WELL CONTROL EQUIPMENT SYSTEMS SAFETY 2020 ANNUAL REPORT

HIGHLIGHTS

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WELL CONTROL EQUIPMENT SYSTEMS SAFETY
2020 Annual Report

Highlights

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INTRODUCTION

The 2020 Annual Report Highlights: Well Control Equipment Systems Safety, produced by the Bureau of Transportation Statistics (BTS), provides information on well control equipment (WCE) failures that occurred in the course of rig well operations in the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) during the calendar year. SafeOCS is a BTS confidential reporting program for collecting and analyzing data to advance safety in offshore energy operations. This report is based on information collected through SafeOCS and includes an analysis of reported events involving WCE systems, including blowout preventer (BOP) equipment. Additionally, BTS reviewed BSEE Well Activity Report (WAR) data to estimate equipment and activity levels and identify and evaluate stack pull events. Data in this report is presented by WCE system type (subsea or surface) and by when the event occurred (in-operation or not-in-operation). The terms subsea and surface reference the type of applicable BOP system, not the equipment's location (above or below the waterline) at the time of failure. This report does not cover every WCE failure event in the GOM OCS in 2020, as some events were not reported to SafeOCS.

Table 1: Numbers at a Glance, 2017-2020

MEASURE	2017	2018	2019	2020
WELLS				
Wells with Activity	325	389	397	264
Wells Spudded	152	193	188	115
RIGS				
Rigs with Activity	60	59	63	50
Rigs with Reported Events	47	40	36	32
OPERATORS				
Active Operators	27	32	29	28
Reporting Operators	18	14	13	14
BOP DAYS				
Total BOP Days	16,072	17,073	16,990	12,407
In-Operation BOP Days	9,949	10,739	10,515	7,053
Not-in-Operation BOP Days	6,123	6,334	6,475	5,354
COMPONENT EVENTS				
Total Events Reported*	1,420	1,196	995	627
In-Operation Events	245	171	152	65
In-Operation Event Rate	24.6	15.9	14.5	9.2
In-Operation Events per Well	0.8	0.4	0.4	0.2
Not-in-Operation Events	1,175	1,025	843	562
Not-in-Operation Event Rate	191.9	161.8	130.2	105.0
Not-in-Operation Events per Well	3.6	2.6	2.1	2.1
LOC EVENTS				
Loss of Containment Events	1	0	0	0

KEY: In-Operation Not-in-Operation
NOTES:
*Total events reported excludes any events identified in WAR data.
1. The event rate reflects the number of events per 1,000 BOP days.
2. Events per well is calculated from wells with activity, not wells spudded.

SOURCE: U.S. DOT, BTS, SafeOCS Program.

The report is based on data from 627 WCE failure event notifications (606 subsea system and 21 surface system events) submitted to SafeOCS for 2020, the fourth full year of WCE failure reporting. The number of WCE notifications decreased 37.0 percent from 2019. Overall, well activity decreased from 2019 to 2020 (Table 1) as measured by the following:

- Days WCE components were in use, *BOP days*[1] (27.0 percent decrease)
- Wells with activity[2] (33.5 percent decrease)
- Wells spudded (38.8 percent decrease)
- Rigs with activity (20.6 percent decrease)

Of the 627 events, 89.6 percent occurred while not in operation, compared to 84.7 percent in 2019, with the remainder occurring while in operation. For in-operation events, the event rate and events per active well were also lower in 2020 compared to 2019. No leaks of wellbore fluids to the environment, classified as loss of containment, were reported to SafeOCS in 2020, and only one such event has been reported since 2017.

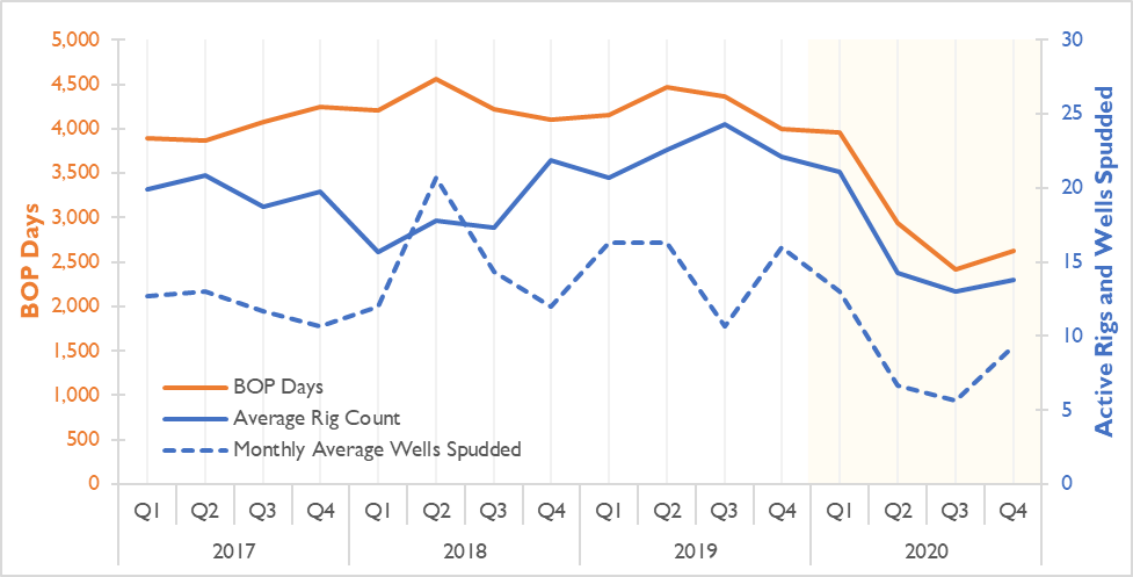
Drilling Activity Levels during the COVID-19 Pandemic

The coronavirus pandemic was a significant factor in the overall decrease in drilling activity levels in 2020, as reflected by a sharp decrease in the second quarter, when the economy slowed dramatically (Figure 1). Demands on the U.S. transportation system fell significantly, with schedules and ridership for commercial airlines, rail, and transit systems dropping to record lows as passenger travel declined.[3] These rapid changes increased uncertainty in the upstream demand for oil and gas. In addition, concern for the health of the crews contributed to lowered drilling activity levels due to partial or full facility evacuations because of positive COVID cases. Drilling hours worked in the GOM OCS also declined in 2020, dropping about 24.7 percent from 2019 (25.5 million to 19.2 million), as shown in Figure 2.

[1] The number of days during which some or all the WCE components may have been in use and had any likelihood of failure. For rigs with one BOP stack, this is equivalent to the total number of days the rig was operating. For rigs with two BOP stacks, the number of days the rig was operating was multiplied by 1.48, based on an estimated increase in WCE components.
[2] The number of wells worked on by rigs, regardless of the well operation.
[3] U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 2020* (Washington, DC: 2020). https://doi.org/10.21949/1520449

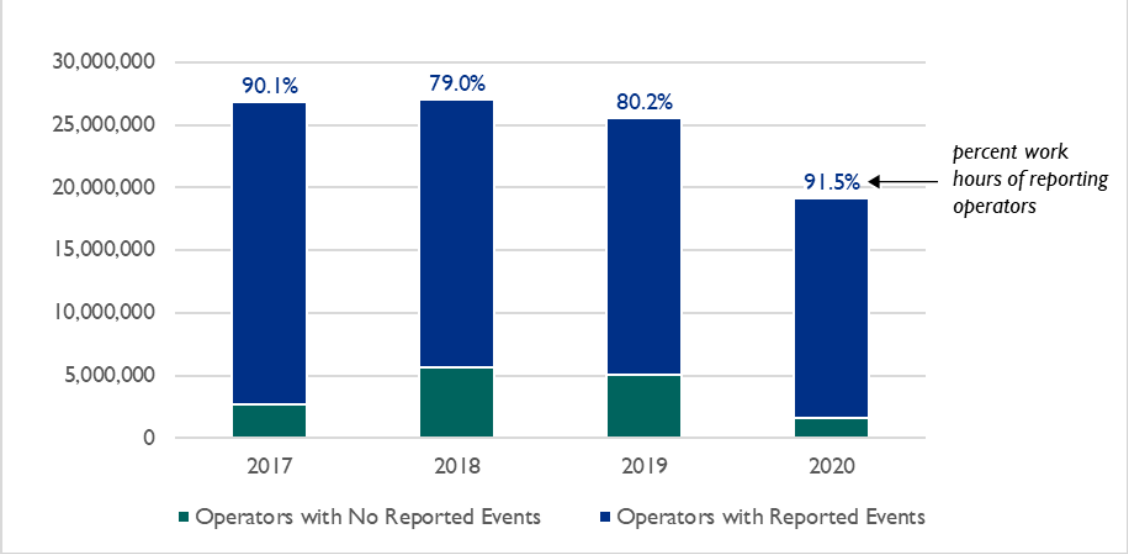
However, using hours worked as a measure of relative participation in the SafeOCS WCE failure reporting program, participation remained high. Operators who reported WCE failure events contributed 91.5 percent of all drilling hours worked in 2020.

Figure 1: Drilling Activity in the Gulf of Mexico OCS, 2017-2020



SOURCES: U.S. DOT, BTS, SafeOCS Program. Rig counts from Baker Hughes Rig Count, https://rigcount.bakerhughes.com/.

Figure 2: Drilling Hours Worked, GOM OCS, 2017-2020



NOTE: Includes both operator and contractor work hours. Reporting operators are those that submitted at least one event notification to SafeOCS.

SOURCE: U.S. DOT, BTS, SafeOCS Program. Work hours from BSEE OCS Performance Measures data.

SUBSEA WCE SYSTEMS

A subsea WCE system involves a subsea BOP and associated equipment such as BOP controls, BOP stack, riser system, diverter, choke and kill, and auxiliary equipment. Table 2 lists measures for subsea wells and subsea system events for 2017 to 2020. Each year since 2017, more than 91.0 percent of reported events occurred on subsea BOP systems as opposed to surface systems. For 2020, 606 events were reported for subsea BOP systems, equating to 96.7 percent of all events. As in previous years, most 2020 events (90.8 percent) occurred while not in operation.

From 2019 to 2020, both the percent of in-operation events and the rate of in-operation events based on BOP days decreased, by 22.3 percent and 36.6 percent, respectively. The number of in-operation events resulting in a stack pull remained the same in 2020 compared to 2019, with eight subsea stack pulls reported.

Table 2: Subsea Systems Numbers at a Glance, 2017-2020

MEASURE	2017	2018	2019	2020
WELLS				
Wells with Activity	165	172	189	142
Wells Spudded	87	107	102	74
RIGS				
Total Rigs with Activity	32	31	29	26
With One Subsea Stack	10	9	14	13
With Two Subsea Stacks	22	22	15	13
Rigs with Reported Events	29	24	21	22
OPERATORS				
Active Operators	17	16	20	19
Reporting Operators	11	10	10	11
BOP DAYS				
Total BOP Days	10,900	10,135	9,883	8,447
In-Operation BOP Days	6,334	5,672	5,272	4,317
Not-in-Operation BOP Days	4,566	4,463	4,611	4,130
COMPONENT EVENTS				
Total Events Reported*	1,305	1,127	908	606
In-Operation Events	187	136	108	56
In-Operation Event Rate	29.5	24.0	20.5	13.0
In-Operation Events per Well	1.1	0.8	0.6	0.4
Not-in-Operation Events	1,118	991	800	550
Not-in-Operation Event Rate	244.9	222.0	173.5	133.2
Not-in-Operation Events per Well	6.8	5.8	4.2	3.9
BOP STACK MOVEMENTS				
Total Stack Runs	200	178	212	145
Successful Runs	167	152	158	120
Stack Pulls	10	8	8**	8**
LOC EVENTS				
Loss of Containment Events	1	0	0	0

KEY: In-Operation Not-in-Operation

NOTES:

* Total Events Reported excludes any events identified in WAR data.

** WAR data from 2019 and 2020 was reviewed for stack pulls not reported to SafeOCS, which are included here (0 in 2019 and 3 in 2020).

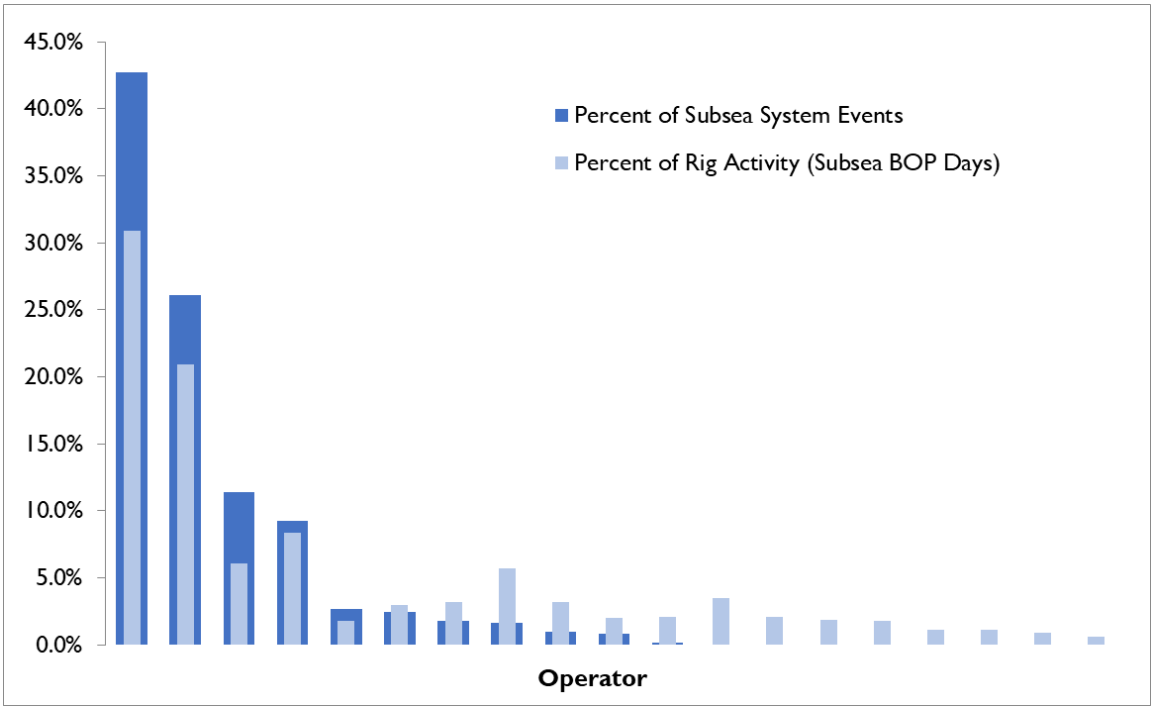
1. The event rate reflects the number of events per 1,000 BOP days.
2. Events per well is calculated from wells with activity, not wells spudded.

SOURCE: U.S. DOT, BTS, SafeOCS Program.

Reporting Operators

Figure 3 shows subsea system events and rig activity (measured in BOP days) for the 19 active operators with subsea system well operations in 2020. The 11 reporting operators represent most of the drilling activity as measured by their proportion of subsea BOP days (87.1 percent). All but four of the 26 active rigs were represented in event reporting (84.6 percent), an increase from 72.4 percent in 2019.

Figure 3: Subsea System Events and Rig Activity by Operator, 2020



SOURCE: U.S. DOT, BTS, SafeOCS Program.

Root Causes of Events

For subsea system events, wear and tear as a root cause was considerably lower in 2020 compared to the 2017–2019 average (Table 3). A higher percentage of 2020 notifications attributed the failure to procedural error (i.e., an error during operations) or documentation error (e.g., an incorrect torque or pressure rating in a document).

One of the largest differences between the 2020 versus the 2017–2019 root cause distributions is for in-operation procedural errors, with an increase of 11.0 percent (Table 4).

Of these in-operation events, issues cited include reported nickel leaching issues and debris in shuttle valves. The makeup of such debris varies widely and could include slithers of flashing from elastomeric seals, corrosion particulates from a metallic part, or other water-borne particles drawn in through remotely operated vehicle intervention receptacles.

Table 3: Root Causes of Subsea Not-in-Operation Events, 2017-2020

ROOT CAUSE	2017 - 2019	2020
Design Issue	15.4%	19.8%
QA/QC Manufacturing	8.7%	5.3%
Maintenance Error	11.8%	13.5%
Procedural Error	5.8%	12.7%
Documentation Error	0.3%	12.2%
Wear and Tear	52.7%	33.6%
Other	0.4%	0.4%
NOT DETERMINED		
Inconclusive	0.1%	0.0%
Assessment Pending	3.4%	2.5%
Not Reported	1.2%	0.0%

SOURCE: U.S. DOT, BTS, SafeOCS Program.

Table 4: Root Causes of Subsea In-Operation Events, 2017-2020

ROOT CAUSE	2017 - 2019	2020
Design Issue	16.9%	19.6%
QA/QC Manufacturing	4.4%	5.4%
Maintenance Error	6.3%	7.1%
Procedural Error	5.1%	16.1%
Documentation Error	0.9%	5.4%
Wear and Tear	52.2%	39.3%
Other	0.7%	0.0%
NOT DETERMINED		
Inconclusive	0.0%	0.0%
Assessment Pending	11.1%	7.1%
Not Reported	2.3%	0.0%

SOURCE: U.S. DOT, BTS, SafeOCS Program.

Stack Pull Events

In 2020, five stack pulls were reported to SafeOCS and an additional three stack pulls were identified in WAR, for a total of eight subsea stack pulls. Considering only the stack pulls reported to SafeOCS, 8.9 percent of in-operation events in 2020 (5 of 56) led to the more operationally disruptive outcome of a stack pull, compared to 7.4 percent in 2019 (8 of 108).

Table 5 shows the equipment and failure types for events leading to subsea stack pulls from 2017 to 2020. As in previous years, external leaks are the predominant failure type leading to stack pulls in 2020. As all the external leaks were of water-based BOP control hydraulic fluids, rather than wellbore fluids, they typically pose a lower risk to the environment.

While the root cause of the three stack pulls identified in WAR is unknown to SafeOCS, of the remaining five, two had a reported root cause of wear and tear, one was attributed to design issue, one attributed to procedural error, and one is currently unknown as the assessment is still pending.

Table 5: Equipment and Types of Failures Associated with Subsea Stack Pulls, 2017-2020

Item	Component	Failure Type	2017-2020		2020 Only	
			In-Operation Events	Stack Pulls	In-Operation Events	Stack Pulls
Annular Preventer	Operating System Seal	External leak	2	1	-	-
		Internal leak	2	1	-	-
	Packing Element	Fail to open	1	1	1	1
		Internal leak	1	1	1	1
		Leakage	8	2	-	-
Autoshear Deadman EHBS	Piping Tubing	External leak	2	2	-	-
	SPM Valve	External leak	1	1	1	1
		Fail to close	1	1	-	-
	Timing Circuit	Incorrect timing	1	1	-	-
BOP Control Pod	Check Valve	External leak	1	1	1	1
	Gas Valve	External leak	1	1	1	1
	Interconnect Cable	Mechanical damage	1	1	-	-
	Piping Tubing	External leak	6	2	1	
	SPM Valve	External leak	18	2	1	-
BOP Controls Stack Mounted	Electrical Connector	Failure to transmit signal	1	1	-	-
	Hose	External leak	10	1	1	-
	Piping Tubing	External leak	6	2	1	1
	Shuttle Valve	External leak	3	1	-	-
Pipe Ram Preventer	Bonnet Face Seal	External leak	1	1	-	-
	Ram Block Seal	Fail to seal	15	2	5	-
Riser	Choke and Kill Line	Blockage	1	1	-	-
Shear Ram Preventer	Operating System Seal	Internal leak	1	1	1	1
	Ram Block Hardware	Mechanical damage	1	1	-	-
	Ram Block Seal	Fail to seal	1	1	-	-
Stack Choke and Kill System	Choke and Kill Valve	External leak	2	1	-	-
	Flex Loop Hose	External leak	3	2	1	1
Telescopic Joint	Packer	External leak	3	1	-	-
Total			**94**	**34**	**16**	**8**

NOTE: The three 2020 stack pulls identified only in WAR are included in this table and reflected in the counts.
SOURCE: U.S. DOT, BTS, SafeOCS Program.

RCFA Lessons Learned

Table 6 below summarizes the findings for the root cause failure analyses (RCFAs) that included preventive actions for subsea in-operation events in 2020. While a single investigation can involve multiple events, each of the three RCFAs shown represents an individual event. One of the RCFAs (row 2 in the table) involved nickel leaching from the use of demineralized water in BOP control fluid systems.

Table 6: RCFA Findings for In-Operation Subsea Events, 2020

	ROOT CAUSE	ROOT CAUSE DETAILS	RECOMMENDED FOLLOW-UP ACTION
1	Design Issue	Fault parameters on subsea electronic module (SEM) determined to be overly sensitive to the presence of high frequency sound.	OEM to adjust the sensitivity to high frequency sound that triggered a shut-down with upgrade.
2	Procedural Error	The company-wide water treatment regime was changed, making the BOP control fluid water incompatable for use with the tungsten-carbide control valve parts in use.	Field test a re-hardener to supply minerals to combat the binder leaching.
3	Procedural Error	The flowline seal was energized at a pressure higher than the recommended maximum, causing the seal to roll and fail.	Follow recommended operating procedures for pressure range.

SOURCE: U.S. DOT, BTS, SafeOCS Program.

SURFACE WCE SYSTEMS

A surface WCE system includes a BOP located above the water on the rig and associated equipment such as BOP controls, BOP stack, riser system, diverter, choke and kill, and auxiliary equipment. Table 7 lists aggregate statistics for surface wells and surface system events for 2017 to 2020. Each year since 2017, less than 10.0 percent of reported events have occurred on surface BOP systems, with 2020 having the lowest percentage of all reporting years (3.3 percent or 21 of 627). As in previous years, approximately half of 2020 surface system events (57.1 percent) occurred while not in operation. As the evaluation of WAR data for surface stack pulls is ongoing, an analysis of surface stack pulls is omitted from this report and will be included in the annual report.

Table 7: Surface System Numbers at a Glance, 2017-2020

MEASURE	2017	2018	2019	2020
WELLS				
Wells with Activity	160	217	208	122
Wells Spudded	65	86	86	41
RIGS				
Rigs with Activity	28	28	34	24
Rigs with Reported Events	19	16	15	10
OPERATORS				
Active Operators	19	24	21	17
Reporting Operators	11	8	9	8
BOP DAYS				
Total BOP Days	5,172	6,938	7,107	3,960
In-Operation BOP Days	3,615	5,067	5,243	2,736
Not-in-Operation BOP Days	1,557	1,871	1,864	1,224
COMPONENT EVENTS				
Total Events Reported*	115	69	87	21
In-Operation Events	58	35	44	9
In-Operation Event Rate	16.0	6.9	8.4	3.3
In-Operation Events per Well	0.36	0.16	0.21	0.07
Not-in-Operation Events	57	34	43	12
Not-in-Operation Event Rate	36.6	18.2	23.1	9.8
Not-in-Operation Events per Well	0.36	0.16	0.21	0.10
LOC EVENTS				
Loss of Containment Events	0	0	0	0

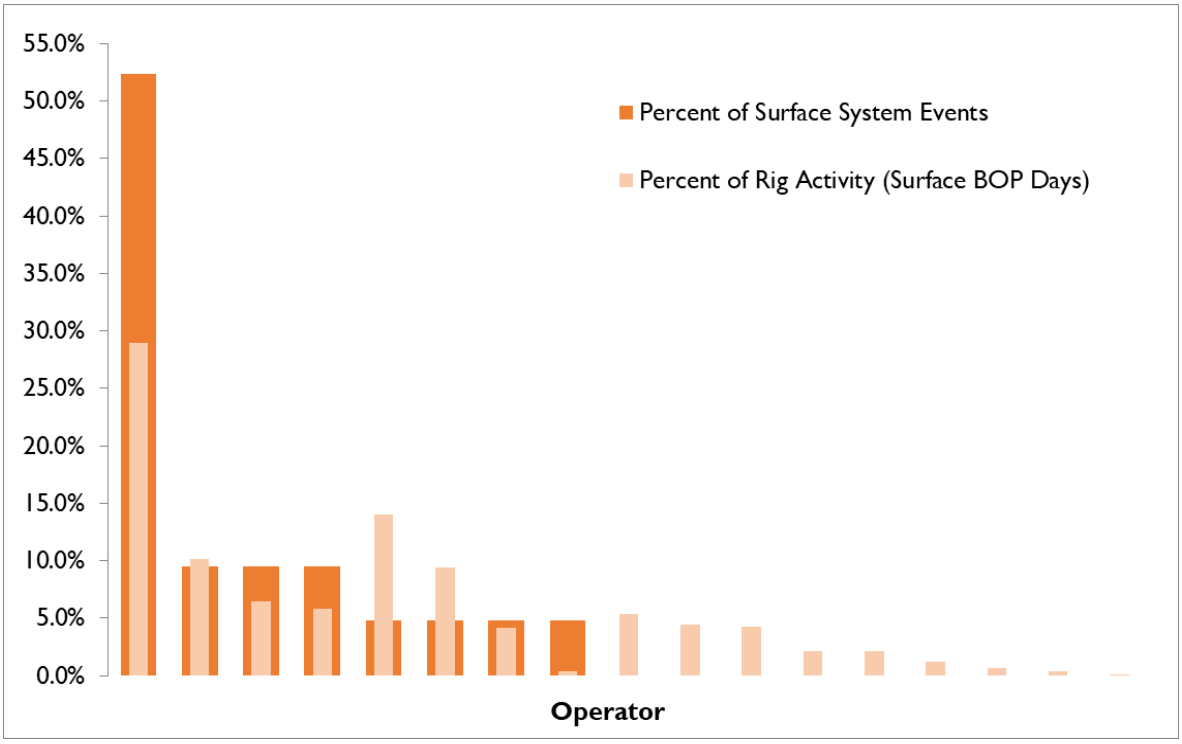
KEY: In-Operation Not-in-Operation
NOTE: *Total Events Reported excludes any events identified in WAR data.
1. The event rate reflects the number of events per 1,000 BOP days.
2. Events per well is calculated from wells with activity, not wells spudded.

SOURCE: U.S. DOT, BTS, SafeOCS Program.

Reporting Operators

Figure 6 shows surface system events and rig activity (measured in BOP days) for the 17 active operators with surface system well operations in 2020. The eight reporting operators represented 47.1 percent of active operators and accounted for 79.5 percent of surface BOP days. Overall, the rate of reporting on equipment failure events for surface systems by either active operators or active rigs remains below 50.0 percent.

Figure 4: Surface System Events and Rig Activity by Operator, 2020



SOURCE: U.S. DOT, BTS, SafeOCS Program.

Root Causes of Events

For surface systems, wear and tear has remained the most frequently reported root cause of events, reported for 10 of the 12 not-in-operation events and all nine (100.0 percent) in-operation events in 2020. The types of failed components varied, including regulators, seals, and valves, among others.

Table 8: Root Causes of Surface Not-in-Operation Events, 2017-2020

ROOT CAUSE	2017 - 2019	2020
Design Issue	3.0%	0.0%
QA/QC Manufacturing	6.0%	0.0%
Maintenance Error	13.4%	0.0%
Procedural Error	4.5%	0.0%
Wear and Tear	40.3%	83.3%
Other	8.2%	16.7%
NOT DETERMINED		
Inconclusive	2.2%	0.0%
Assessment Pending	4.5%	0.0%
Not Reported	17.9%	0.0%

SOURCE: U.S. DOT, BTS, SafeOCS Program.

Table 9: Root Causes of Surface In-Operation Events, 2017-2020

ROOT CAUSE	2017 - 2019	2020
Design Issue	5.1%	0.0%
QA/QC Manufacturing	2.9%	0.0%
Maintenance Error	1.5%	0.0%
Procedural Error	0.0%	0.0%
Wear and Tear	59.9%	100.0%
Other	6.6%	0.0%
NOT DETERMINED		
Inconclusive	0.7%	0.0%
Assessment Pending	5.8%	0.0%
Not Reported	17.5%	0.0%

SOURCE: U.S. DOT, BTS, SafeOCS Program.

REPORT NOTES

- Due to rounding, numbers in tables and figures may not add up to totals.
- SafeOCS may receive WCE event notifications after the publication of reports. If notifications are received after publication that meaningfully impact this report's results and conclusions, an addendum may be published.
- Numbers are adjusted in each report to reflect updated information and may vary from previously published reports. All results and references to previous data in this report represent updated numbers unless otherwise stated.