

Annulus Alerting Tool

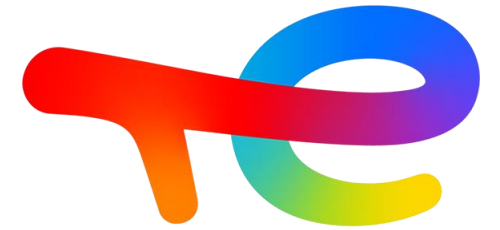
Detecting the onset of 'Abnormal' Annulus Behaviour

A Statistical Annuli Thresholding Proof of Concept

Gregory Orih - TotalEnergies E&P UK Limited

SPE ICoTA European Well Intervention Conference

15th November 2023

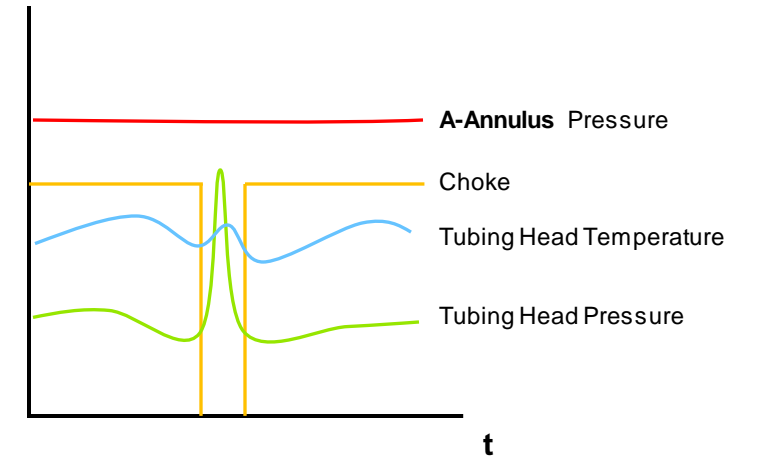
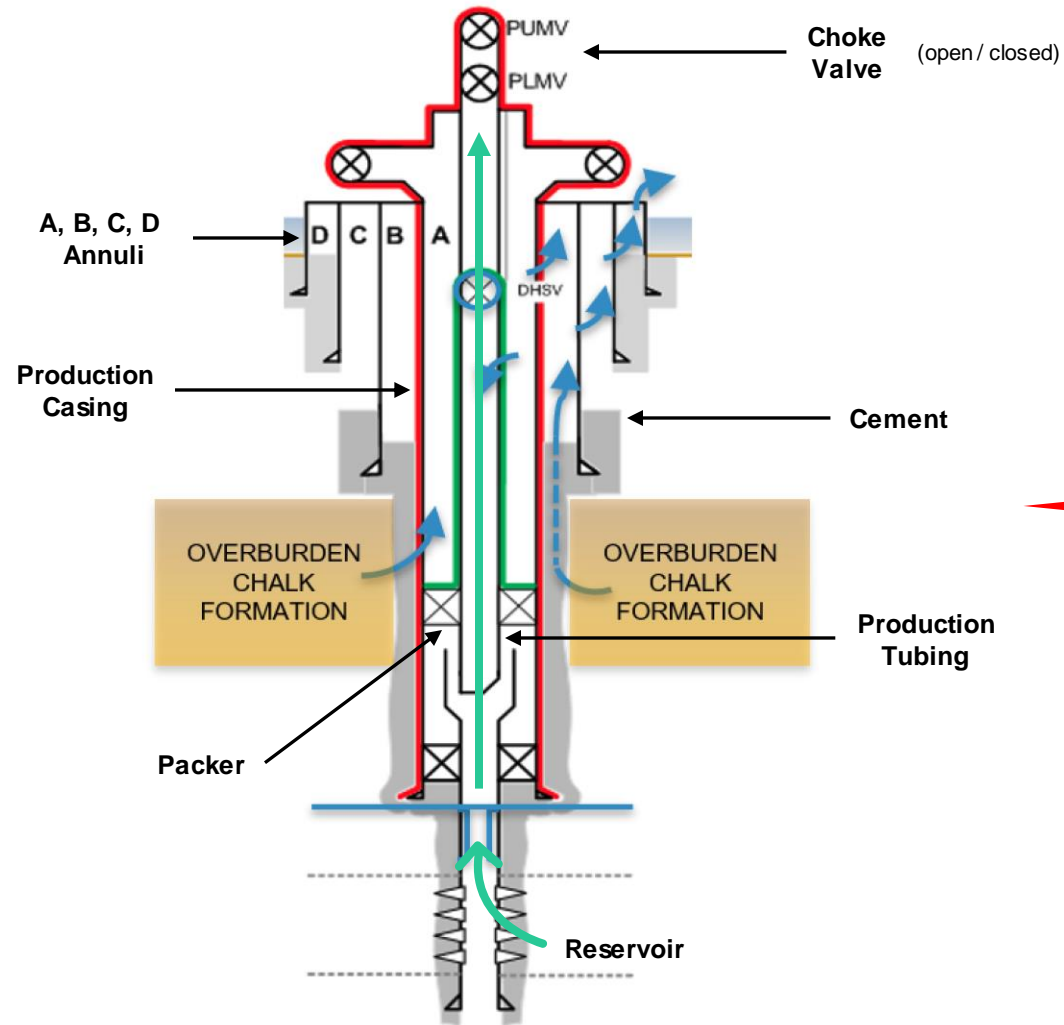


TotalEnergies

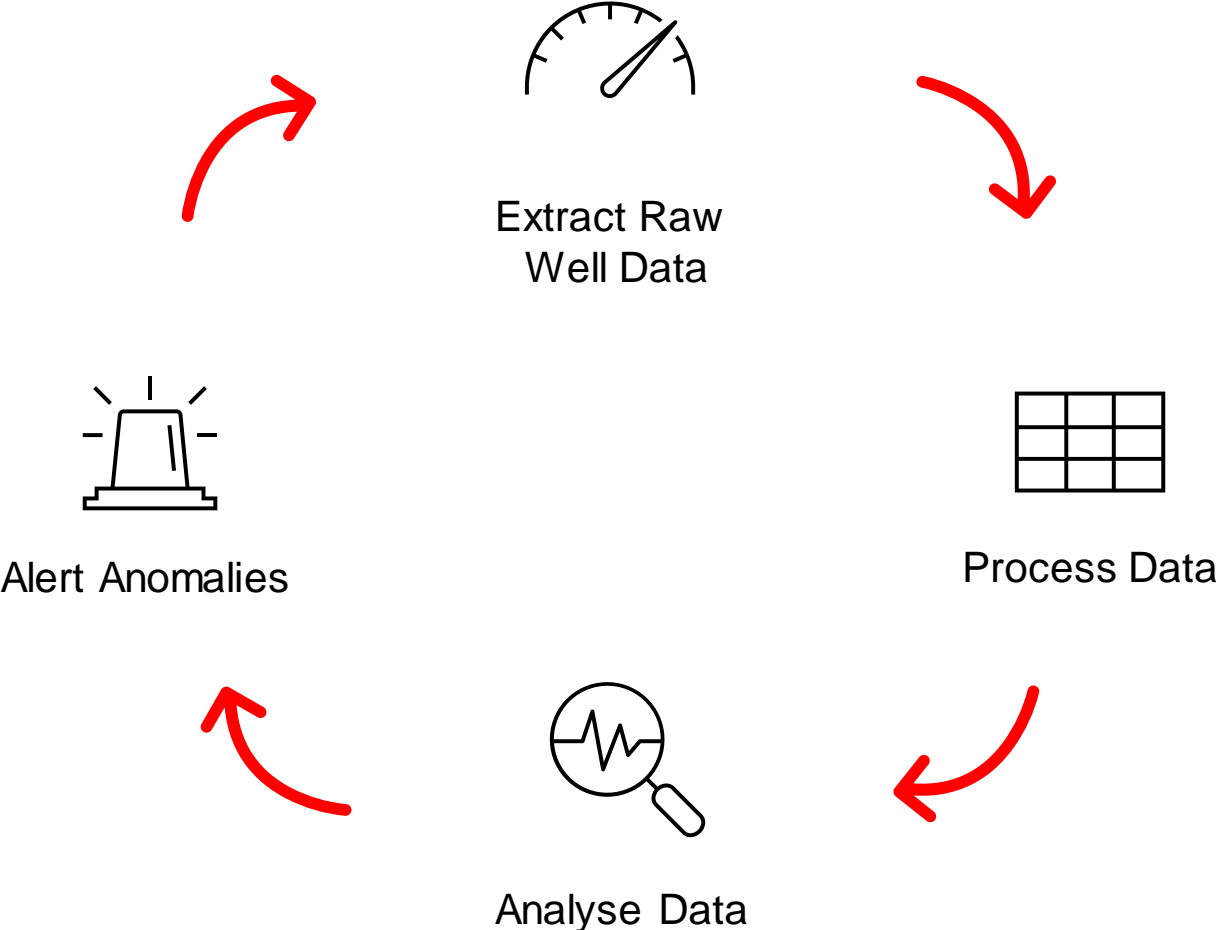
Agenda

1. The Annuli + Use Case
2. Annuli Failure Mode Example
3. Thresholding POC Solution
4. Summary

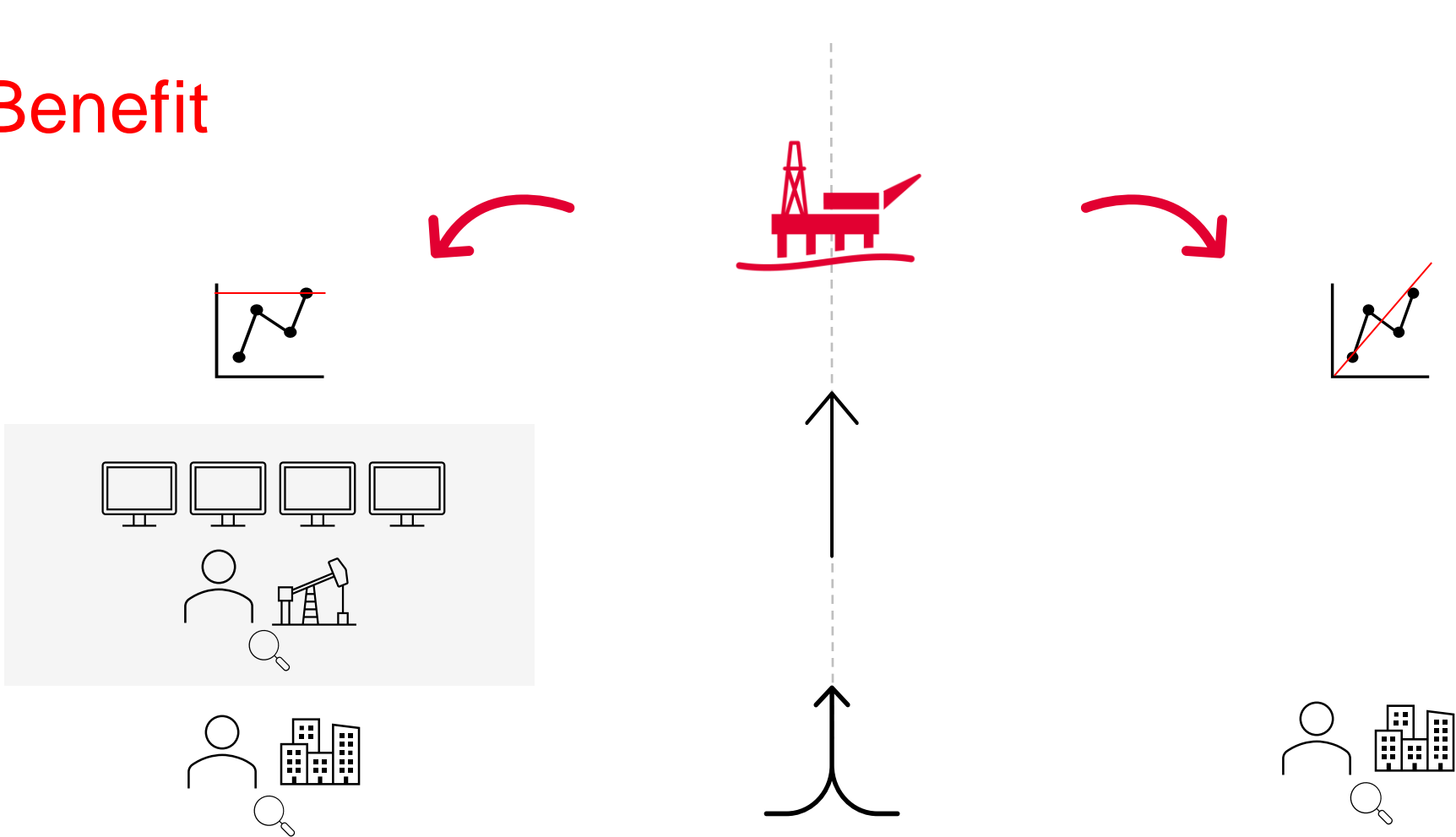
Well Annuli



The Use Case



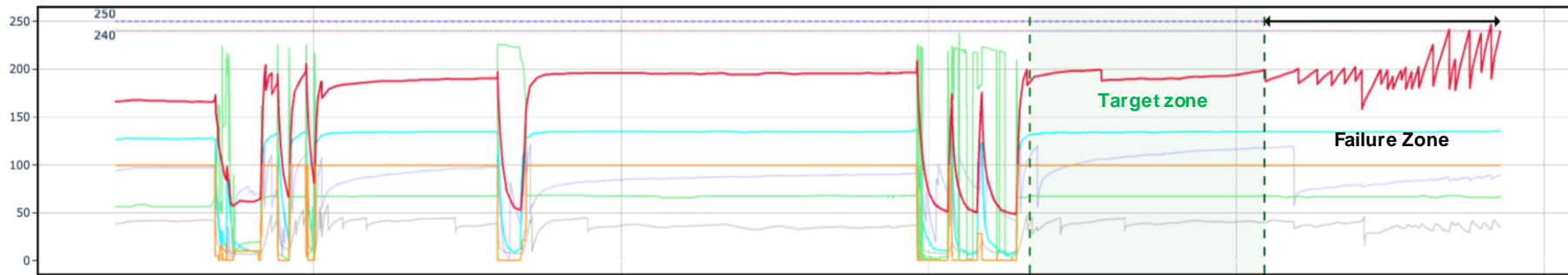
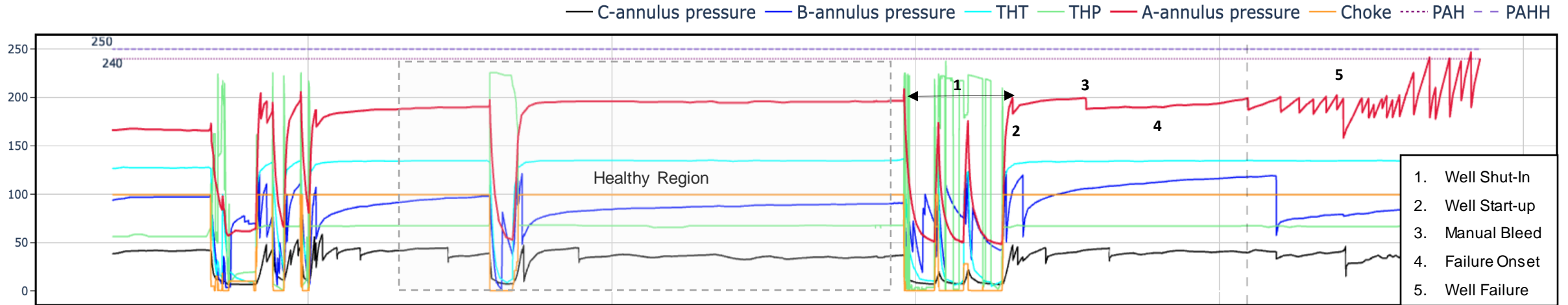
The Benefit



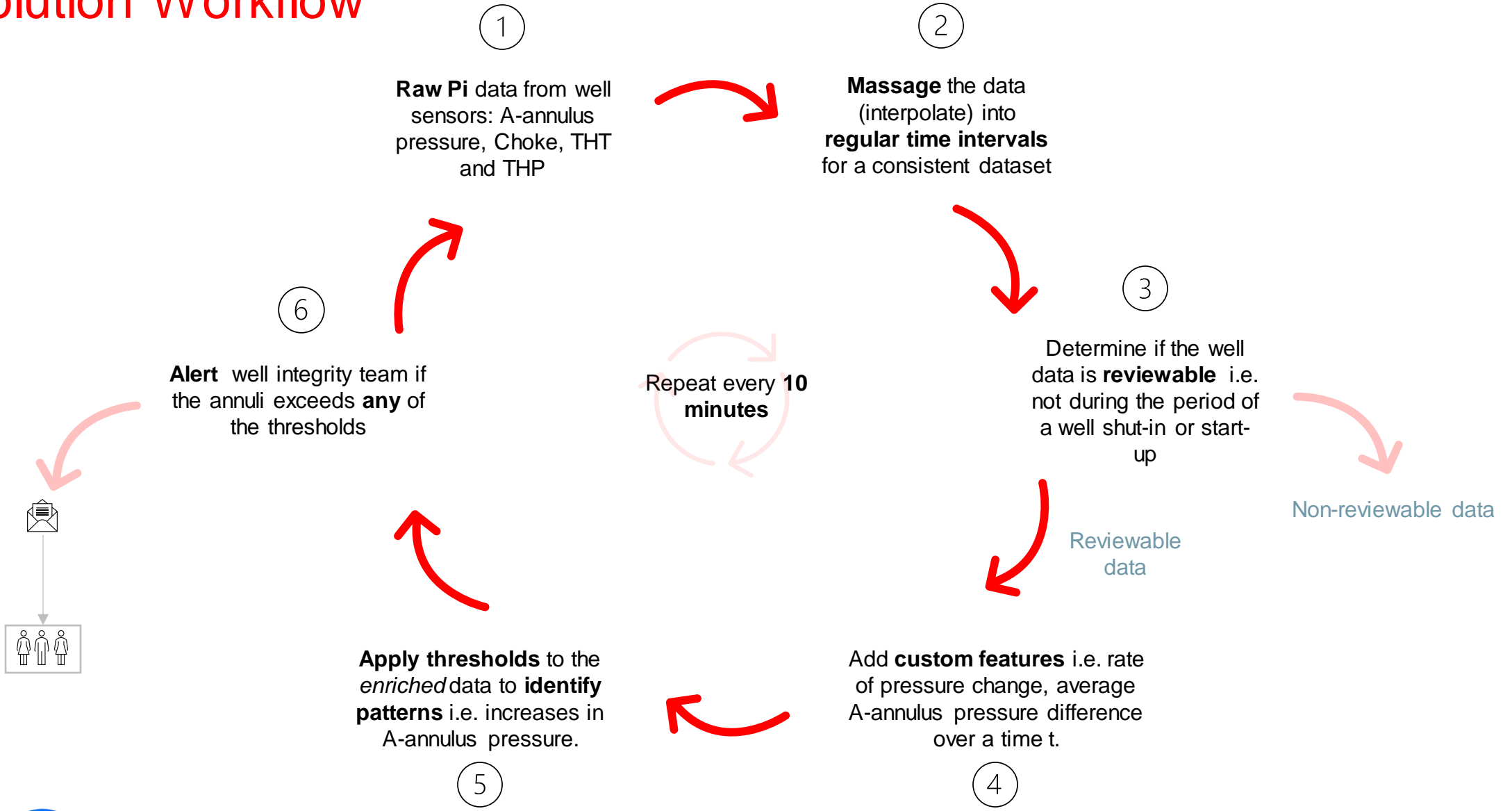
- Improved **safety** with enhanced anomaly detection
- **Direct communication** between annuli alert and onshore Well Integrity team

Annuli Sustained Pressure Failure Identification

Layered timeseries plots of Well 'A' raw sensor values from 2006-12-01 to 2007-02-02

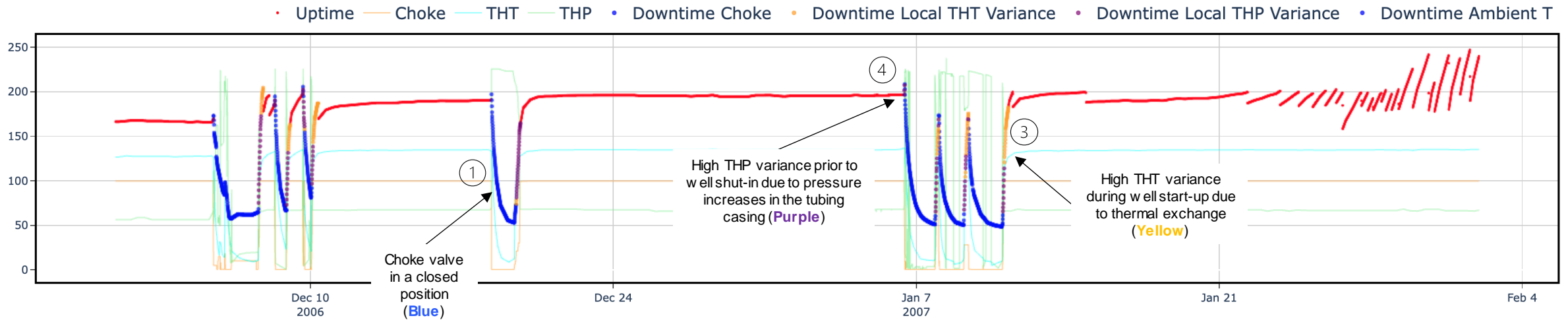
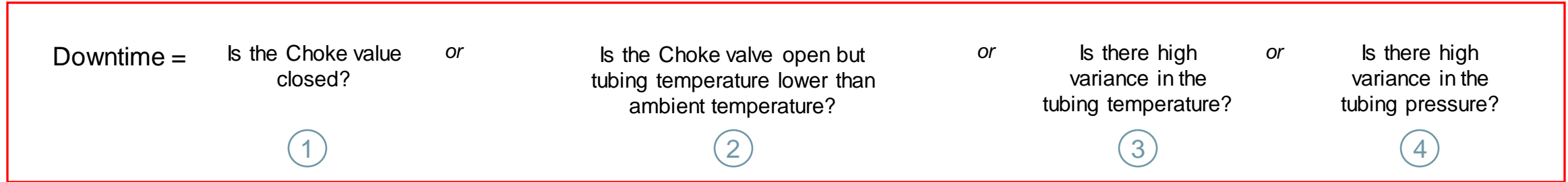


Solution Workflow



Context Filtering

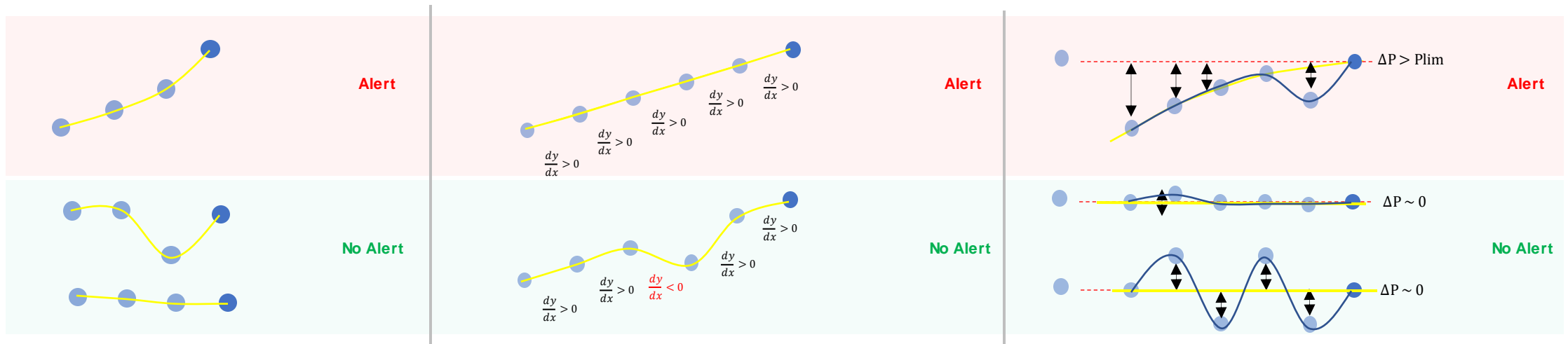
Context Filtering removes downtime data to ensure that the thresholding is only applied to stable operation (uptime) or *reviewable* data.



Threshold Logic

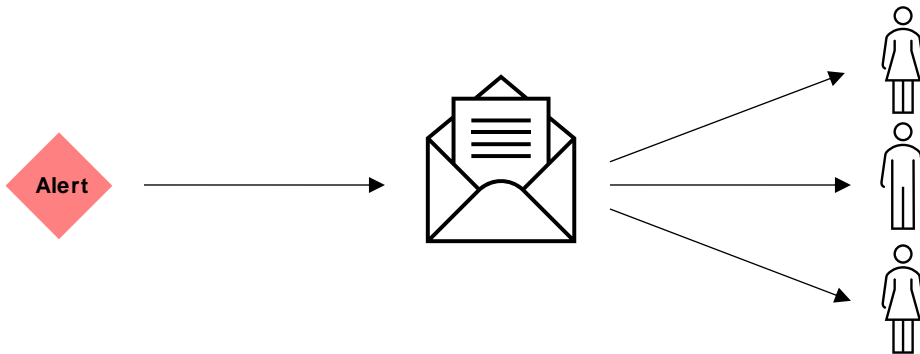
Thresholding Logic is applied to **reviewable A-annulus Pressure** and an alert is raised if any of the following thresholds are exceeded

Thresholds =	Consecutive Concave Up	Abrupt Pressure Fluctuation	Consecutive Positive Gradient	Mean Pressure Diff
	Have there been C_{L1} consecutive concave upwards pressure data points?	or Has there been an abrupt pressure fluctuation in the last 30 min?	or Have there been C_{L3} consecutive data points of a positive pressure gradient?	or Is the pressure difference over N data points greater than P_{Lim} ?
	①	②	③	④



The Alert

- Each alert sends an email to each engineer in the Well Integrity team.
- The email consists of the **meta data** causing the alert and a **screenshot of the alerting data point and recent historic data**.



New Alert from Well 22/30C-B1 (W283745)

Annuli Thresholds Exceeded:
(4) 5-day Average A-Pressure Difference
 Alert Explanation(s):
 (4) Average A-annulus pressure difference over the previous 5 days (720 data points) greater than 5 bar, evidence of a positive A-annulus pressure trend.

22/30C-B1 Recent 12-day Well Sensor Data Snapshot

Uptime = Data to be reviewed. Known data abnormalities such as **well shut-in** and **well start-up** have been filtered out.
Downtime = Data that is *not* reviewed.
22/30C-B1 Uptime Conditions (data is filtered out if *any* condition is not met):

[Choke % > 20] | [THT > 22°C] | [$\sigma_{THT} \leq 0.4651$] | [$\sigma_{THP} \leq 0.3723$]

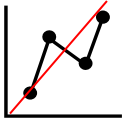
Annuli Data

Date and Time	: 05/09/2022 23:40	
A-Annulus Pressure	: 86.48881081095897	(bar)
PI Timestamp	: 2022-09-05 23:00:00+00:00	
Choke	: 59.999	(%)
THT	: 123.03	(°C)
THP	: 42.023	(bar)
Local σ_{THT}	: 1.4210854715202004e-14	
Local σ_{THP}	: 0.15804324036195627	
Uptime	: 1	
Downtime Capture	: 1.8	
Concave Upwards Pattern	: 0	
Abrupt Pressure Fluctuation	: 0	
Consecutive Positive Gradient	: 0	
5-Day Average A-Pressure Diff	: 10.132116916745847	(bar)

PI Vision: <https://gbepabz-appvi03.main.glb.corp.local/PIVision>

Thresholding Results

- Identified and labelled **5** known historic In-Production Sustained A-annulus Pressure Failures.
- Applied the thresholds to uptime well data to determine if the logic *would have* provided an alert during the onset of failure (in the target zone).
- Compare the thresholding to the existing monitoring Pressure Alarm High (**PAH**) and Pressure Alarm High High (**PAHH**) in place.

	Well 'A'	Well 'B'	Well 'C'	Well 'D'	Well 'E'
Thresholding 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
PAH / PAHH 	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Summary

Thresholding applied to **raw Pi** data every **10 minutes**

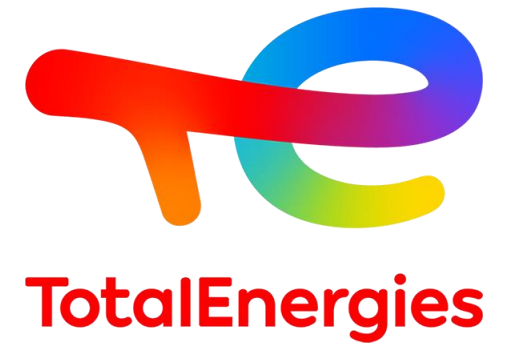
Thresholding is only applied to **reviewable (uptime)** annuli data

Solution contains **4 thresholding logics**

Evaluated on **5 historic In-Production Sustained A-annulus pressure failures**

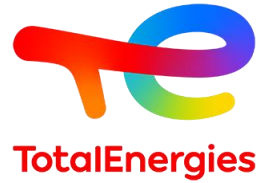
Real-time **alert via email**

Initial go-live complete – Up-scale to other TEPUK Assets ongoing



Thank you

Disclaimer and copyright reservation



Definition - TotalEnergies / Company

The entities in which TotalEnergies SE directly or indirectly holds an interest are separate and independent legal entities. The terms "TotalEnergies", "TotalEnergies company" and "Company" used in this document are used to refer to TotalEnergies SE and its affiliates included in the scope of consolidation. Similarly, the terms "we", "us", "our" may also be used to refer to these entities or their employees. It cannot be inferred from the use of these expressions that TotalEnergies SE or any of its affiliates is involved in the business or management of any other company of the TotalEnergies company.

Disclaimer

This presentation may include forward-looking statement within the meaning of the Private Securities Litigation Reform Act of 1995 with respect to the financial condition, results of operations, business, strategy and plans of TotalEnergies that are subject to risk factors and uncertainties caused by changes in, without limitation, technological development and innovation, supply sources, legal framework, market conditions, political or economic events.

TotalEnergies does not assume any obligation to update publicly any forward-looking statement, whether as a result of new information, future events or otherwise. Further information on factors which could affect the company's financial results is provided in documents filed by TotalEnergies with the French *Autorité des Marchés Financiers* and the US Securities and Exchange Commission.

Accordingly, no reliance may be placed on the accuracy or correctness of any such statements.

Copyright

All rights are reserved and all material in this presentation may not be reproduced without the express written permission of TotalEnergies.