Markov Process

✓ DU failures (only)

✓ Two types: Sudden failures – λ_u , effect of aging - λ_a

- Modelling of “negative test” of proof test

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3. Simulations & Results

- Single event simulation
- Range for the frequency (ζ) considered are

✓ 3 d, 6 d, 15 d, 21 d, 1month, 2 m, 3 m, 4 m, 5 m, 6 m, 7 m, 8 m, 9 m, 10 m, 11 m , 12 m. (d: days, m: month)

- Selection of failure rate is based on SIL requirement
- Life time: 5 years
- Maintenance policy considered:

✓ AGAN (As good as new - Expensive)

✓ AGAO (As good as Old - Economical)

3. Simulations & Results

- Effect of different maintenance policy on PFD_{avg}
- Effect of changing failure rate λ_a on PFD_{avg}
- Effect of changing failure rate λ_u on PFD_{avg}

4. Future Work

- Analytical Models
- Include effect of DD failures
- Effect of predictive maintenance & redundancies


THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
DANKSCHEEN
TASHAKKUR ATU
YAQHANYELAY
SUKSAMA
BIYAN
SHUKRIA
GRAZIE
MEHRBANI
BOLZÏN
MERCI
GOZAIMASHITA
EFCHARISTO
JUSPAXAR

6. Instantaneous transitions rate for the multiphase Markov process are represented in the figure 4.

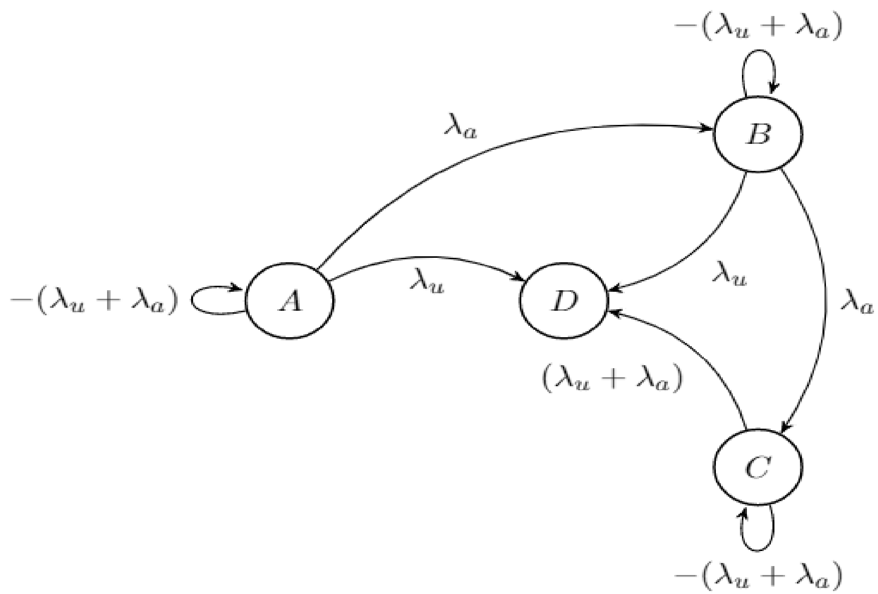

Figure 4: Instantaneous transition rates for the multiphase Markov process

7. In the figures above λ_a represent the effect of ageing on the system, and it will change every time when a proof test is performed on the system. We consider that the proof test has a negative effect on the system condition (shock leading to extra stress) and this negative effect increases ageing transition rates. The modelling of impact of shock is done using the following model.

$$\lambda_a(t_0^+) = \begin{cases} 1.01 * \lambda_a(t_0{}^-) & \text{when system in State A at } t = t_0 \\ 1.03 * \lambda_a(t_0{}^-) & \text{when system in State B at } t = t_0 \\ 1.05 * \lambda_a(t_0{}^-) & \text{when system in State C at } t = t_0 \end{cases}$$

We assume here that a test has occurred at $t = t_0$ and if system is in the failed state at the time of proof test the $\lambda_a(t_0^+)$ is set to λ_a corresponding to the $t = 0$ as we repair system which is as good as new.

Effect of different maintenance policy on PFD_{avg}

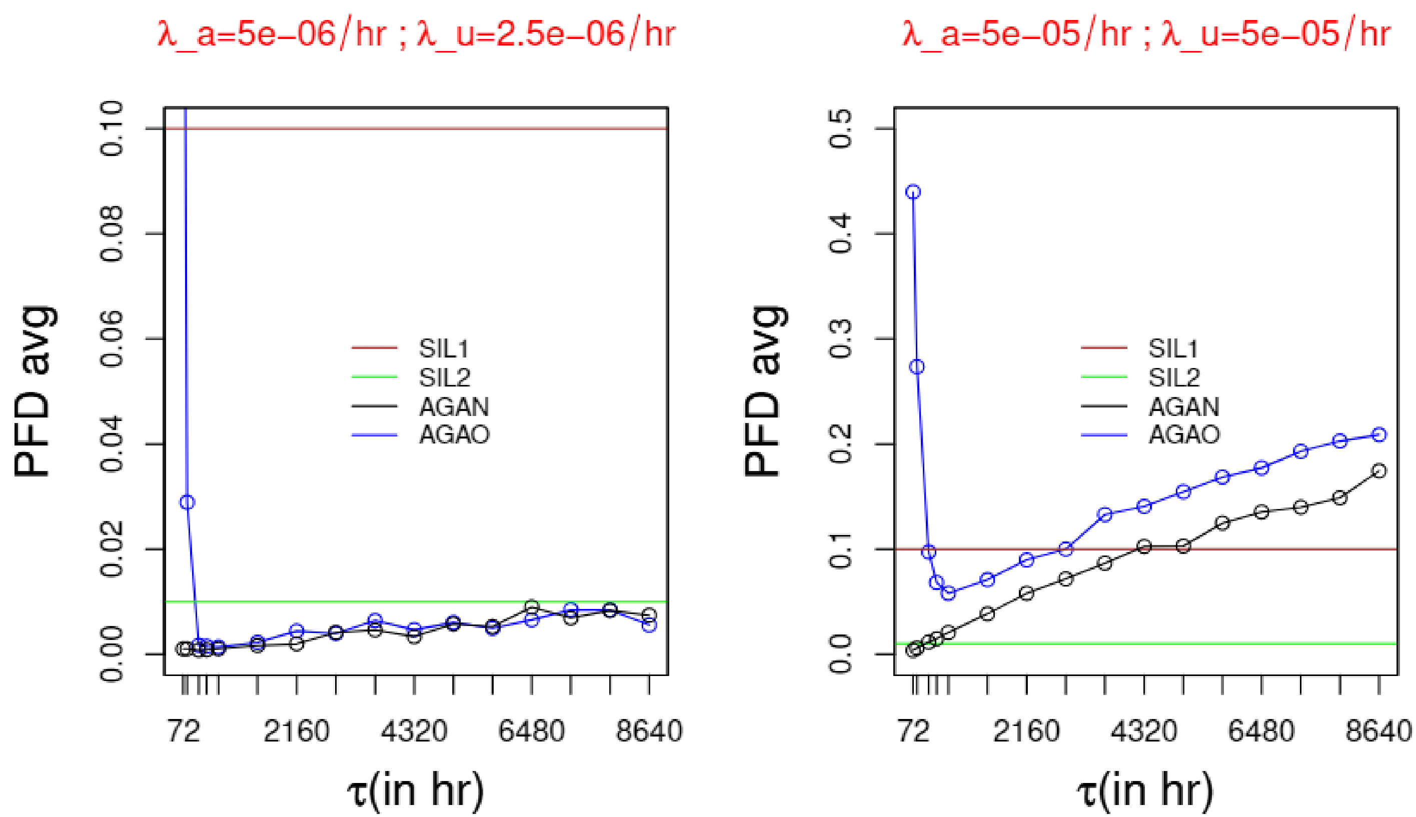

Figure 5: Effect of different maintenance policy on PFD

Effect of changing failure rate λ_a on PFD_{avg}

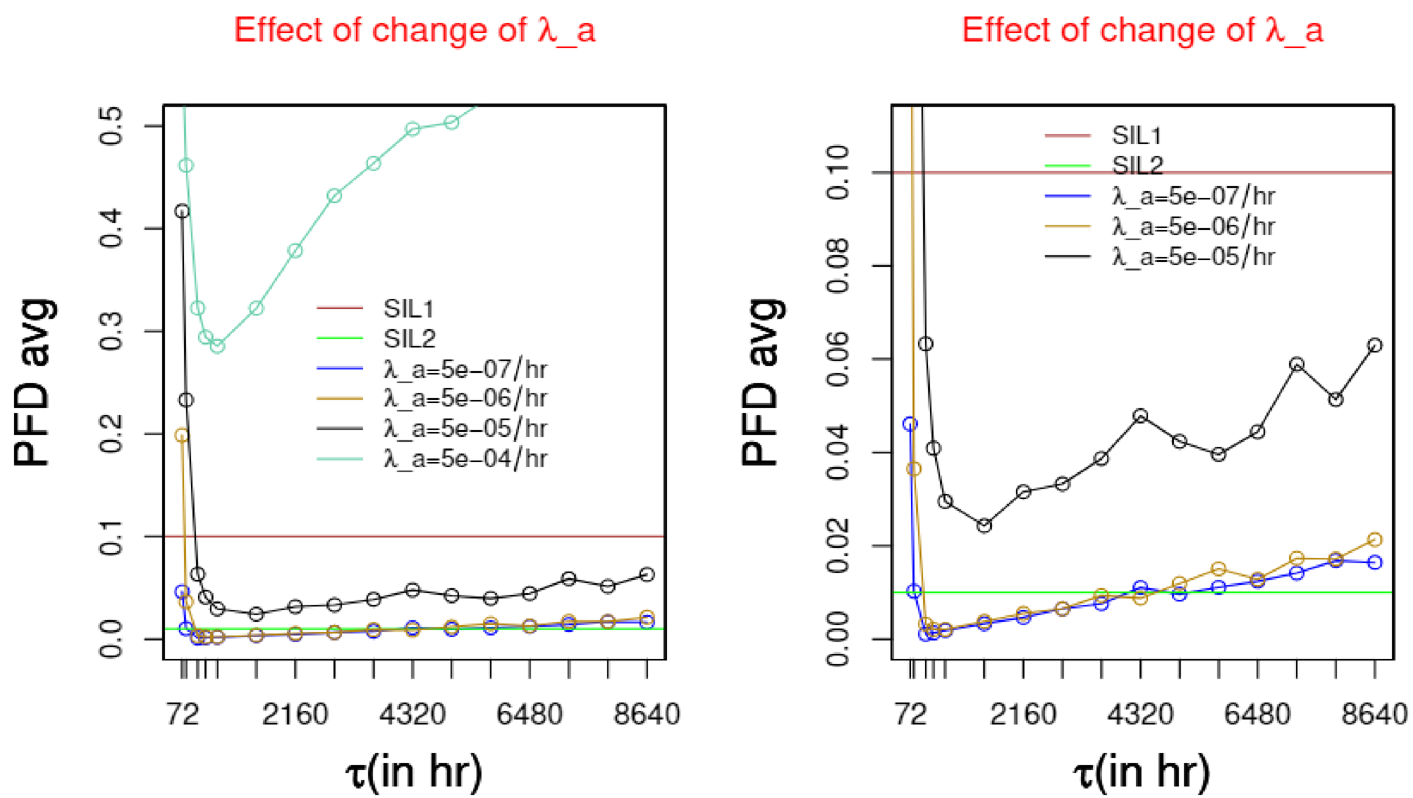

Figure 6: Effect of changing failure rate λ_a on PFD_{avg}

Effect of changing failure rate λ_u on PFD_{avg}

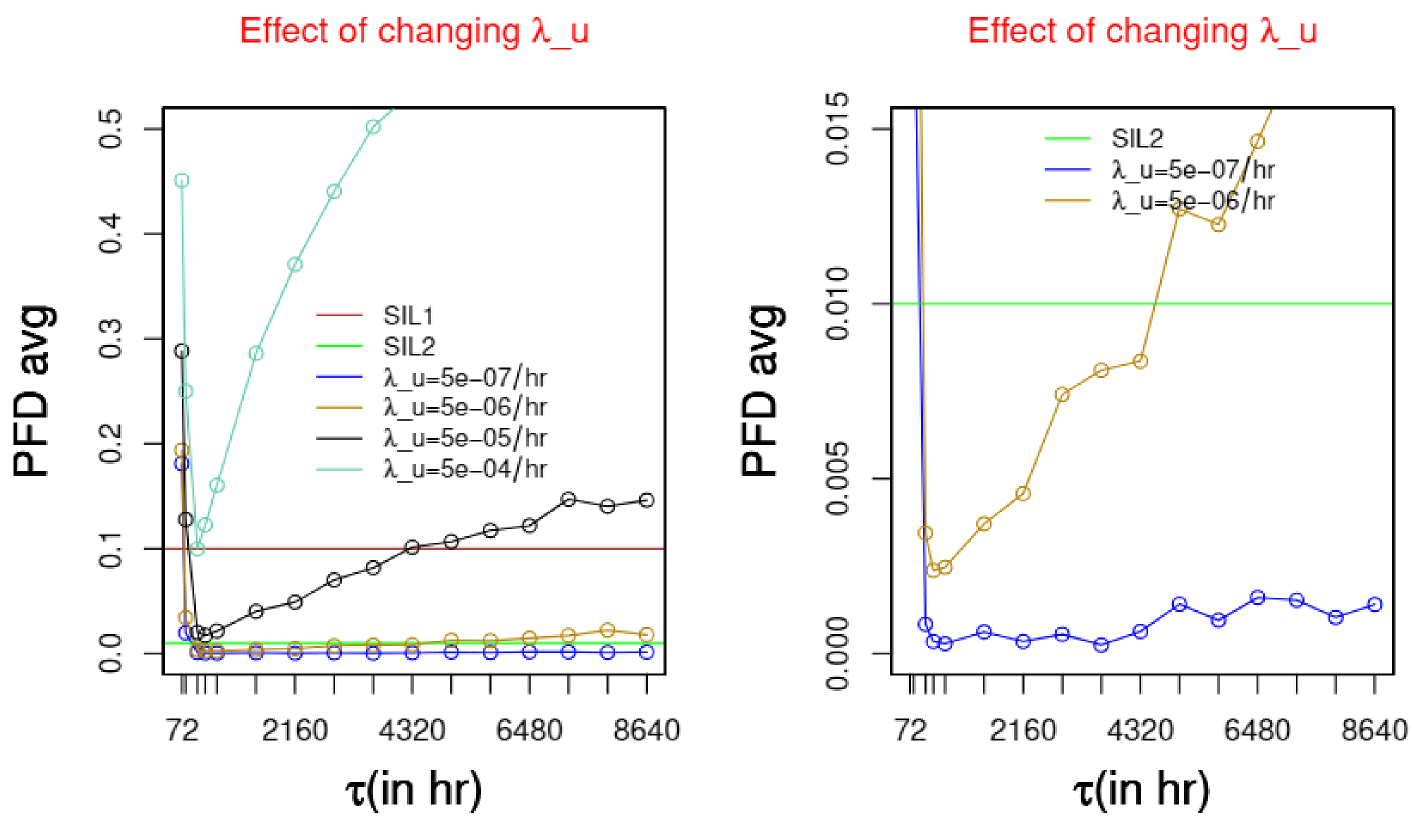

Figure 7: Effect of changing failure rate λ_u on PFD_{avg}