Insights into the International Association of Oil & Gas Producers Well Control Incident Lesson Sharing Database

Document Number	SATECM050			
Revision	**Issue Date**	**Prepared by**	**Reviewed by**	**Approved by**
Final Revision	08/07/2021	Mark Gillard, Muhammad Abbas Bhatti	Eric Wesselingh	Bryan Atchison

Safe Influx Ltd.
Bryan Atchison, Managing Director, bryan.atchison@safeinflux.com
+44 (0) 7912 242421

Table of Contents

1. Purpose

The purpose of this report is to present the findings of an independent analysis of the International Association of Oil & Gas Producers (IOGP) Well Control Incident Lesson Sharing database[1] with a view to using data to underpin an assumption that a significant number of Well Control incidents could be prevented using automated technology.

Analysis of this data supports both the Prevention and Intervention focusses of IOGP's own Global Industry Response Group (GIRG). Safe Influx are analysing this data as an independent innovation provider to the upstream well construction sector who have limited access to Operator data.

2. Techniques

Analysis of the data was undertaken understanding that the data presented to an open forum is necessarily anonymised and generalised to protect confidentiality and liability issues. It is also understood that the data only reports on screened well control incidents where publication can realise value through lessons learned.

In this context, the categorisation and interpretation of data is subject to the detail of information available. All data interpretation is done with the view to learn what happened rather than to attribute blame or provide a personal viewpoint.

Each published case study was therefore categorised in **Table 1** below.

Category	Choice	Reason for Category
Blowout Preventer installed?	Yes/No	Safe Influx equipment is designed to control secondary barrier operation. Where a BOP is not installed, a different mechanism for control will be considered.
Activity when influx noted	Abandonment Cementing Completion Drilling Intervention (BOP) Testing Tripping Other	This attribute is noted to try to understand what was happening when the influx occurred such that proper focus can be made on development of modules
Blowout Preventer Type	Diverter (Likely) Subsea Stack (Likely) surface stack Rig less Unknown	This attribute is noted to detail the BOP type in use at the time of the incident. Where evidence is unequivocal then the attribute is defined. Where any ambiguity is seen in the data a 'likely' or 'unknown' tag is applied to the attribute
MPD Operations?	Yes/No	The attribute is included to ensure that overbalanced drilling techniques are separated from MPD techniques.
Factors affecting incident	Human Failure Technology Failure Organisational Failure	In any Well Control Incident there are always several factors involved and it is a combination of these that lead to escalation. This category identifies which of three possible factors are present and then identifies the Key Failure Point

[1] International Association of Oil & Gas Producers (IOGP) Well Control Incident Lesson Sharing database, https://safetyzone.iogp.org/WCILessonsShared/WCILS/main.asp

Would Automated Well Control have prevented the incident?	Yes/No	Where a human or organisational failure is identified as the key contributor to the incident, it is assumed that automatic well control would have either. • Detected an influx sooner. • Executed a close command without intervention. And therefore, prevented the incident (or an escalation of the incident) Where technological failure is identified as the key contributor to the incident, a judgment is made as to whether automatic well control equipment would have been effective (or not)

Table 1 - Categorisation of Analysis Attributes

After the initial analysis was performed, an additional attribute was identified based on interpretation and experiences. It is understood that this attribute may be subject to additional opinion and scrutiny.

Key Failure Point – this is a data interpretation that identifies the likely reason why **incident escalation** occurred. The Key Failure Point is not necessarily the reason why the incident initially occurred.

Additional analysis was performed using historical rig count data (Baker Hughes Rig Count)[2] and historical (Brent Crude) oil price data[3]

3. Failure Points and Automation

While automation can never completely replace human intervention, arguably automation can enhance or takeover from any failure produced by organisational flaws or human factors. For the purposes of this analysis, the following definitions[4] are applied.

Technology Failure

Where a well control event has been caused by or escalated by a failure of a piece (or pieces) of equipment directly related to secondary well control. Examples would be a valve or lubricator failure, RCD failure (MPD related) or BOP failure.

Organisational Failure

Where a well control event has been caused by failure to adhere to a process or processes directly related to well control. Examples would be not following a pre-agreed procedure, drilling beyond a pre-arranged pressure ramp.

Human Failure

Where a well control event has been caused or escalated by a human reaction such as a lack of communication, a slow reaction, or a cascade of responsibilities.

[2] https://rigcount.bakerhughes.com
[3] www.tradingeconomics.com
[4] These definitions broadly follow the definitions set out in ***SINTEF Report Automation and Autonomous Systems: Human centred design Version 2020-12-15.***

It is understood that categorising failure points in this manner may (to some extent) overgeneralise these failures. It is also recognised that there will be a variable overlap of the failure points (either in dependency or characterisation) as depicted in **Figure 1**. Given the understandable absence of granularity in the data analysed in this report, this categorisation approach is considered appropriate.

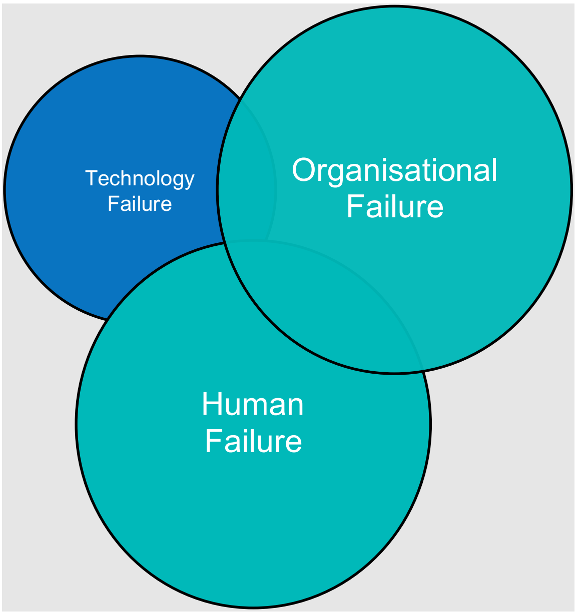

Figure 1 - Overlap of Failure Mechanisms in Well Control

The overlap of these criteria does however emphasise that automation can influence a considerable part of any solution by reducing the impact of human and organisational failure.

4. Data Analysis

43 Well Control incidents were reported in the IOGP database between 2014 and 2021 as shown in **Table 2**.

Year	Technology Failure	Human Failure	Organizational Failure	Total
2014		**5**	**2**	**7**
2015	**1**		**3**	**4**
2016	**3**	**1**	**1**	**5**
2017	**1**		**4**	**5**
2018	**1**	**4**	**1**	**6**
2019	**1**	**2**	**1**	**4**
2020	**3**	**1**	**3**	**7**
2021 (to June)		**5**		**5**
Grand Total	**10**	**18**	**15**	**43**

Table 2 - IOGP Well Control Incidents

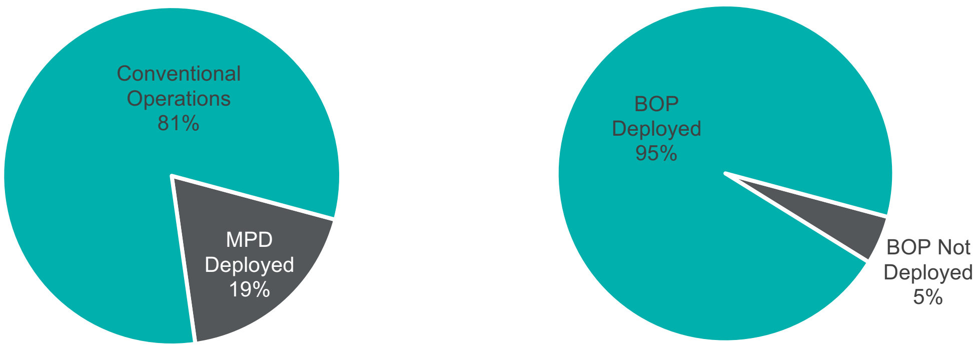

Figure 2 - Equipment Categorisation

Analysis of the incidents summarised in **Figure 2** above shows that:

- 2 of the incidents occurred from shallow events where no secondary well control equipment was deployed.
- 3 of the incidents occurred during rig less operations where well control equipment consisted of a lubricator and wireline BOP.
- 8 (19%) of incidents occurred when MPD equipment was deployed
- All incidents reported in 2021 were attributable to Human Failure.

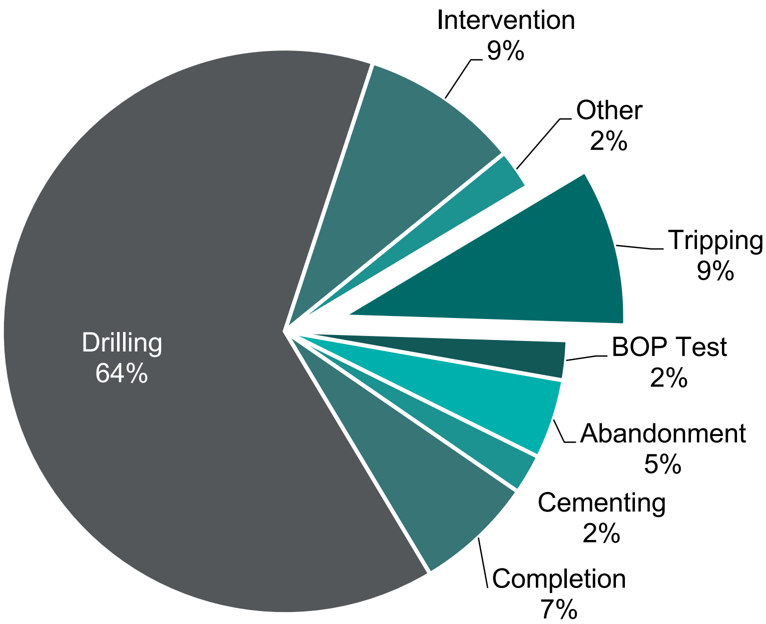

Figure 3 - Well Control Incidents vs. Activity

Analysis of the incidents summarised by activity in **Figure 3** above shows that:

- 27 (64%) of the incidents occurred while drilling, and 4 (9%) occurred while tripping (represented by the exploded pie segment). The remaining 12 incidents occurred during 'non-drilling operations such as completion, intervention, cementing and abandonment operations.
- Only 9% of total well control incidents were reported when tripping operations were in progress. This proportion is somewhat unexpected, as traditional thinking would indicate that tripping operations present more opportunity for well control incidents to occur due to influences such as loss of hydrostatic overbalance, swabbing effects and personnel intervention.

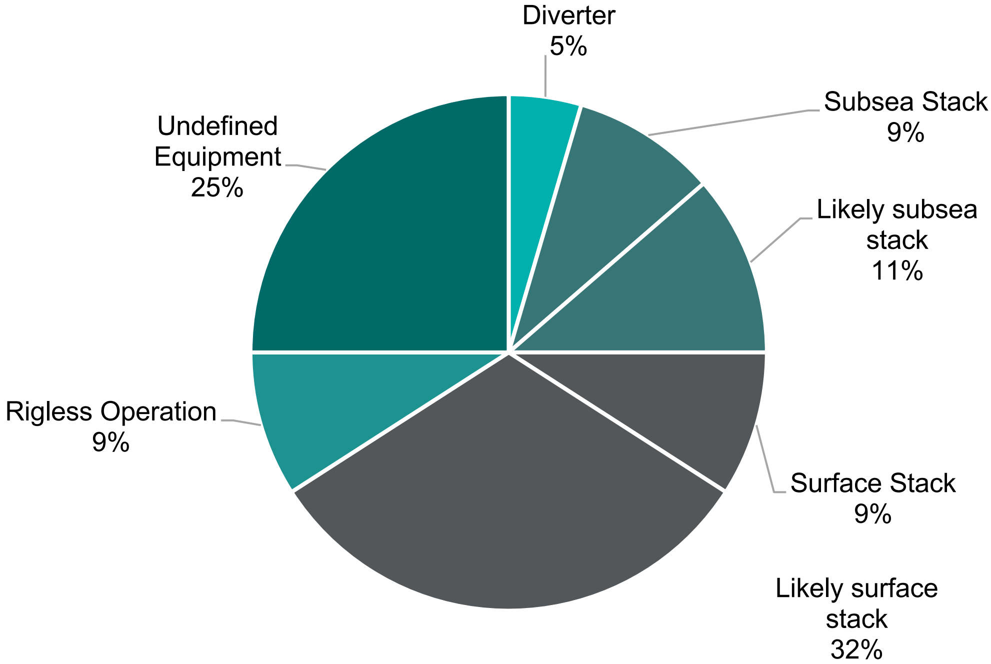

Figure 4 - Well Control Incidents vs. Well Control Equipment Used

Further interrogation of the various incidents was achieved by identifying the type of secondary well control equipment used. This analysis is summarised in **Figure 4** above.

- Most incidents (41%) occurred when a surface BOP stack was used (or is likely to have been used), 20% when a subsea BOP stack was deployed (or likely to have been deployed).
- There were several incidents (11) where it was not possible to confidently define the type of secondary well control equipment.

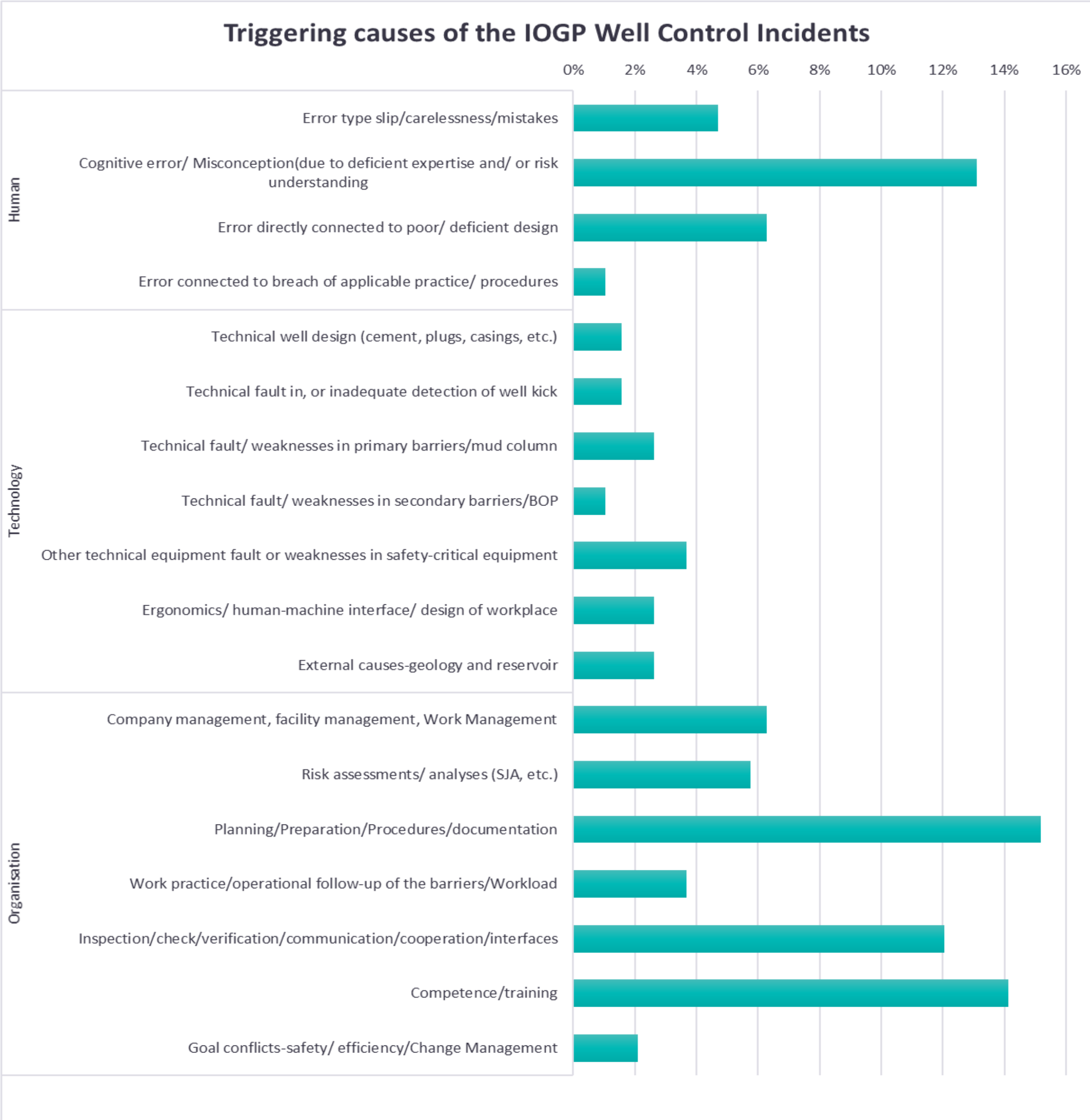

Figure 5 - Well Control Incidents – Failure Points[5]

Each incident will feature several factors that caused or escalated the outcome. Analysis of the data demonstrates that while some incidents demonstrate several failure points, these points are concentrated mainly on human and organisational failures. Technology failure is not a significant contributor to well control incidents.

[5] As defined ***SINTEF Report Automation and Autonomous Systems: Human centred design Version 2020-12-15.***

5. Insights

Further analysis of the incidents enabled the identification of a dominant (or key) contributing factor (root cause) that led to the occurrence of the incident or its subsequent escalation.

Source : www.tradingeconomics.com

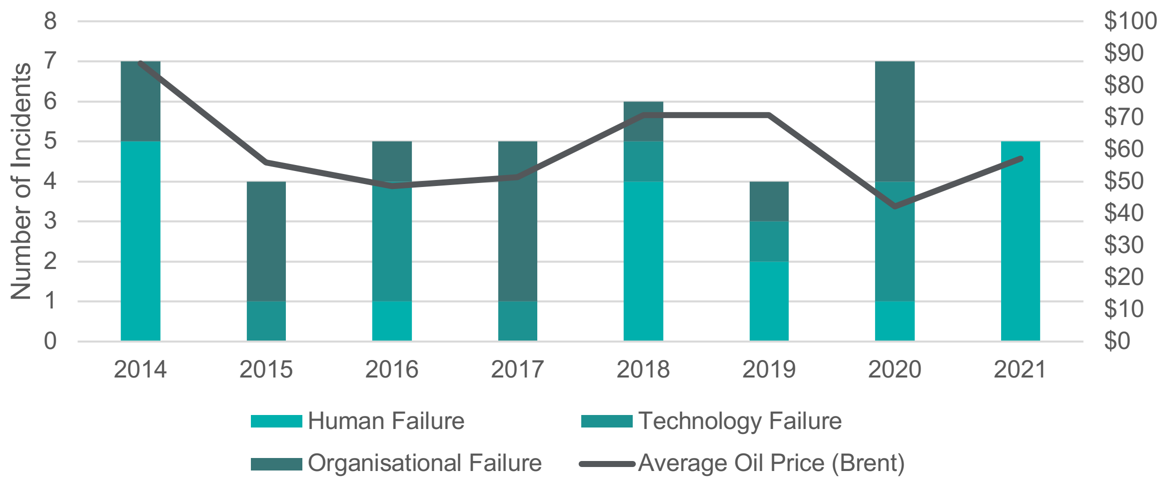

Figure 6 - Key Failure Point vs. Brent Crude Oil Price ($/bbl.)

Source: BakerHughes Worldwide Rig Count)

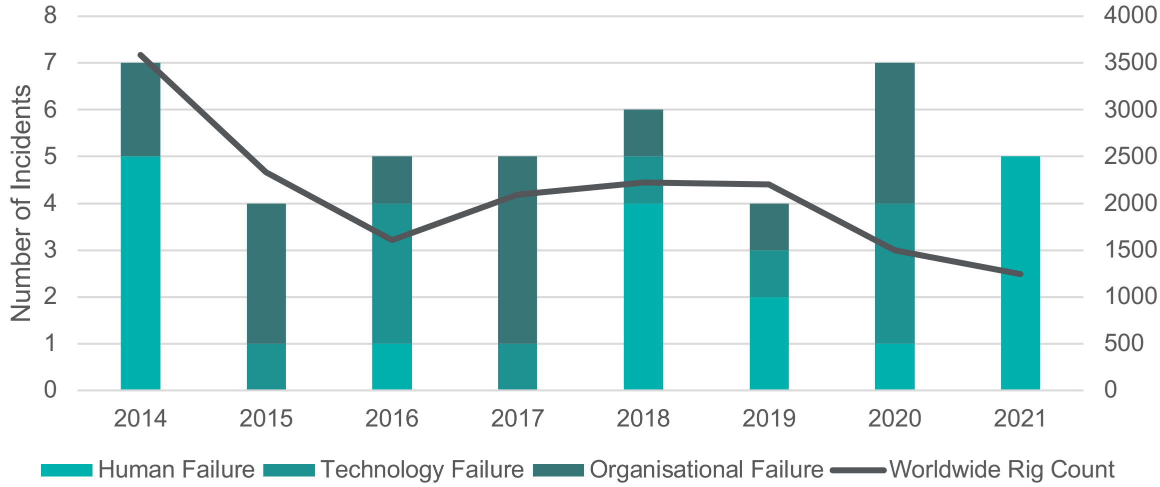

Figure 7 - Key Failure Point vs. Worldwide Rig Count

The oil price (Brent Crude) and rig count[6] was included to establish whether there is a correlation between well control events and activity. This correlation is not conclusive.

[6] The worldwide rig count is taken from the published Baker Hughes Rig count. The statistics presented do not include rig activity in Russia or China. However, it is unlikely that well control reports from these areas are included in the IOGP database, so the inclusion of these additional datasets was considered appropriate.

6. Conclusions

This report is aimed to understand the most likely key failure points of the published Well Control Incidents and to answer the question:

Would Automated Well Control have reduced the impact of or even prevented the well control incident?

There is a high potential that more blowout events may happen within the upstream oil and gas industry unless other risk reducing measure are considered, so to answer this question, several other factors need to be considered:

- Automation is designed to improve performance by removing inevitable human and organisational failures in any circumstance and to support reliable of technological failures by reducing reaction times by using machine-based speeds.
- A study comparing the influence of Human Factor of traditional well control versus automated well control, shows a reduction in probability of human error by 94% for blowout events. (Marex 2020) [7].

A distinct analogy is the acceptance of Automated Braking Systems (ABS) and Dynamic Stability Control (DSC) on automobiles, where the process of sudden (emergency) actions are taken over (at least in part) by the car itself – improving stopping distances and avoiding a loss of directional control.

Both ABS and DSC have a default setting of 'active'. ***The operator must decide to deactivate the systems.***

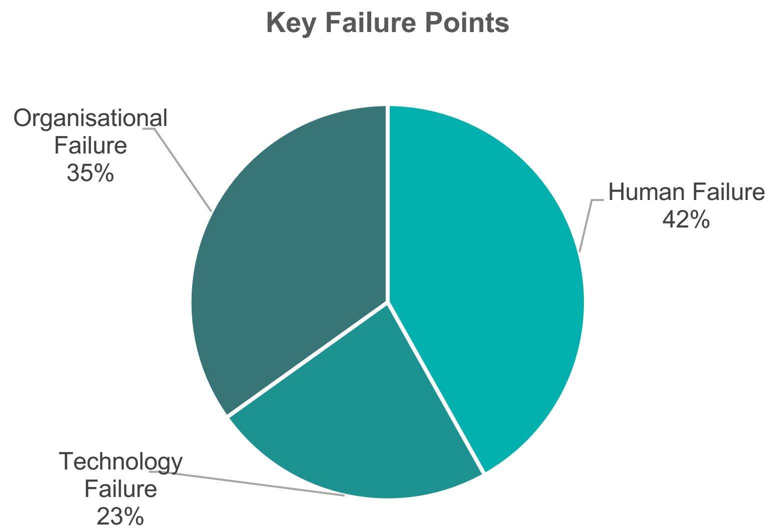

Figure 8 - Key Failure Points

[7] Safe Influx Automated Well Control System, Comparative Human Factors Analysis; Marex Marine and Risk Consultancy 0283-01 V2.0: September 2020

The analysis in Section 4 of this report categorises the Key Failure Point for each incident and concludes that 23% of incidents were directly attributable to technology failure, 35% were attributable to organisational failure and the remaining 42% involved a failure related to human behaviours.

An initial conclusion is that 77% of the reported well control incidents could have been prevented by using robust management systems and Automated Well Control Systems. It is also possible that some proportion of the incidents caused by technology failure could have been minimised using an Automated Control System that will operate faster and without human intervention.

As mentioned in Section 2, the data analysis is intended to be entirely objective (facts based on the reports) and given that it has been performed on a generalised dataset, the conclusion may have some shortcomings.

Additional insights that allowed an element of subjectivity (based on individual's industry experience) similarly concludes that more than 70% of the recorded incidents could have been prevented using automated systems.

Both conclusions underpin the fact that reducing influx size and eliminating the occurrence of uncontrolled well control incidents should be at the forefront of industry aspirations.

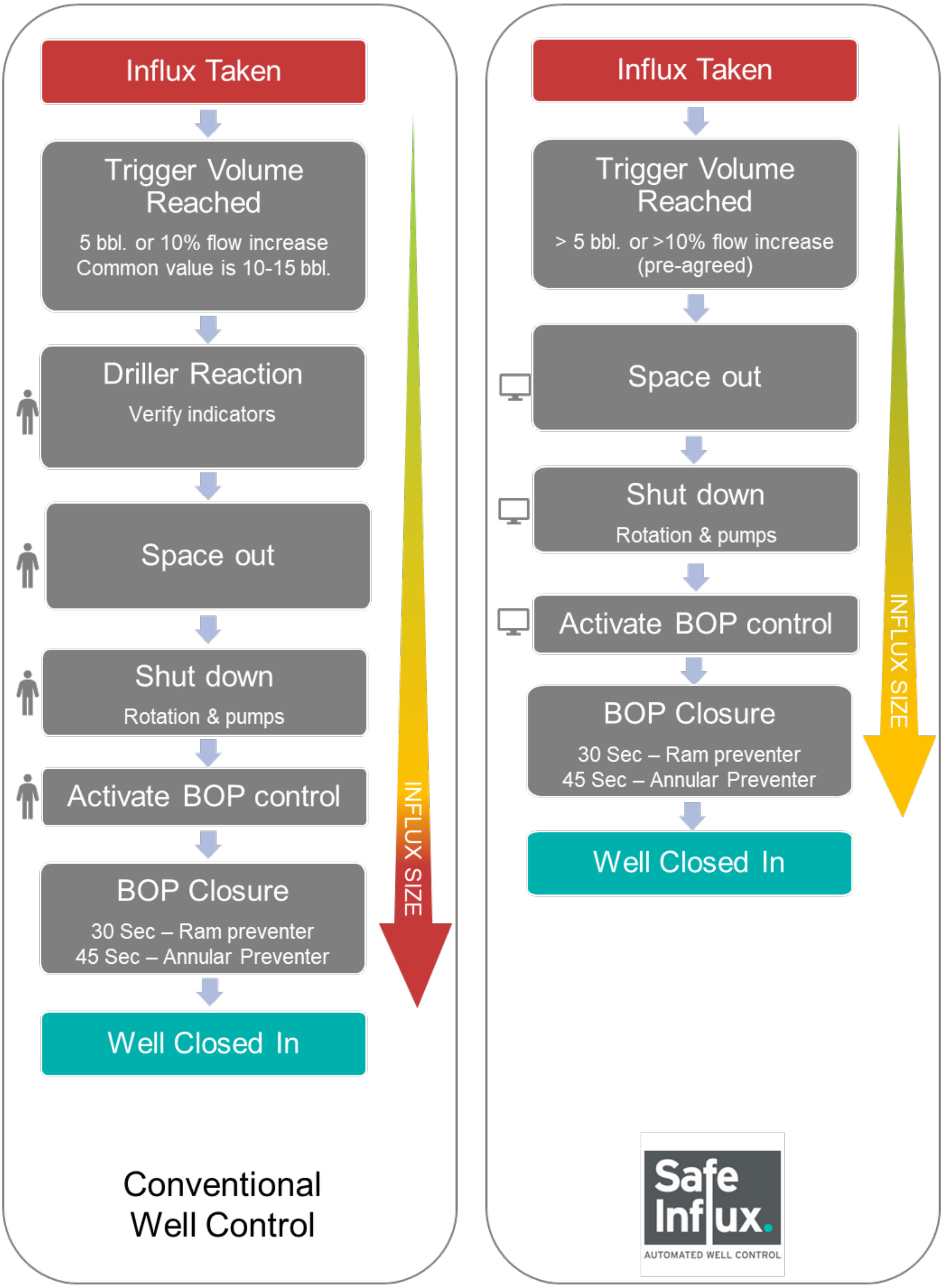

Figure 9 - The effect of Automation on Influx Size

However, careful and considered implementation of automation within the well control envelope is vital to the next step change in well operations safety and integrity.

Implementation of automation must take into the account the capacities and abilities of both humans and machinery. Such change is best implemented through a stepped automation level approach such as suggested by the Sheridan & Verplank (1978)[8].

[8] Sheridan, T. B., & Verplank, W. L. 1978. Human and computer control of undersea teleoperators. Cambridge, Mass: Massachusetts Institute of Technology

End of Document

info@safeinflux.com
www.safeinflux.com