1. Introduction

This article describes how, using modern tools such as SimulationX®, and models of control systems can be used to perform evaluations of a 'Brown Field' site in order to predict potential system failures before they occur.

The fundamental objective in performing an evaluation of the production control system with a simulation tool is to ensure that the behaviour of the integrated system will meet the acceptance criteria as stated in the relevant ISO documents, as well as those specified by the client. When combined with extensive system knowledge, SimulationX® can be used to conduct a system trend analysis on an operational 'Brown Field' development identifying system performance degradation and consequently reducing the risk of production loss. These losses may also represent unacceptable levels of risk to people and the environment.

2. Using SimulationX® to predict failures in a control system

Can potential failures be identified by simulation?

The simple answer is yes. In conjunction with using variable system parameters, simulation models are built and utilised as tools to simulate and predict degradation trends in the equipment components. These trends can be further used to establish a mitigation strategy for preventative maintenance of the field.

3. Where to start

All control systems have initial simulation and analysis results as a baseline. The areas of the system that could potentially cause a catastrophic failure and potential loss of production can now be identified. This is best established with a Risk Assessment - defining risk categories and building a Risk Assessment Matrix.

Typical Risk categories Format can be defined like this;

Category	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Significant	H	M	M	L	L
Minor	M	L	L	L	L

	Risk Definition	Many events, without proper planning, can have unreasonable levels of risk. However, By applying risk management strategies, you can reduce the risk to an acceptable level
E	Extremely high risk	Activities in this category contain unacceptable levels of risk, including catastrophic and critical injuries that are likely to occur, and/or serious environment repercussions. Organisations should consider whether they should eliminate or modify activities that still have an "E" rating after applying all reasonable risk management strategies
H	High Risk	Activities in this category contain potentially serious risks that are likely to occur. Application of proactive risk management strategies to reduce the risk is advised. Organisations should consider ways to modify or eliminate unacceptable risks
M	Moderate Risk	Activities in this category contain some levels of risks that are Unlikely to occur. Organisations should consider what can be done to prevent any negative outcomes.
L	Low Risk	Activities in this category contain minimal risk and are unlikely to occur. Organisations can proceed with these activities as planned

An example of a simplified Risk Assessment Matrix can be defined like this;

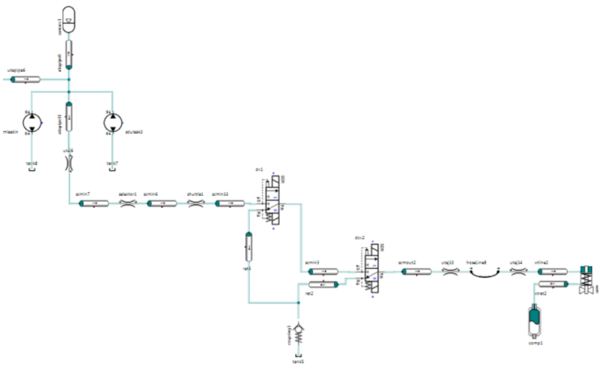
Sub system	**Description of Performance Degradation**	**Risk**	**Consequence**	**Severity**	**Probability**	**Risk**
Specific equipment element in the system	Level of input characteristics that has changed	Describe the effects on field operability, control etc.	Safety, Loss of Production etc.	Increased pressure recovery time		
SCM DCV	Minor Leakage	Supply pressure decay until DCV fails to stroke open	Minor	Minor	Likely	Low
SCM DCV	Major Leakage	Supply pressure decay until DCV fails to stroke open	Loss of Production	Critical	Occasional	High
SCM	Minor Leakage	Supply pressure decay until tree valve actuator fails to stroke open	Increased pressure recovery time until Loss of Production occurs	Minor	Likely	Low

An in-depth study of the field is now conducted, with particular attention to detail with regard to the sub components individual degradation, including fatigue, and life cycle characteristic changes. Another key input factor is live feedback data collected from the field.

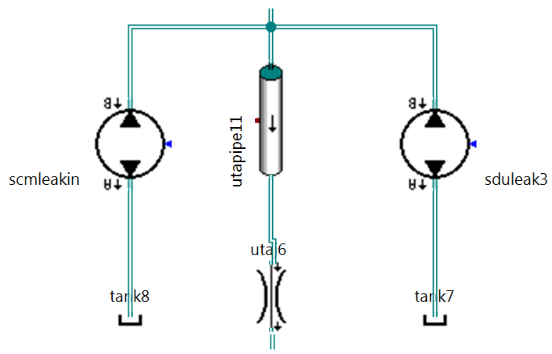
Historically, this has proved to be a challenge to obtain, but is already being produced by the system but needs to be actively recorded. Critically, this data provides information which can give an indication of premature failures in the system, component operation and performance behaviour, and overall system leakages.

4. SimulationX® Model

An example of part of a system model of the in SimulationX® is shown below.



The libraries in SimulationX® allow the user to develop interdisciplinary simulation models fast and efficiently. As shown in the part model below, the hydraulic libraries for example can be used as elements for introducing a fluid loss out of the system.



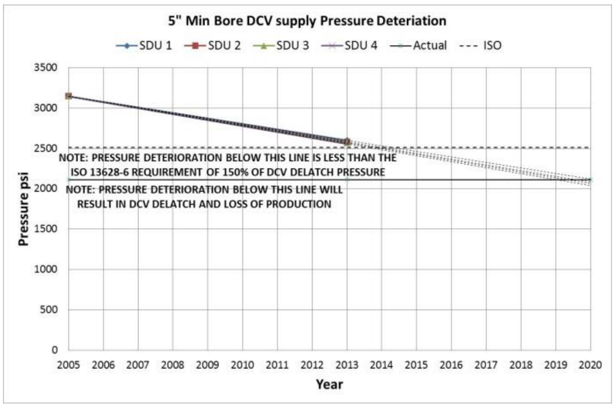
5. Trend Analysis

Initially, sensitivity runs are performed based on given weak point inputs such as hydraulic leaks, friction losses, accumulator pre-charge decay, and connector failure. This will establish performance consequences such as;

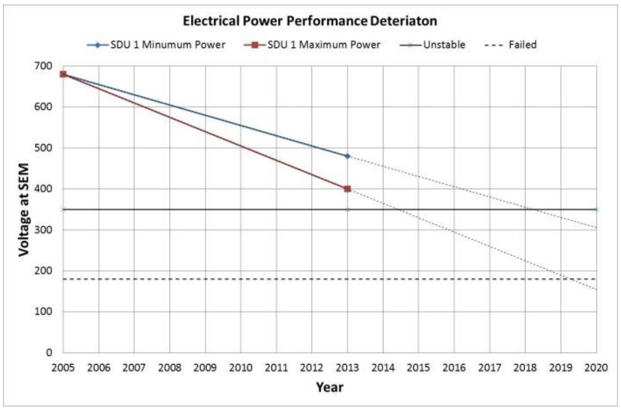
- System charge up time
- Valve closing and opening time
- Power loss and voltage drop

Following these simulation runs, the results can be plotted on a graph, along with the results obtained from the baseline system analysis. From this, the results can be extrapolated into trend lines. These trend lines help in identifying potential modes of failure before they occur, minimizing the effects of an unscheduled production loss.

The following plot illustrates a typical 5” Xmas tree hydraulic actuator operation, and how different leakage points interact with the safe operation of the DCV’s as the system leakage deteriorates over time.



The following plot illustrates electrical power degradation curves for an SDU cluster. As a rule the power supply in this example will become unstable when the SEM receives less than half the voltage delivered from the EPU.



It should be noted that this work is unique to each field, although the process is hereditary.

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