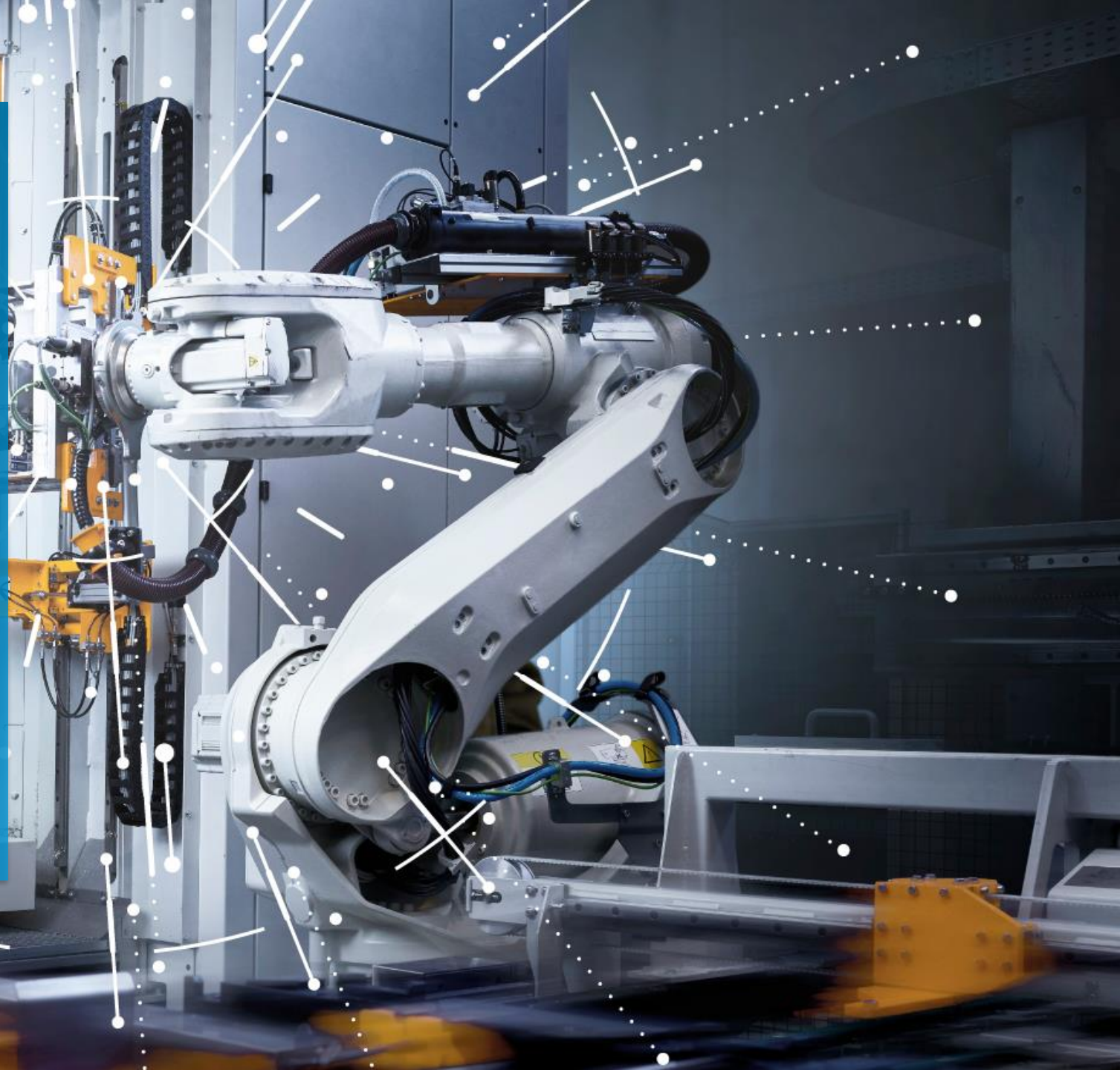


flex.

Waters 2020 FPY Improvement Activities

25 Nov 2020



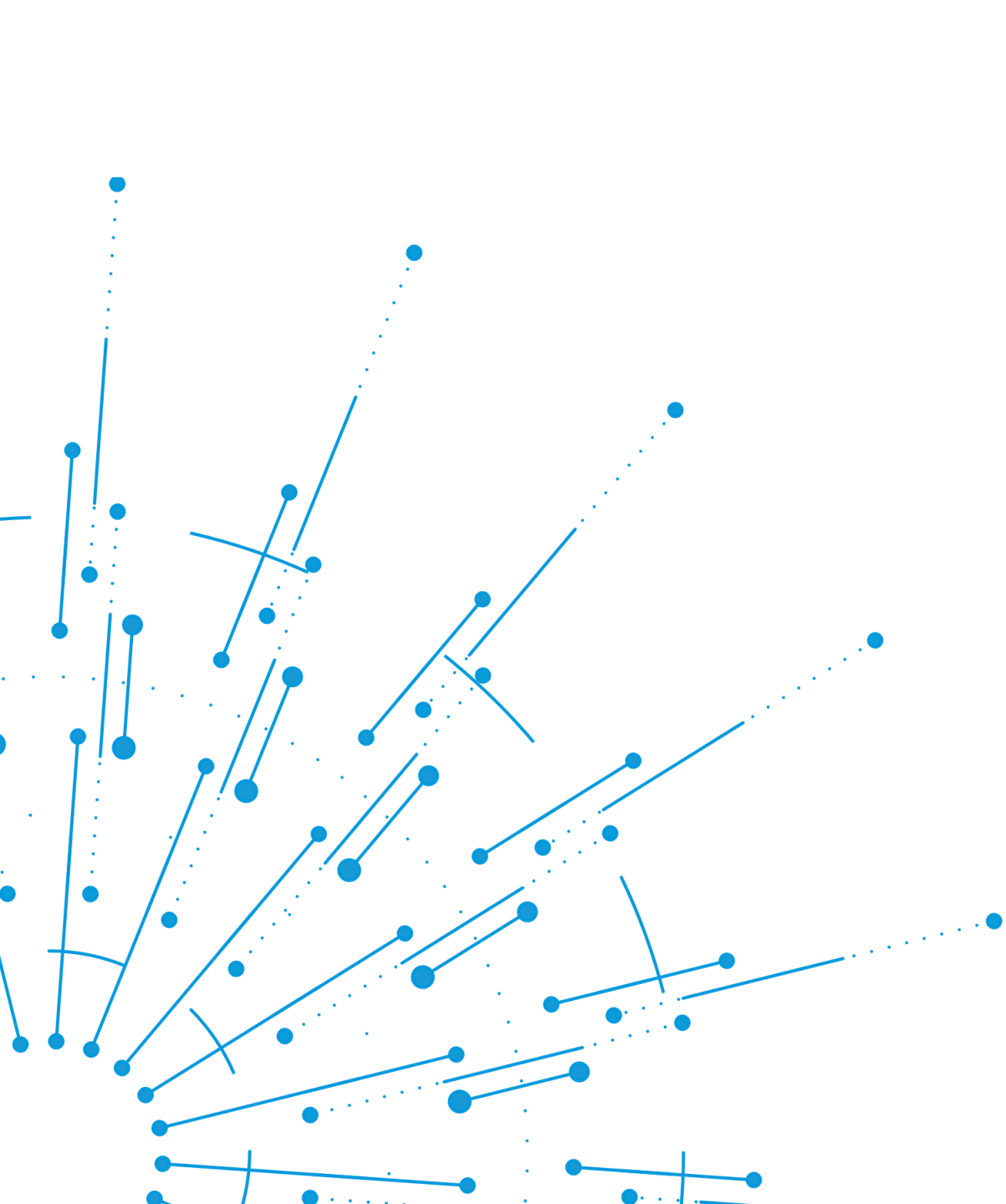
Goal and Objective

1. To achieve FPY for Detector PDA, Detector TUV and BSM/QSM Family
 - Detector TUV equal and greater 96.56%
 - Detector PDA equal and greater 77.44%
 - BSM equal and greater 50.70%
2. The approach is to optimize the test coverage through process , consumables and test enhancements. It is a conjunction efforts to work between Milford, WPPL and Flex.
3. Flex is to plot out the Pareto Charts for Detector PDA, Detector TUV and BSM/QSM Family across all the failures reported in Year 2019. Flex is to fill up all the actions taken and efforts in the past 1 year and so the upcoming as well as on going activities for yield improvement.
4. Milford and WPPL team are to provide more technical advice and actions in term of test software and specification, test and pre-inspection methods as well as the control of test samples / consumables to ensure test coverage are fully optimized and enhanced.

FPY Improvement Summary

Model	Target 2020	Q1 2020	Q2 2020	Q3 2020	Q4 2020	Item	Progress
Alliance	84.25 %	91.10 %	87.93 %	90.56 %	86.88 %	NA	NA
						NA	NA
						NA	NA
BSM & QSM+	51.59 %	48.70 %	45.58 %	53.00 %	53.82 %	Test Compositional Accuracy	Monitoring in progress • Every 2 weeks changing of interface tubing
						Test Flow Rate Accuracy	Monitoring in progress • Improve tube going to waste NOT to submerged in the waste can
						Test Input Prime with MeOH	Monitoring in progress • Manual Priming (EVALS20019)
PDA Detectors	77.44 %	74.89 %	65.48 %	65.32 %	71.37 %	Communication Failure	Completed 600 data points on all 6x Testers (EVALS20015 closed) • TE82882-9, 10, 14 showing better yield • TE82882-8, 11, 13 showing low yield Eric Turner increased data base for affected 3x testers TE82882-8, 11, 13 . • Min 120x Data points per port collection per EVALS20033 in progress.
						Drift	Low priority to work on as current yield is 1.39%
						Final Drift	Low priority to work on as current yield is 0.86%
TUV Detectors	96.56 %	95.15 %	99.16 %	99.06 %	97.30 %	Dual Noise	No Dual Noise for 5 consecutive months (Apr'20 – Aug'20). CLOSED
						Noise	NA
						NA	NA
Pumps	99.85 %	100 %	99.32 %	100 %	100 %	1x unit failed in the month of Apr '20 due to Component faulty - replaced 2100057520	NA
						NA	NA
						NA	NA

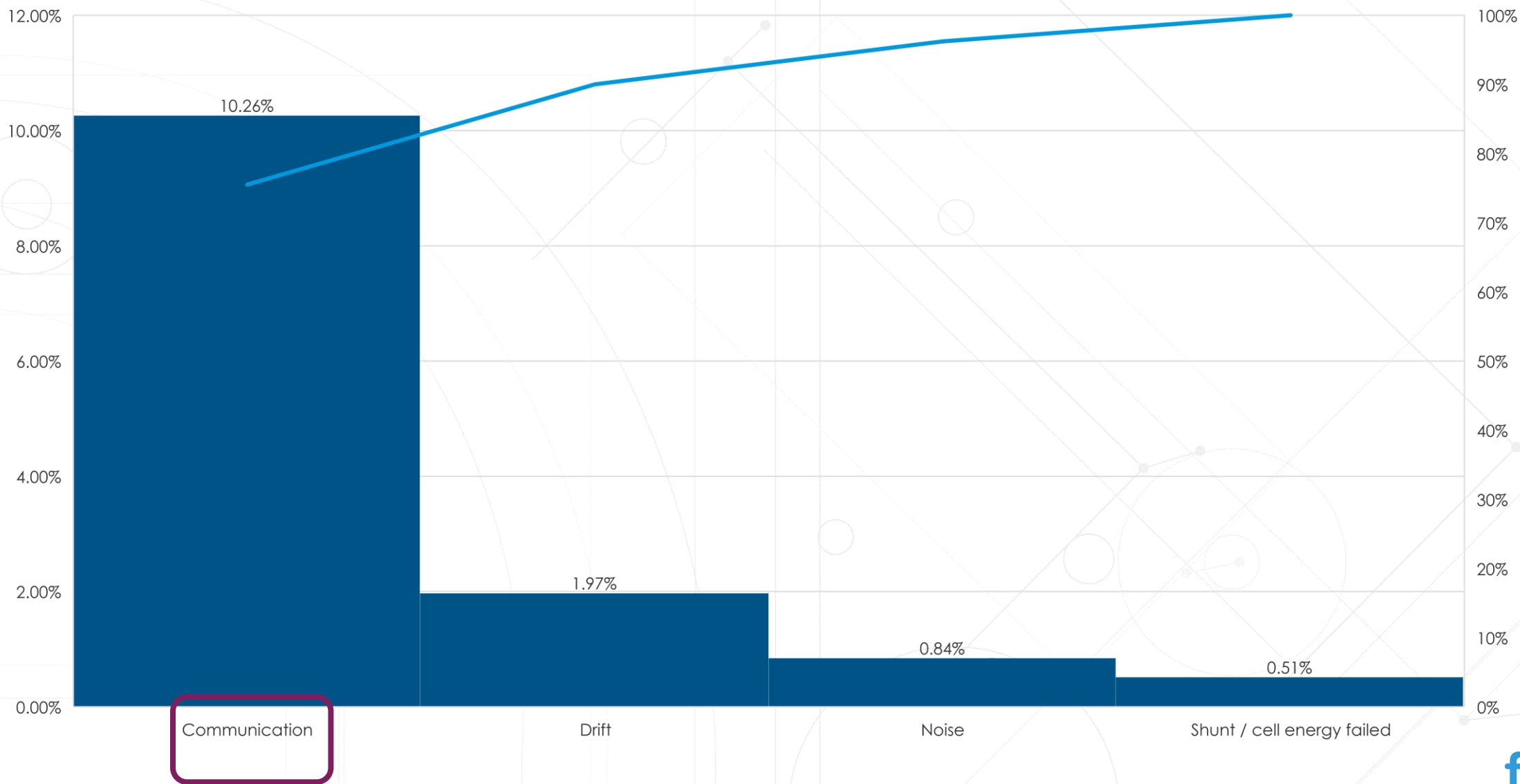
- Q4 Yield % up to Oct'20



PDA Detectors – Yield Improvement

Pareto Chart for PDA Detectors

PDA Detectors Pareto Jan - Dec'19

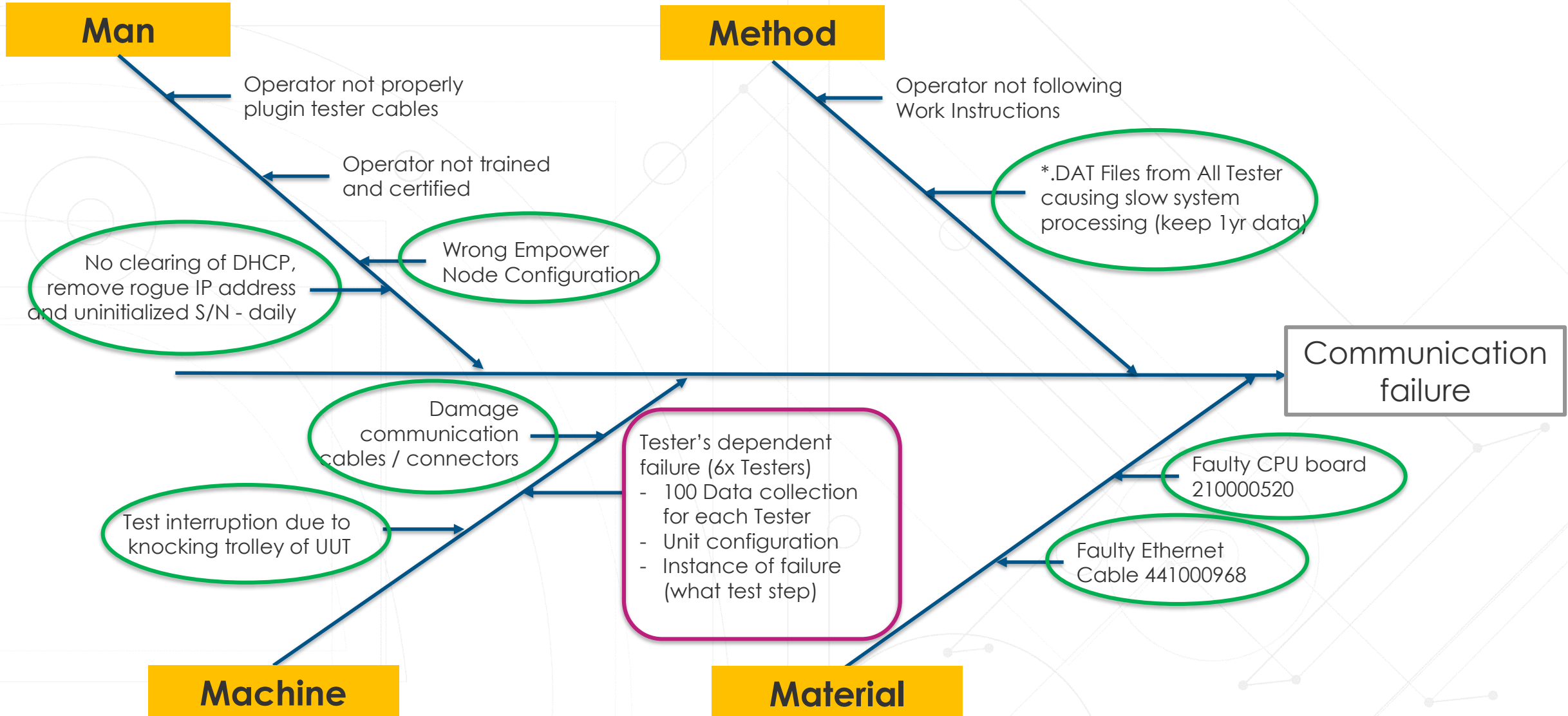


PDA Detectors – Failure Mode

Failure Modes	PDA Detectors
Communication	10.26%
Drift	1.97%
Noise	0.84%
Shunt / cell energy failed	0.51%
Total failure % contributed	13.59%

- Yield from Jan-Dec'19

Yield Improvement – Communication Failure



PDA Detectors – 2020 FPY Improvement Plans

No	Failure	% Fail 2019	% Improve 2020	Actions & Results	
				Flex	PIC / Date
1	Communication Failure	10.26%	5.00%	Tester ID: - TE82882-8 ,TE82882-9, TE82882-10, TE82882-11, TE82882-13, TE82882-14 Communication Failure: - Removed old *DAT Files from 2016 to 2019. Implemented. - Review Ethernet\RS232 interface headers. Implemented. - Mount separating fence at TE82882-13. Implemented. - Removed Empower Node with conflict. Implemented. - Test Operator daily clearing of DHCP, remove rogue IP and initialize the SN. Implemented. - EVALS20015 To collect 100 data points for TE82882- 8, 9, 10, 11, 13 and 14. Completed total 600 data points on 29 Jul 20 - Milford Team had remote access to the PDA Final Testers - made adjustment on database table on TE82882-8 - clear rouge instrument TE82882-11 - Milford Team had remote access to the PDA Final Testers - made adjustment on database table on TE82882-13 - EVALS20033 To collect min. 10 data points per port per tester to TE82882-8, TE82882-11, TE82882-13 - TE82882-8 - Relay box caused high loss comm; Going to replace relay box - Tester can use direct LAN cable to continue test - TE82882-11 - FPY improved from 58% to 76% after database adjustment. - Checking on relay box and cables to see if can improve further for this testers. - TE82882-13 - Port 3 LAN cable caused high loss comm. Fixed by replacing LAN cable. - Data collection is in progress	Joel, David / 26 Dec 19 Joel / 27 Mar 20 Joel, Aldwin / 09 Mar 20 Joel, David / 06 Mar 20 Joel, Shamsul / 06 Mar 20 Joel / 24 Apr 20 Joel, HZL, Eric Turner / 25 Aug 20 Joel, HZL, Eric Turner / 17 Sep 20 Joel, HZL, Eric Turner / 30 Oct 20 extend to Nov'20

Yield Improvement – Communication Failure

Monitoring in 2020 – Communication Failure

Model – PDA Detectors Family

Month	Total Unit Tested	Communication (failure%)
		2019 Ref rate 10.26%
Jan -2020	347	12.68%
Feb -2020	379	14.78%
Mar -2020	305	12.13%
Apr -2020	187	19.25%
May -2020	199	17.09%
Jun -2020	178	11.24%
Jul -2020	248	29.03%
Aug -2020	254	9.84%
Sep -2020	305	22.95%
Oct -2020	489	18.81%

Detector PDA – Communication Failure

Aug 2020	Detector PDA 2019 Ref failure rate – 10.26% Achieved – 16.78% (Jan-Oct'20)	Improvement				
PIC	Joel, Aldwin					
Purpose						
- High failure rate affecting first pass yield - Focus on communication failure - Testers TE82882-8, 11 and 13 contribute to low yield.						
Progress			Project Status			
- Completed 4M analysis. - EVALS20015 To collect 100 data points for TE82882- 8, 9, 10, 11, 13 and 14. - EVALS20015 Completed total 600 data points on 29 Jul 20. - EVALS20033 To collect min. 10x data points per port per tester to TE82882-8, TE82882-11, TE82882-13			Q1	Q2	Q3	Q4
			4M Analysis Completed	Data Collection Completed	New Data Collection In progress	
Next Steps			Risks & Issues			
- Work on TE82882-8, -11, -13 with Milford Team to remote access the PDA Final Testers - Eric Turner made adjustment on database table on TE82882-8, -11, -13 and clear rouge instrument TE82882-11						

Yield Improvement – Communication Failure

Collect min 120x data points for 3 Testers:

Manual Data Collection from after Eric Turner suggestion Start: 13 Oct 2020 (EVALS20033)				
TE82882	TE82882-8	TE82882-11	TE82882-13	Total
TESTED	53	63	50	163
LOSS COMM	13	14	18	45
FPY %	74.00%	77.78%	64.00%	72.39%
Baseline (EVALS20015)	55.00%	58.00%	57.00%	56.67%
Target	80.00%	80.00%	80.00%	80.00%

- Refer to manual data collection table as of 17 Nov 20.

Eric Turner increased data base for affected 3x testers TE82882-8, 11, 13.

❑ Min120x data points collection per EVALS20033 in progress.

❑ EVALS20033 To collect min.10x data points per port per tester to TE82882-8, TE82882-11, TE82882-13

❖ TE82882-8

- ✓ Relay box caused high loss comm; Going to replace relay box
- ✓ Tester can use direct LAN cable to continue test

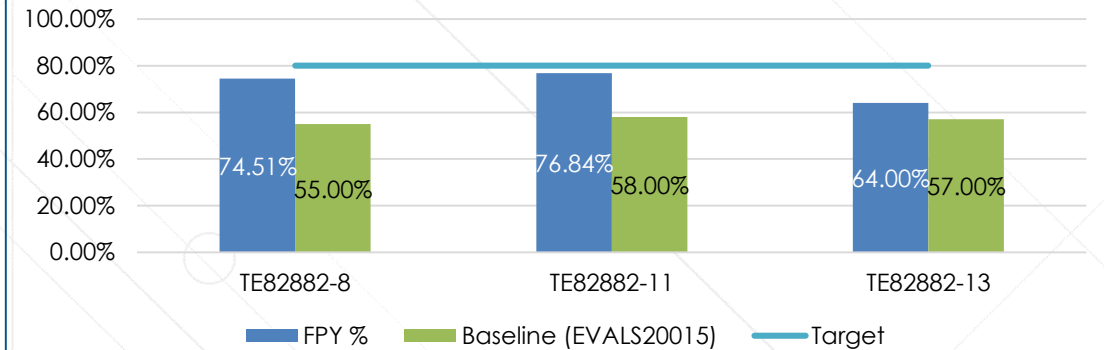
❖ TE82882-11

- ✓ FPY improved from 58% to 76% after database adjustment.
- ✓ Checking on relay box and cables to see if can improve further for this testers.

❖ TE82882-13

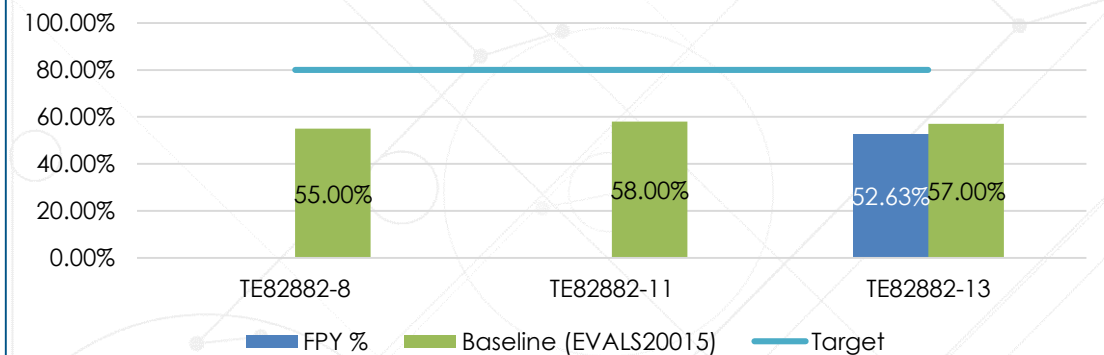
- ✓ Port 3 LAN cable caused high loss comm. Fixed by replacing LAN cable.
- ✓ Data collection is in progress

TE2882 PDA FINAL TESTER (After Data)

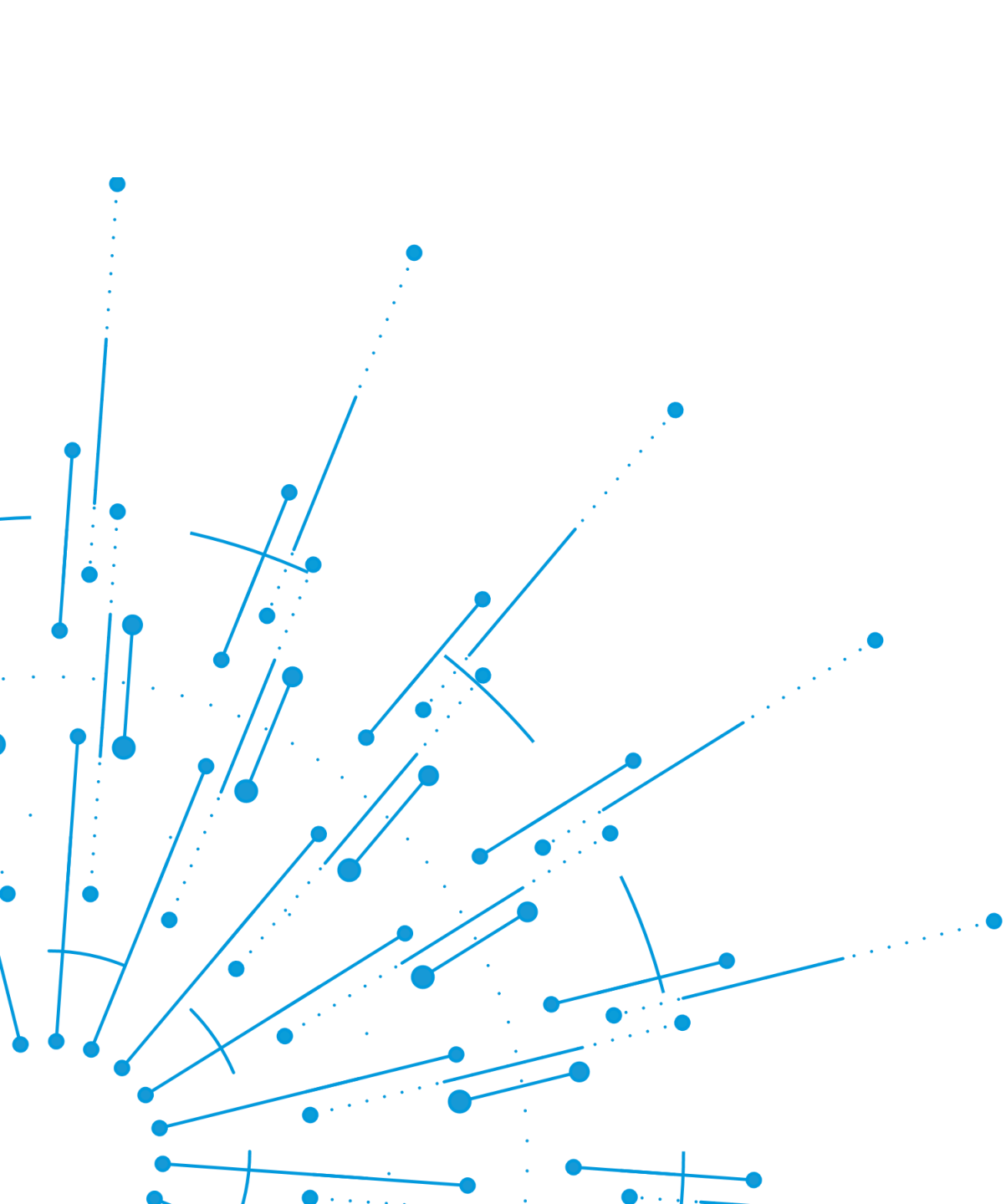


- TE82882-8 Implementing of direct ethernet
- TE82882-11 Increased database table size
- TE82882-13 replaced ethernet head at POS3

TE2882 PDA FINAL TESTER (Before Data)



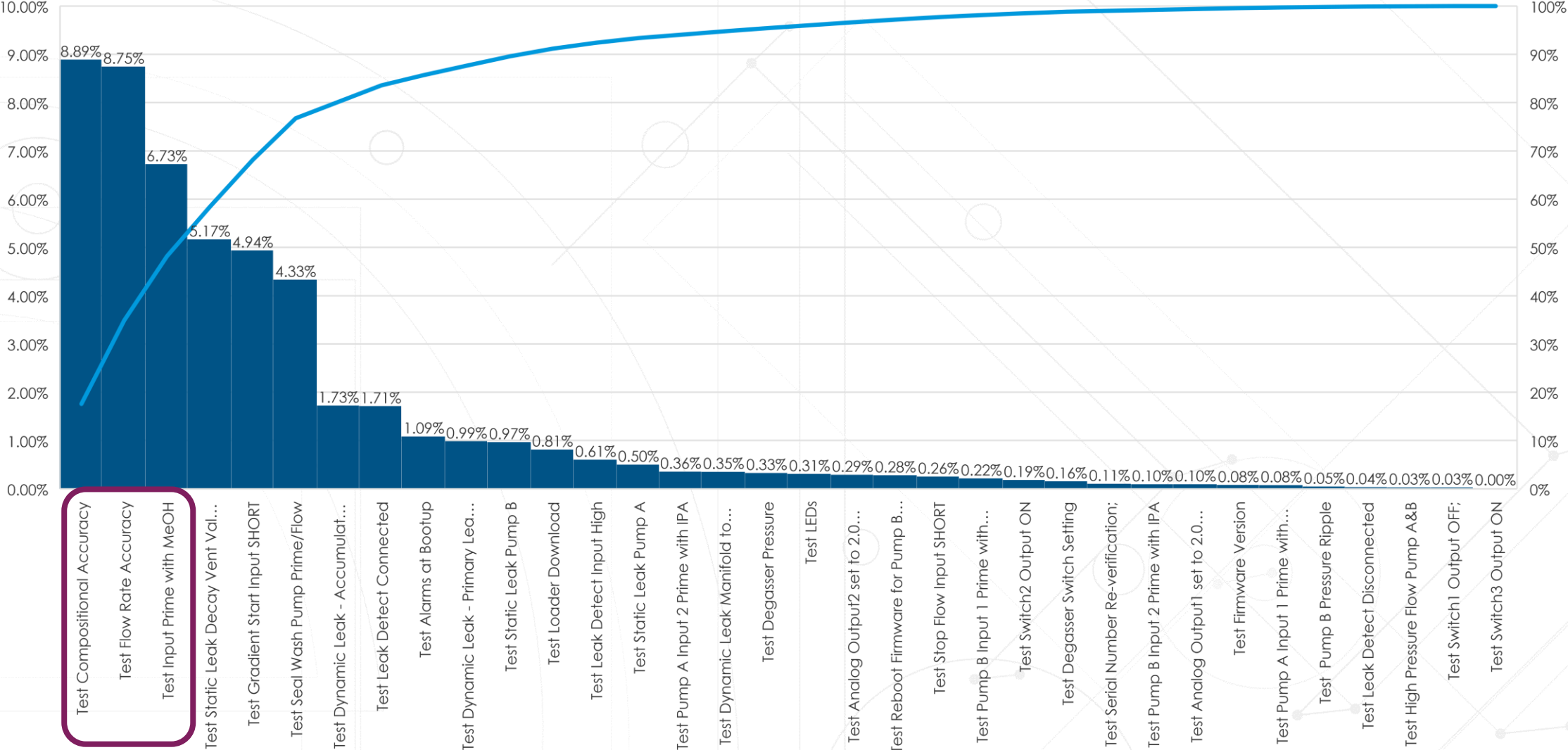
- Verification of measurement and computing (relay box)



BSM, QSM Plus – Yield Improvement

Pareto Chart for BSM, QSM Plus

BSM/QSM Plus Jan'19 – May'20

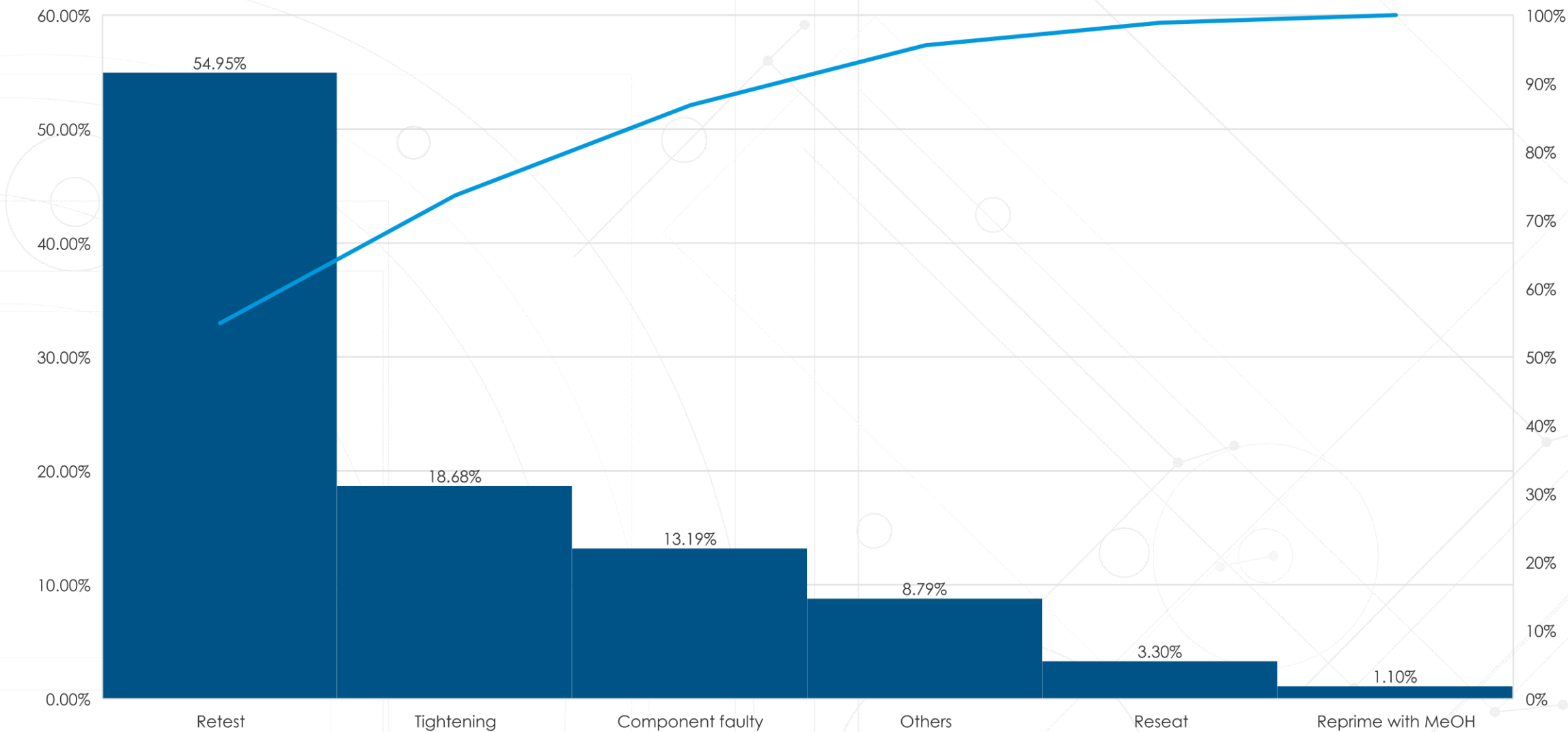


BSM, QSM Plus – Failure Mode

Failure Modes	BSM, QSM Plus
Test Compositional Accuracy	8.89%
Test Flow Rate Accuracy	8.75%
Test Input Prime with MeOH	6.73%
Test Static Leak Decay Vent Valve to Filter/Mixer	5.17%
Test Gradient Start Input SHORT	4.94%
Test Seal Wash Pump Prime/Flow	4.33%
Test Dynamic Leak - Accumulator Leak Rate	1.73%
Test Leak Detect Connected	1.71%
Test Alarms at Bootup	1.09%
Test Dynamic Leak - Primary Leak Rate	0.99%
Test Static Leak Pump B	0.97%
Test Loader Download	0.81%
Test Leak Detect Input High	0.61%
Test Static Leak Pump A	0.50%
Test Pump A Input 2 Prime with IPA	0.36%
Test Dynamic Leak Manifold to Filter Tube	0.35%
Test Degasser Pressure	0.33%
Test LEDs	0.31%
Test Analog Output2 set to 2.0 VDC	0.29%
Test Reboot Firmware for Pump B Download	0.28%
Test Stop Flow Input SHORT	0.26%
Test Pump B Input 1 Prime with MeOH	0.22%
Test Switch2 Output ON	0.19%
Test Degasser Switch Setting	0.16%
Test Serial Number Re-verification;	0.11%
Test Pump B Input 2 Prime with IPA	0.10%
Test Analog Output1 set to 2.0 VDC	0.10%
Test Firmware Version	0.08%
Test Pump A Input 1 Prime with MeOH	0.08%
Test Pump B Pressure Ripple	0.05%
Test Leak Detect Disconnected	0.04%
Test Switch1 Output OFF;	0.03%
Test High Pressure Flow Pump A&B	0.03%
Test Switch3 Output ON	0.00%
Total failure % contributed	50.57%

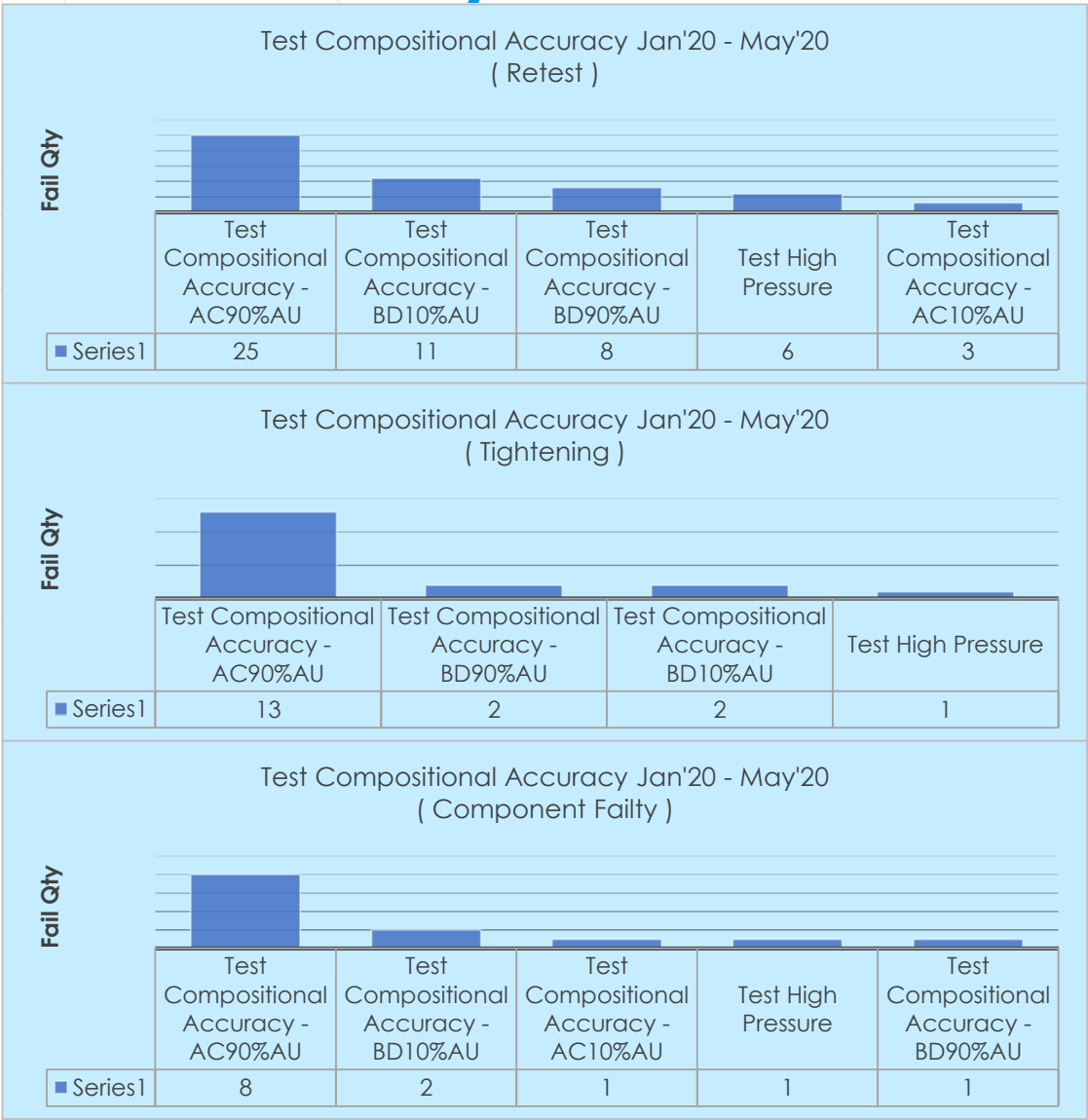
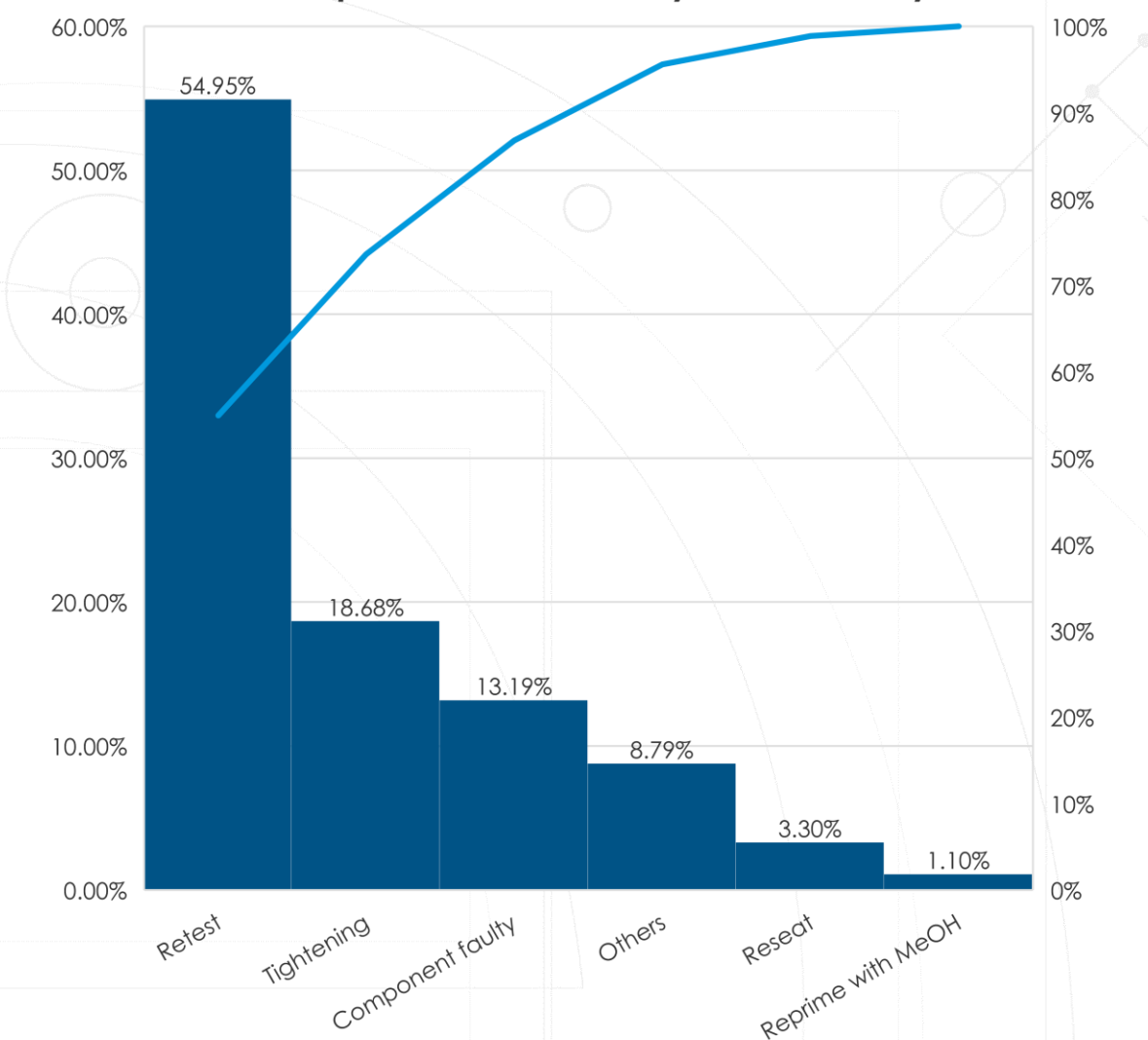
Pareto Chart for Test Compositional Accuracy

Test Compositional Accuracy Jan'20 – May'20

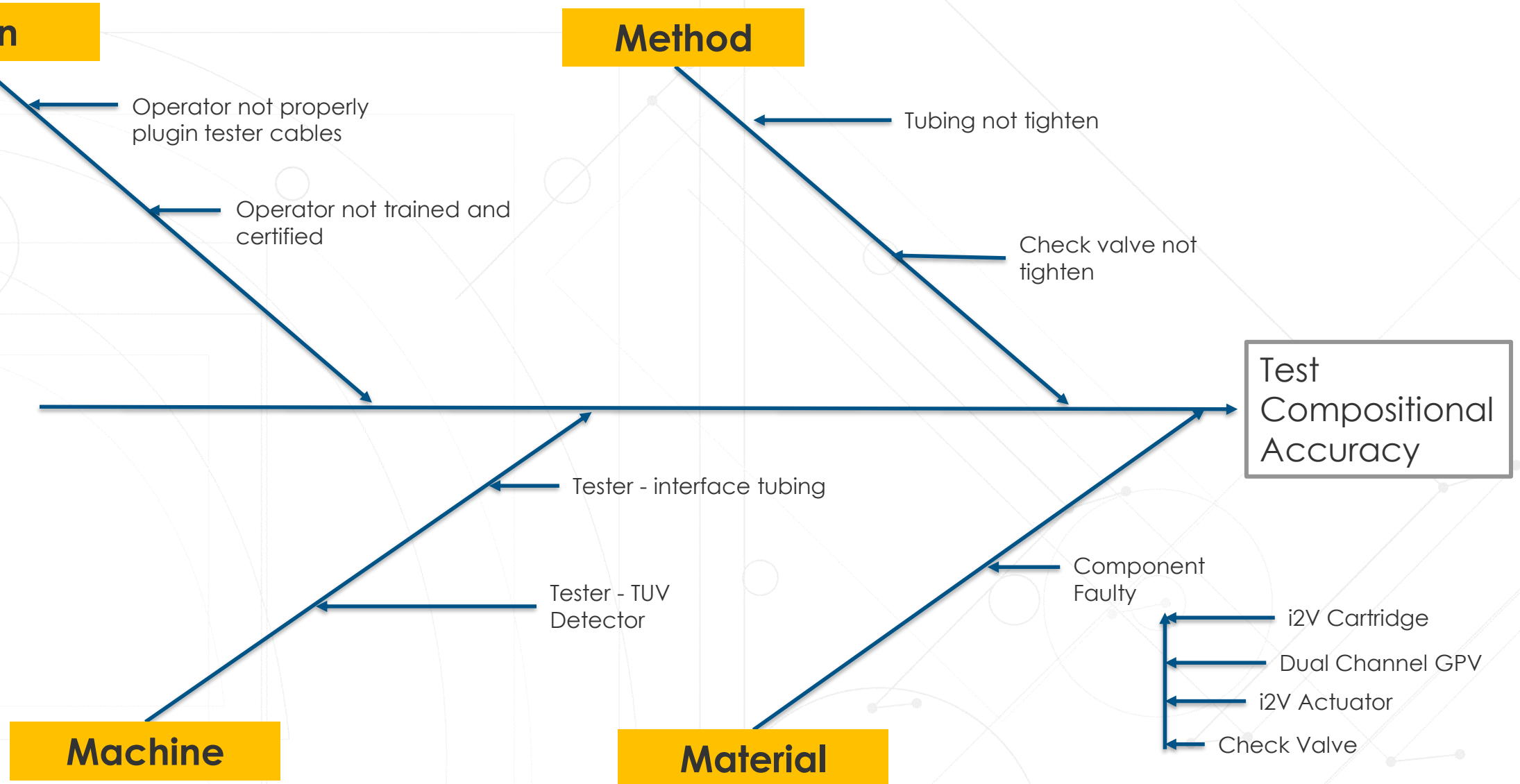


Pareto Chart for Test Compositional Accuracy

Test Compositional Accuracy Jan'20 – May'20



Yield Improvement – BSM, QSM Plus

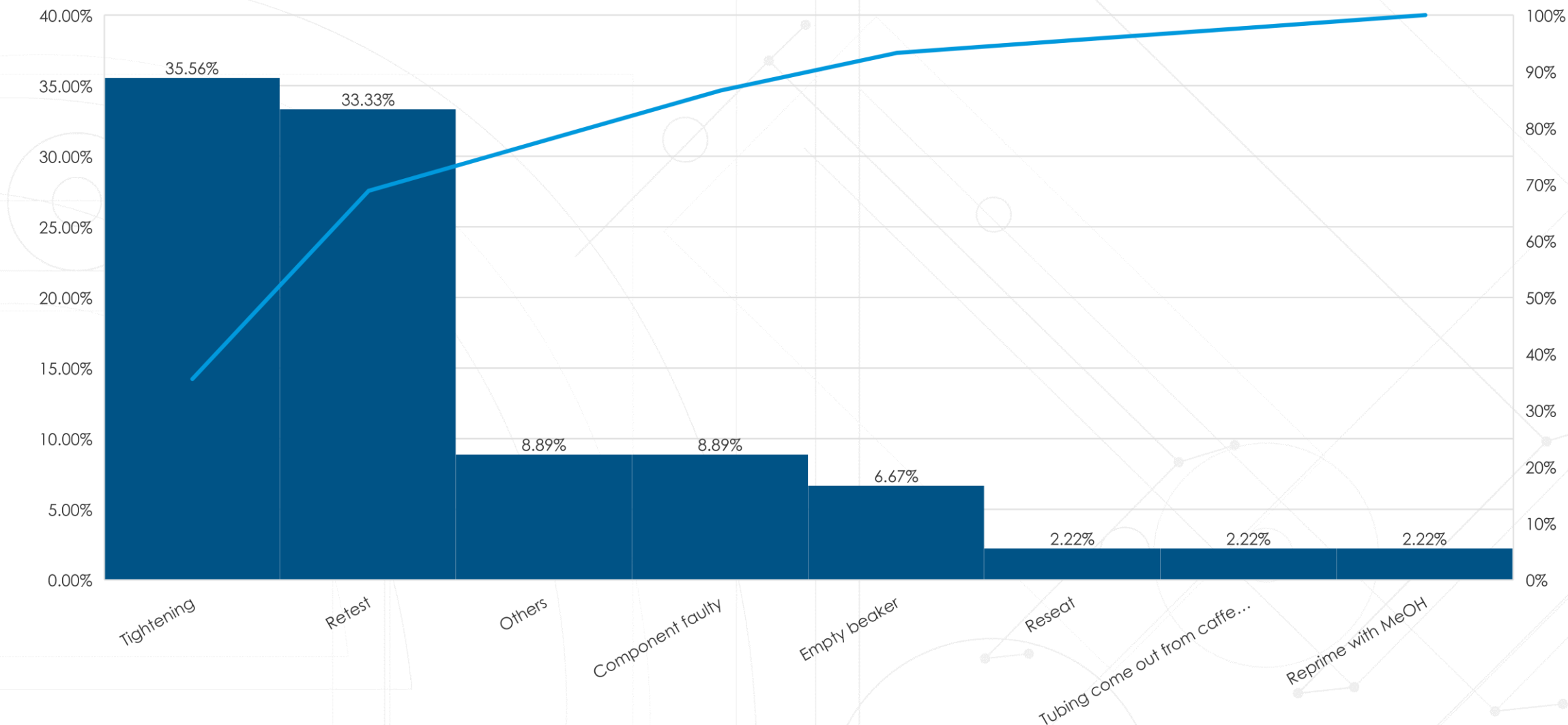


Yield Improvement BSM, QSM Plus 4M – Test Compositional Accuracy

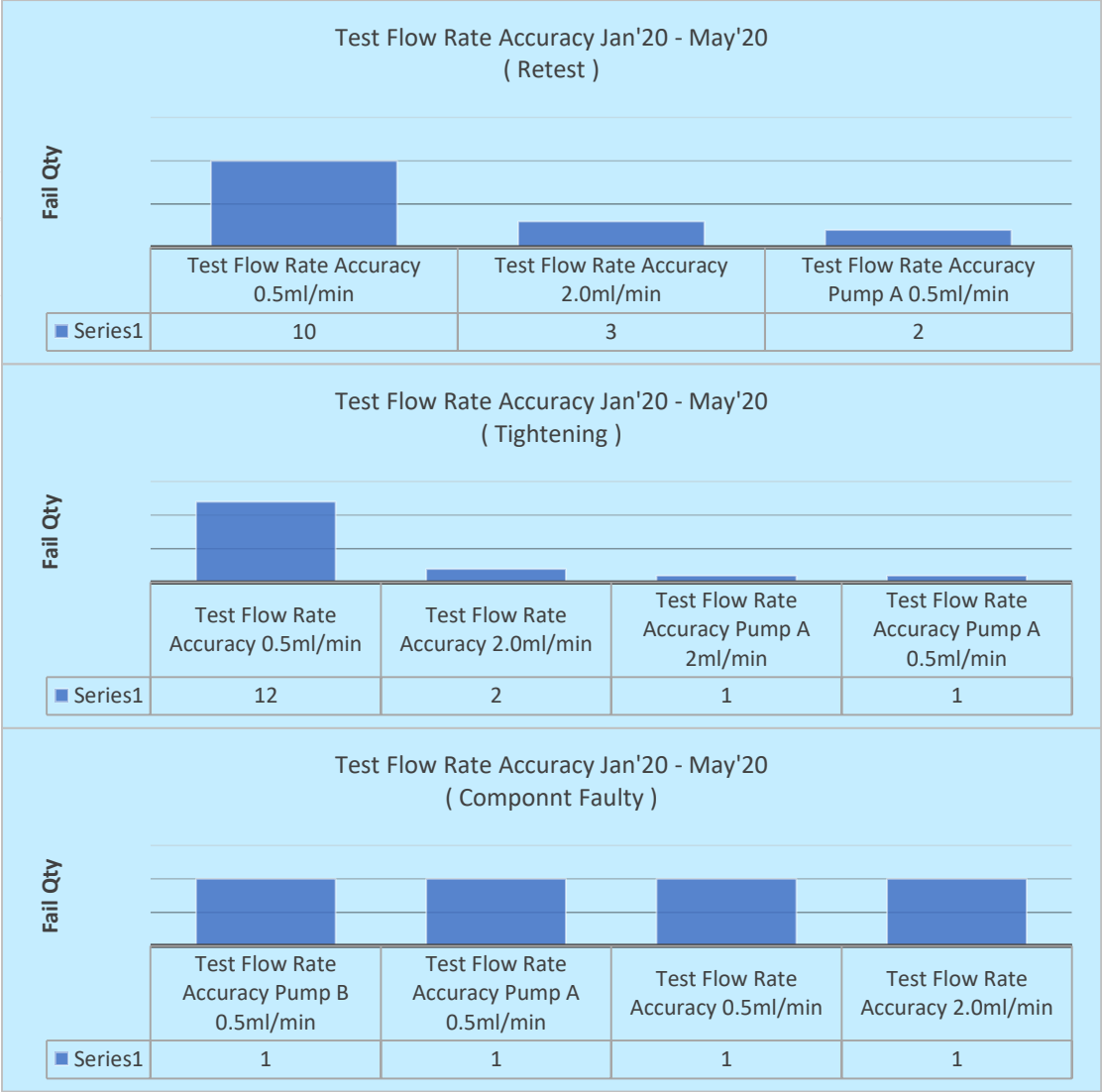
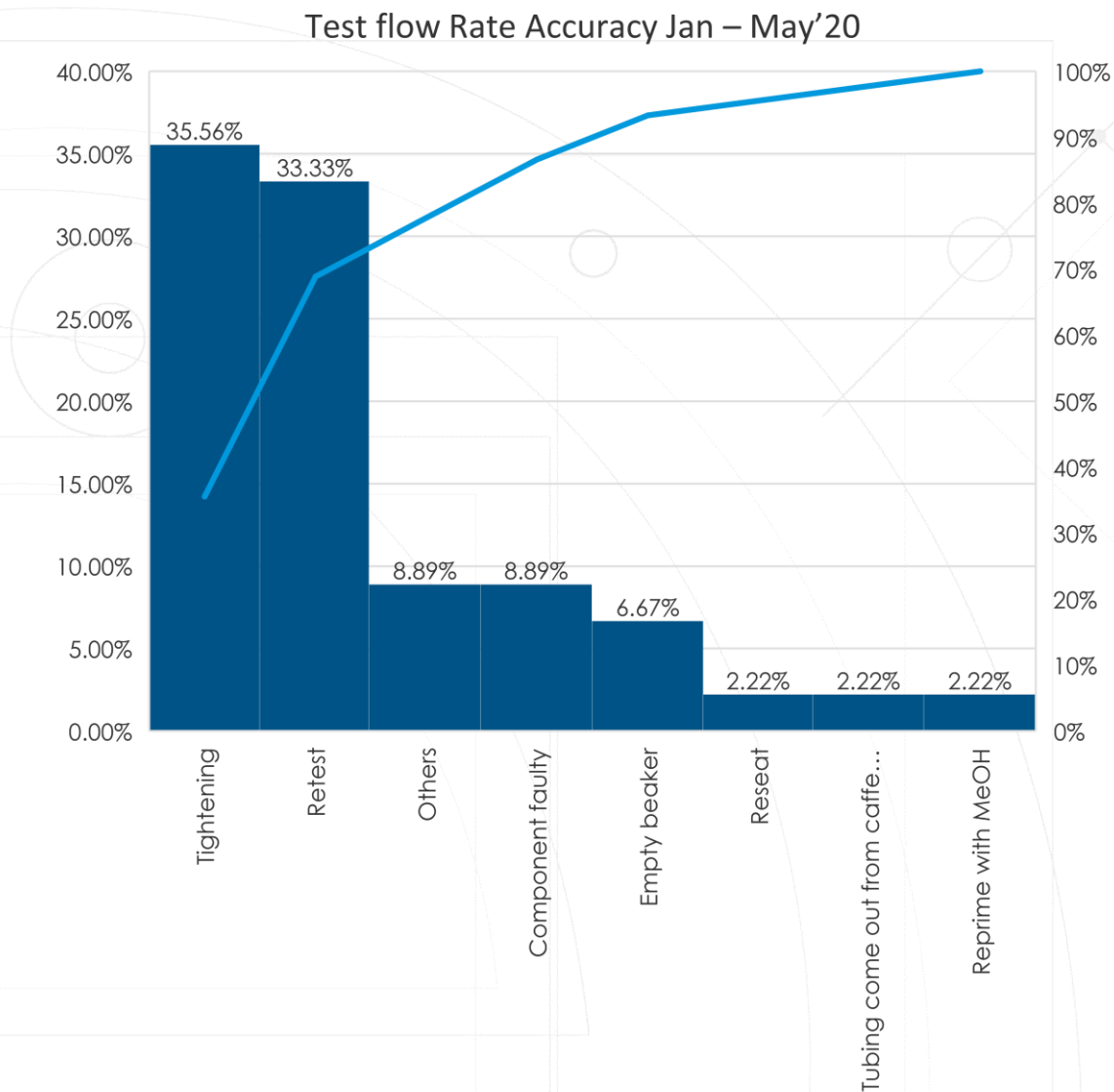
Category	Possible Causes	Verification	Possible Cause (Y/N)	Proposed Action
Man	Operator not properly plugin tester cables	Operators are following as per ASP and TSP.	N	N/A
	Operator not trained and certified	Operators are trained and Certified before commence of work.	N	N/A
Method	Tightening tubing at Chassis Assy	Verified tightening following as per APS. Finger tight, marking and 3/4 tightening using spanner	N	Briefing conducted to refresh operators per AP
	Tightening tubing at Final Test	No torque specified when tightening tubing e.g. interface tubing	Y	Monitoring in progress.
Material	Component Faulty	Parts are check for cosmetics before use	N	Monitoring in progress.
Machine	Retest	Retest without doing anything. AC90%AU is observed to be high as this is beginning of test for compositional accuracy	Y	Monitoring in progress.
		Retightening of interface tubing. Additional ¼ turn.	Y	Monitoring in progress.

Pareto Chart for Test Flow rate Accuracy

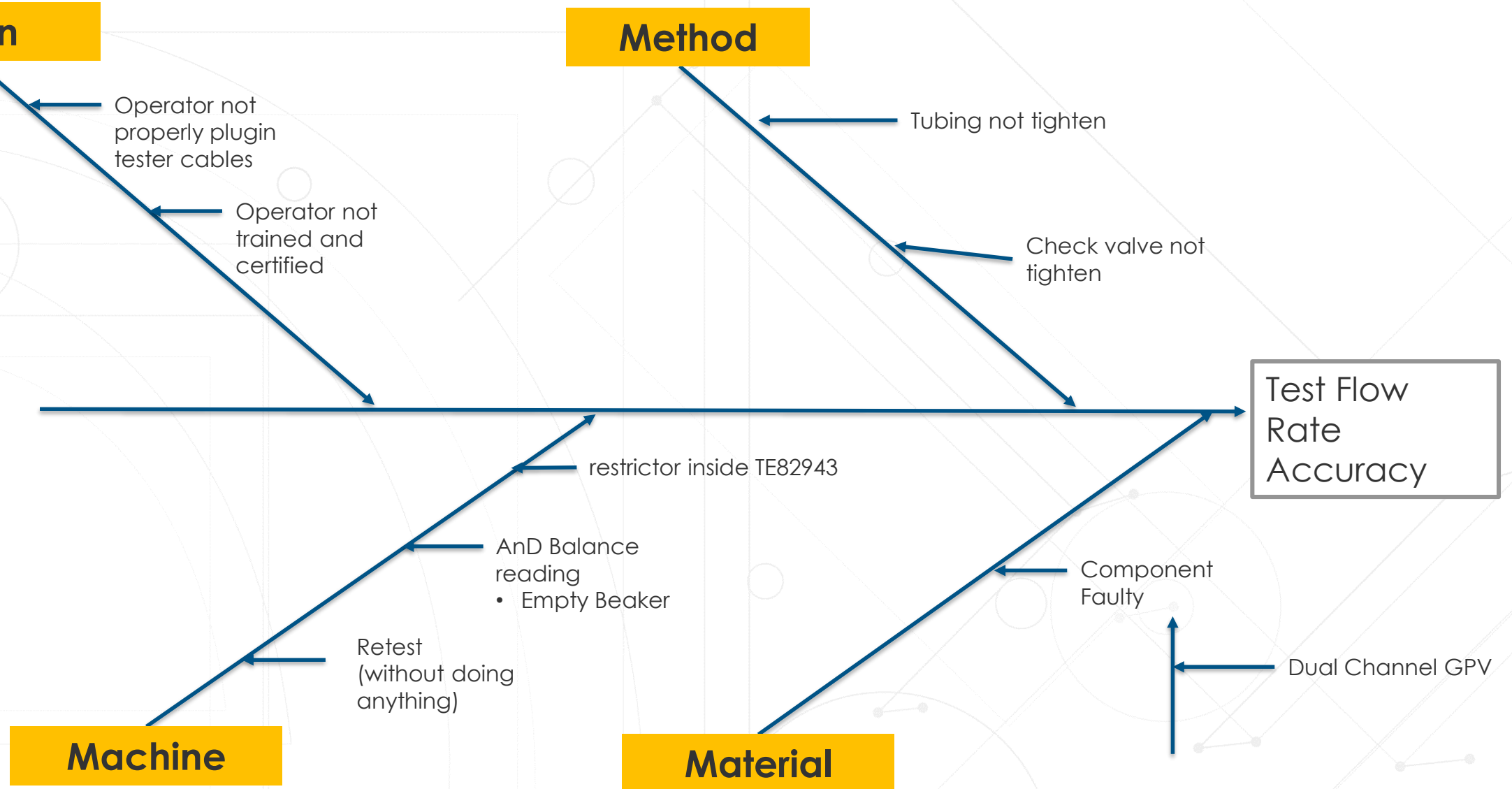
Test flow Rate Accuracy Jan – May'20



Pareto Chart for Test Flow rate Accuracy



Yield Improvement – BSM, QSM Plus



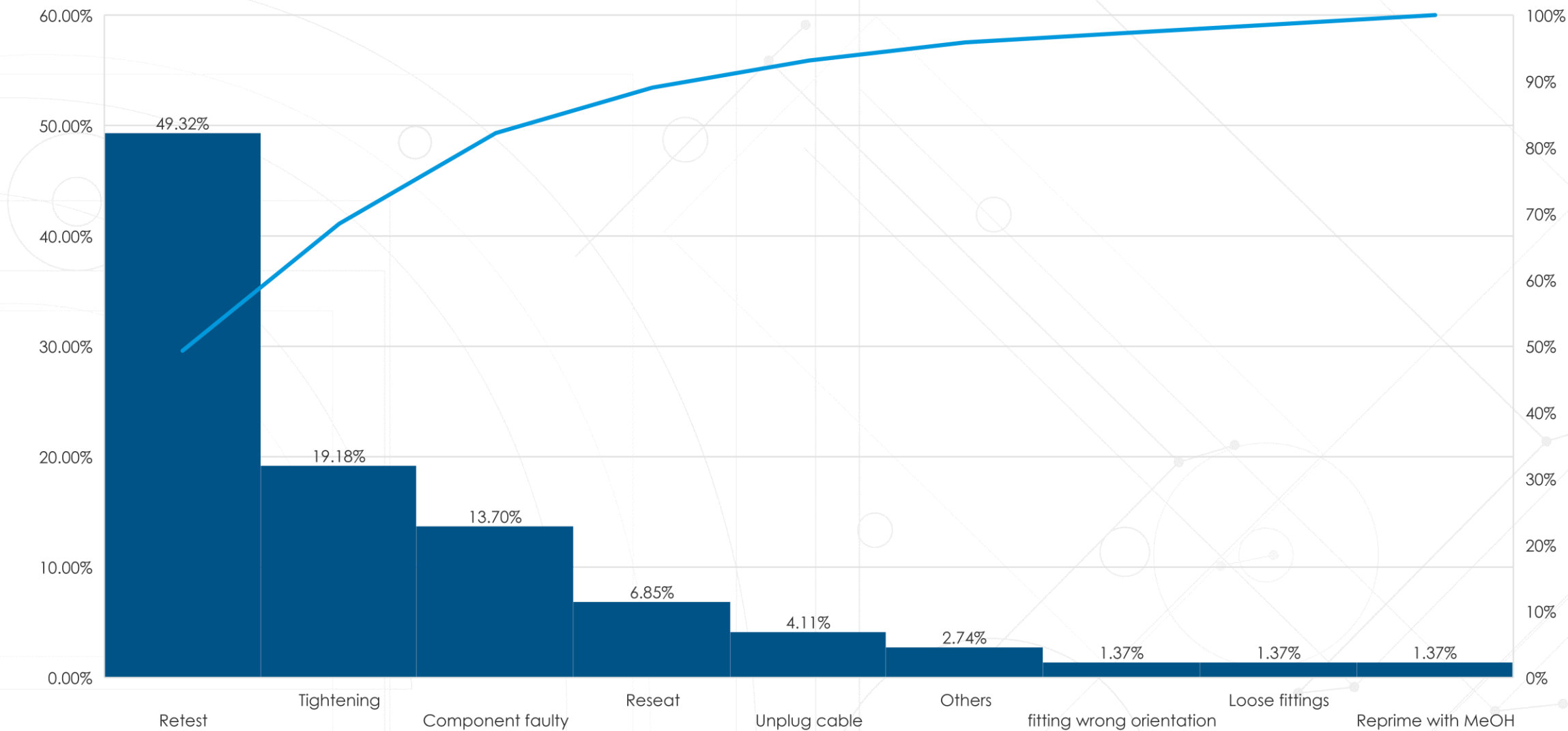
Yield Improvement BSM, QSM Plus

4M – Test Flow Rate Accuracy

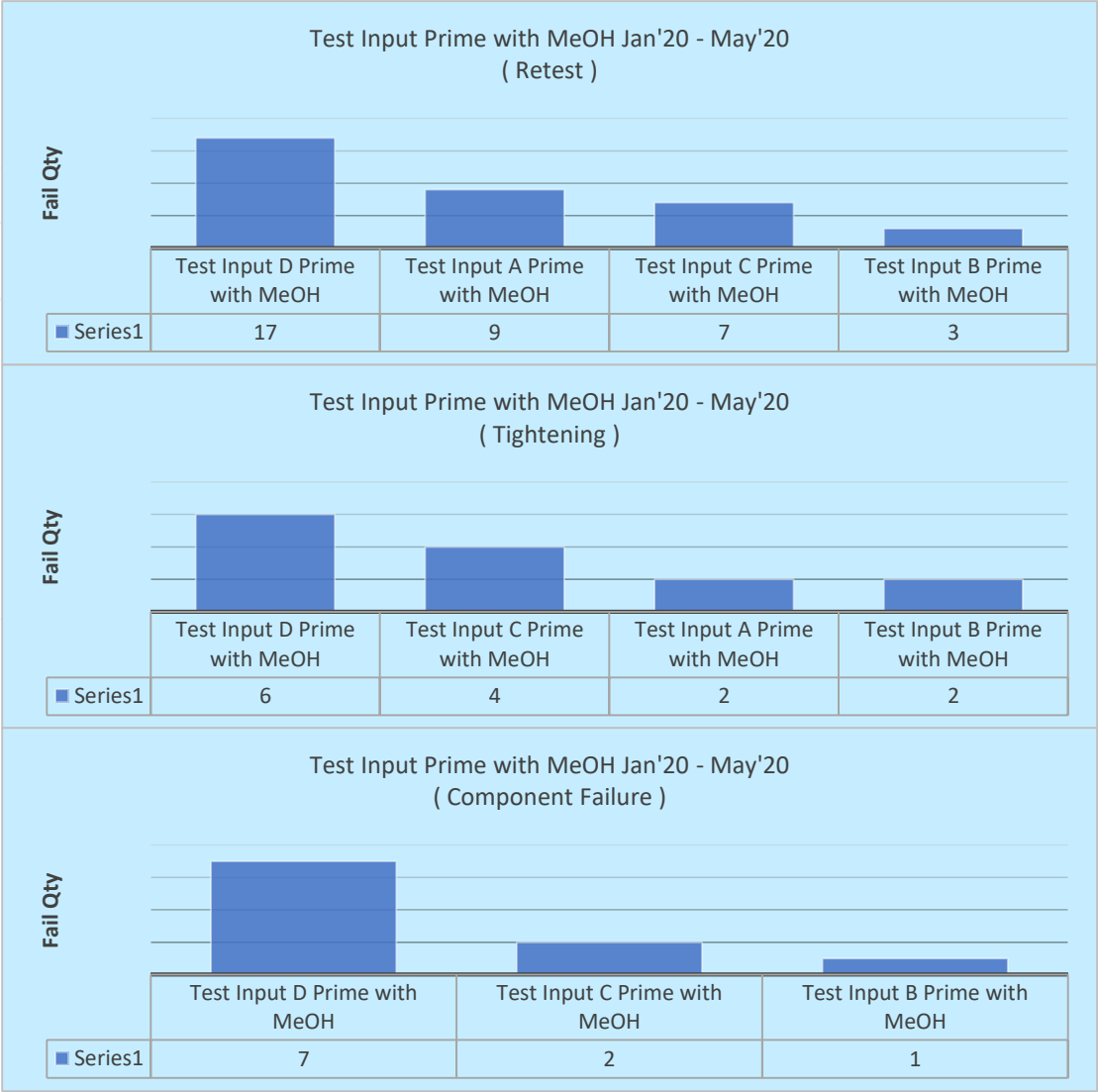
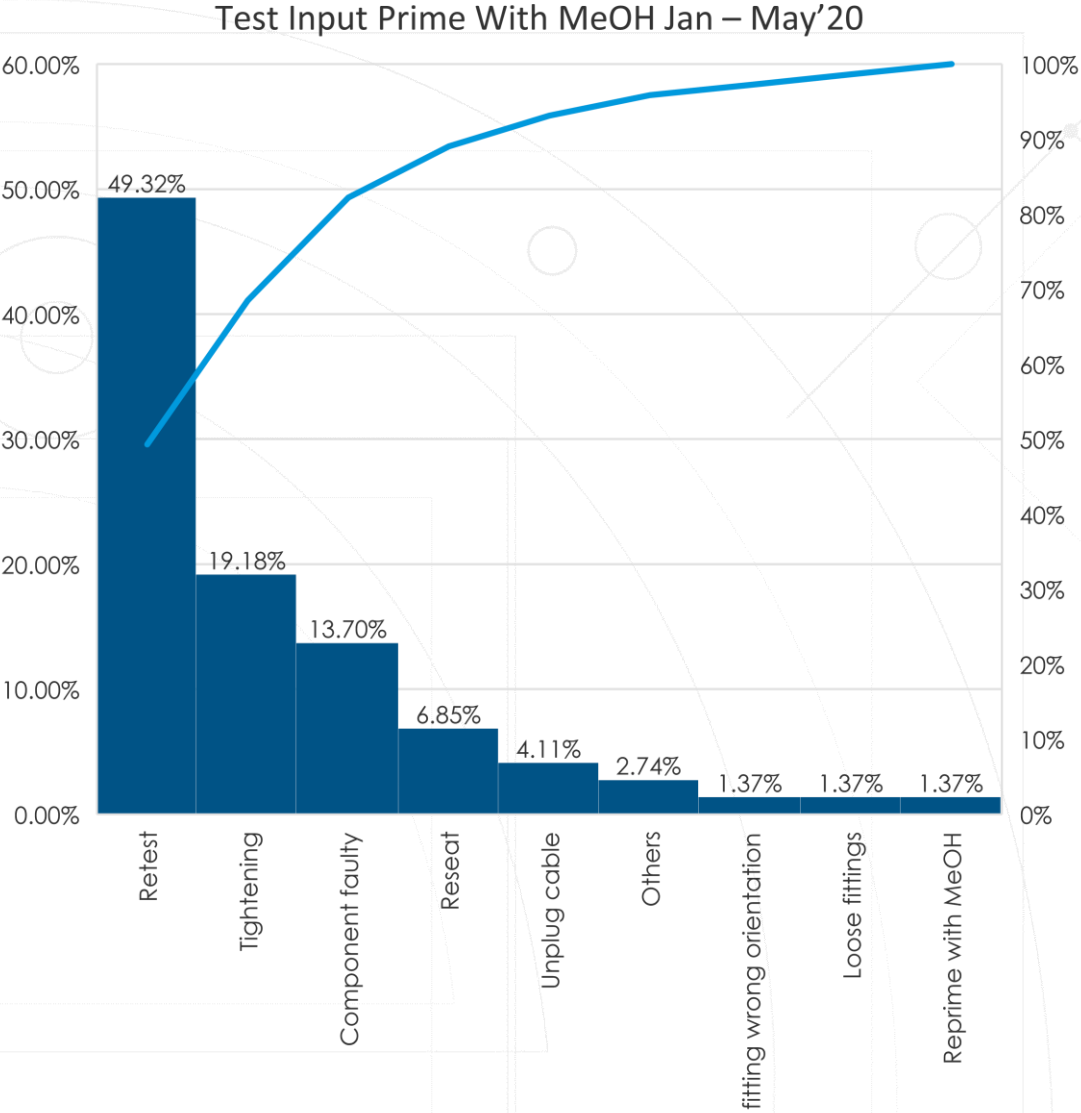
Category	Possible Causes	Verification	Possible Cause (Y/N)	Proposed Action
Man	Operator not properly plugin tester cables	Operators are following as per ASP and TSP.	N	N/A
	Operator not trained and certified	Operators are trained and Certified before commence of work.	N	N/A
Method	Tightening tubing at Chassis Assy	Verified tightening following as per APS. Finger tight, marking and 3/4 tightening using spanner	N	Briefing conducted to refresh operators per AP
	Tightening tubing at Final Test	No torque specified when tightening tubing e.g. interface tubing	Y	Monitoring in progress.
Material	Component Faulty	Parts are check for cosmetics before use	N	Monitoring in progress.
Machine	Retest	Retest without doing anything. 0.5ml accuracy is observed to be high as this is beginning of test for compositional accuracy	Y	Monitoring in progress.
		Verified Preventative Maintenance Due Labels on the TE82943 test box and the TUV is within period.	N	Monitoring in progress.
		Verified Calibration Due label on the AnD Balance is within period.	N	Monitoring in progress.
		Verified Empty Beaker before start test for every unit	N	Monitoring in progress.

Pareto Chart for Test Input Prime with MeOH

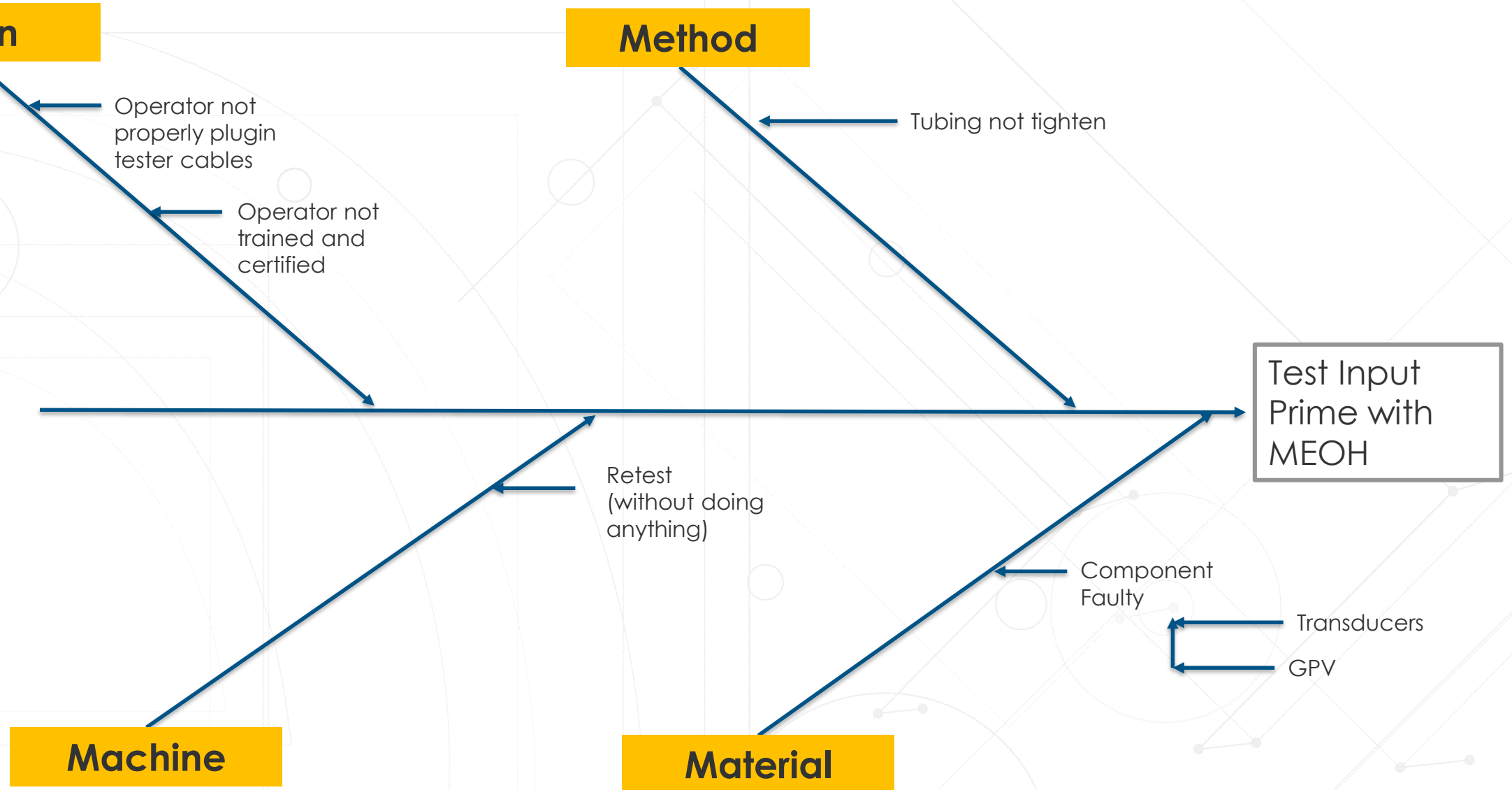
Test Input Prime With MeOH Jan – May'20



Pareto Chart for Test Input Prime with MeOH



Yield Improvement – BSM, QSM Plus



Yield Improvement BSM, QSM Plus 4M – Test Input Prime with MeOH

Category	Possible Causes	Verification	Possible Cause (Y/N)	Proposed Action
Man	Operator not properly plugin tester cables	Operators are following as per ASP and TSP.	N	N/A
	Operator not trained and certified	Operators are trained and Certified before commence of work.	N	N/A
Method	Tightening tubing at Chassis Assy	Verified tightening following as per ASP. Finger tight, marking and 3/4 tightening using spanner	N	Briefing conducted to refresh operators per AP
Material	Component Faulty	Parts are check for cosmetics before use.	N	Monitoring in progress.
Machine	Retest	Retightening of interface tubing additional 1/4 turn.	Y	Monitoring in progress.

BSM, QSM Plus – 2020 FPY Improvement Plans

No	Failure	% Fail Jan'19- May'20	% Improve 2020	Actions & Results	
				Flex	PIC / Date
	Overall Failure	50.57%	12.50%	Tester ID: • TE82943-11, TE82943-12, TE82943-13, TE82943-14, TE82943-15, TE82943-16, TE82943-17, TE8943-18	
1	Test Compositional Accuracy (For QSM+)	8.89% (Jan'19 – May'20)	4.50%	• Pareto analysis, Fishbone, 4M in progress • Top 3 Failure: Retest, Tightening, Component Faulty • Breakdown Category of Compositional Accuracy • Check tubing before start test: ▪ Spiked solution of MeOH ▪ Non-spiked solution of MeOH	Aldwin, Joel / 03 Jul 20 Aldwin, Joel / 17 Jul 20 Aldwin 21 Jul 20 Aldwin 27 Jul 20
2	Test Flow Rate Accuracy (For BSM / QSM+)	8.75% (Jan'19– May'20)	4.50%	• Pareto analysis, Fishbone, 4M in progress • Top 3 Failure: Retest, Tightening, Component Faulty • Breakdown Category of Flow Rate Accuracy • Empty AnD Balance before start test • Look into reseating of components • Improve tube going to waste NOT to submerged in the waste can	Aldwin, Joel / 03 Jul 20 Aldwin, Joel / 17 Jul 20 Aldwin / 21 Jul 20 Aldwin / 27 Jul 20 Aldwin / 27 Aug 20 Joel, Aldwin / 03 Sep 20
3	Test Input Prime with MeOH (For BSM / QSM+)	6.73% (Jan'19 – May'20)	3.50%	• Pareto analysis, Fishbone, 4M in progress • Top 3 Failure: Retest, Tightening, Component Faulty • Breakdown Category of Input Prime with MeOH • Manual Priming (EVALS20019) • Every 2 weeks changing of interface tubing	Aldwin, Joel / 03 Jul 20 Aldwin, Joel / 17 Jul 20 Aldwin / 21 Jul 20 Joel / (QSM – May'20, BSM – Jul'20) Joel / 14 Jul 20

Yield Improvement – BSM, QSM Plus

Monitoring in 2020 – Test Compositional Accuracy

Model – 186015080

Month	Total Unit Tested	BSM, QSM Plus (failure%)
		Jan'19-May'20 Ref rate 8.89%
Jun -2020	53	3.77%
Jul -2020	63	1.59%
Aug -2020	122	6.56%
Sep -2020	182	7.69%
Oct -2020	249	4.42%

*EVALS20019 on month of May 2020.

Yield Improvement – BSM, QSM Plus

Monitoring in 2020 – Test Flow Rate Accuracy

Model – 186015001, 186015080

Month	Total Unit Tested	BSM, QSM Plus (failure%)
		Jan'19-May'20 Ref rate 8.75%
Jun -2020	53	3.77%
Jul -2020	63	11.11%
Aug -2020	122	10.66%
Sep -2020	182	7.14%
Oct -2020	249	14.46%

Yield Improvement – BSM, QSM Plus

Monitoring in 2020 – Test Input Prime with MeOH

Model – 186015001, 186015080

Month	Total Unit Tested	BSM, QSM Plus (failure%)
		Jan'19-May'20 Ref rate 6.73%
Jun -2020	53	3.77%
Jul -2020	63	3.17%
Aug -2020	122	6.56%
Sep -2020	182	1.65%
Oct -2020	249	4.02%

QSM+ – Test Compositional Accuracy

May 2020	Jan'19-May'20 Ref rate 8.89% Achieved – 4.81% (Jun'20-Oct'20)	Improvement	To achieved by 4.5%		
PIC	Aldwin, Joel				
Purpose					
- High failure rate affecting first pass yield - Focus on top 3 failures. Retest, Tightening, Component Faulty					
Progress		Project Status			
- Re-emphasis on marking and tightening of fittings as per ASP - Check tubing before start test - Spiked solution of MeOH - Non-spiked solution of MeOH		Q1	Q2	Q3	Q4
			4M Analysis, Data Collection Completed	Monitoring In progress	
Next Steps		Risks & Issues			
Monitoring of Activities					

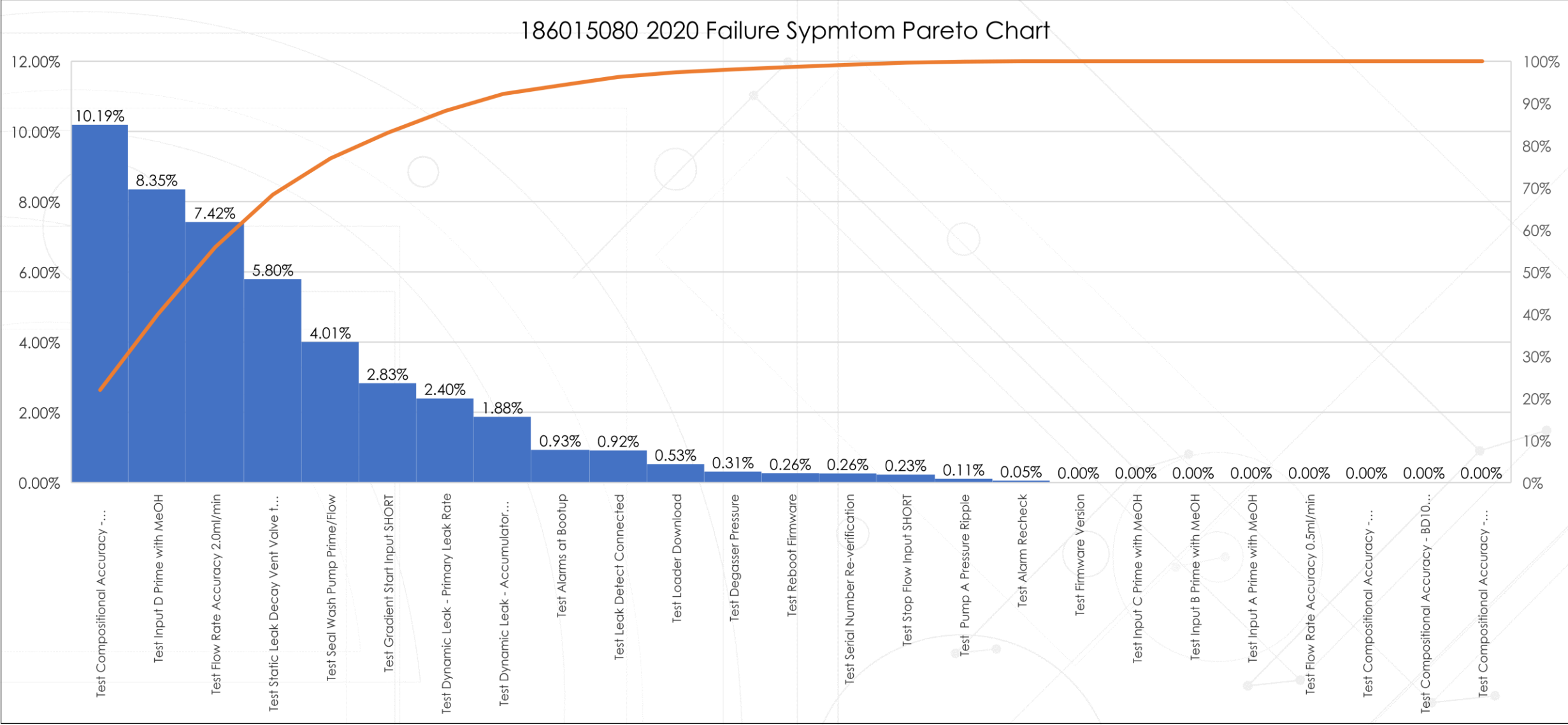
BSM, QSM+ – Test Flow Rate Accuracy

May 2020	Jan'19-May'20 Ref rate 8.75% Achieved – 9.43% (Jun'20-Oct'20)	Improvement	To achieved by 4.5%		
PIC	Aldwin, Joel				
Purpose					
- High failure rate affecting first pass yield - Focus on top 3 failures. Retest, Tightening, Component Faulty					
Progress		Project Status			
- Re-emphasis on marking and tightening of fittings as per ASP - Empty AnD Balance before start test - Tightening of interface tubing additional ¼ turn - Look into reseating of components - Improve tube going to waste NOT to submerged in the waste can		Q1	Q2	Q3	Q4
			4M Analysis, Data Collection Completed	Monitoring In progress	
Next Steps		Risks & Issues			
Monitoring of Activities					

BSM, QSM+ – Test Input Prime with MeOH

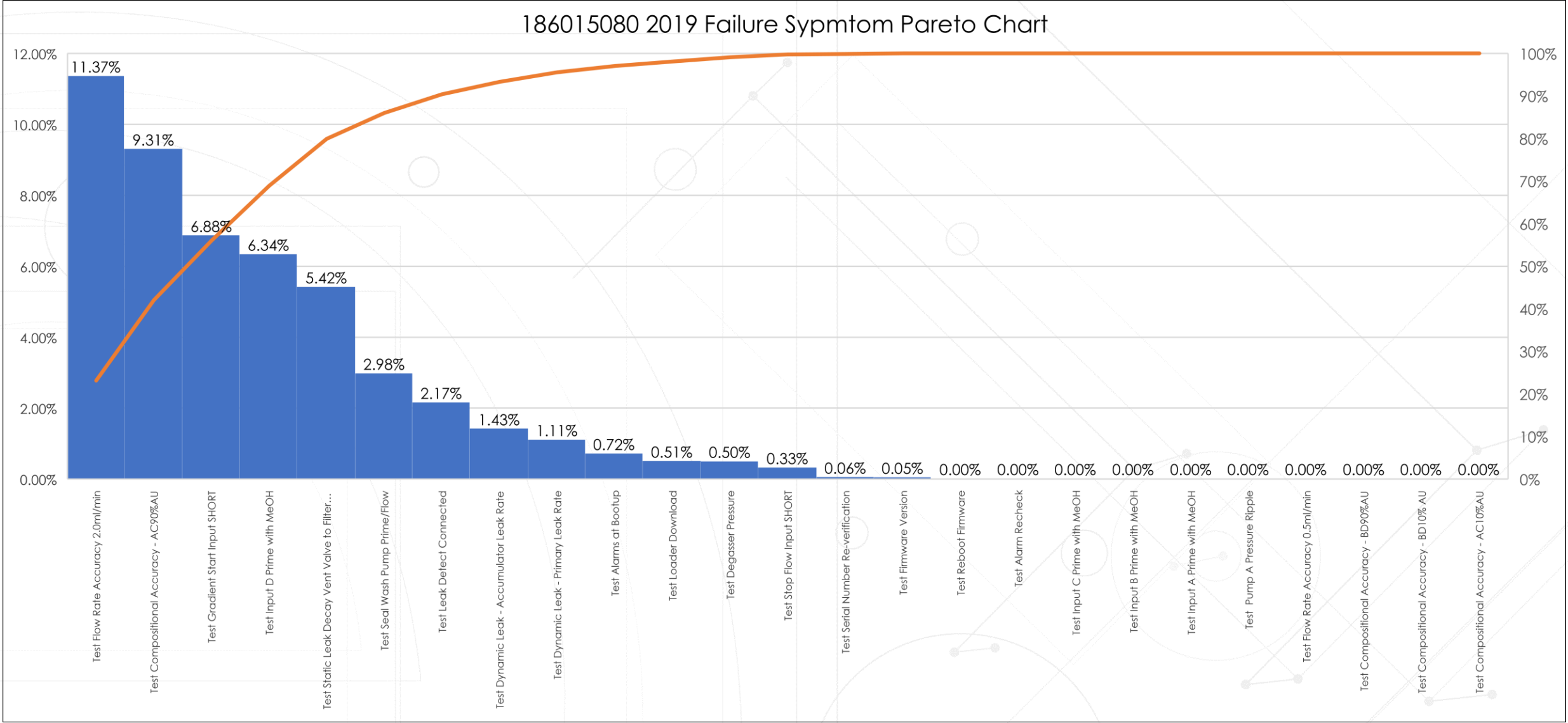
May 2020	Jan'19-May'20 Ref rate 6.73% Achieved – 3.83% (Jun'20-Oct'20)	Improvement	To achieved by 3.5%		
PIC	Aldwin, Joel				
Purpose					
- High failure rate affecting first pass yield - Focus on top 3 failures. Retest, Tightening, Component Faulty					
Progress		Project Status			
- Re-emphasis on marking and tightening of fittings as per ASP - Manual Priming (EVALS20019) - Every 2 weeks changing of interface tubing		Q1	Q2	Q3	Q4
			4M Analysis, Data Collection In progress	Monitoring In progress	
Next Steps		Risks & Issues			
Monitoring of Activities					

QSM Plus – 2020 Failure Pareto

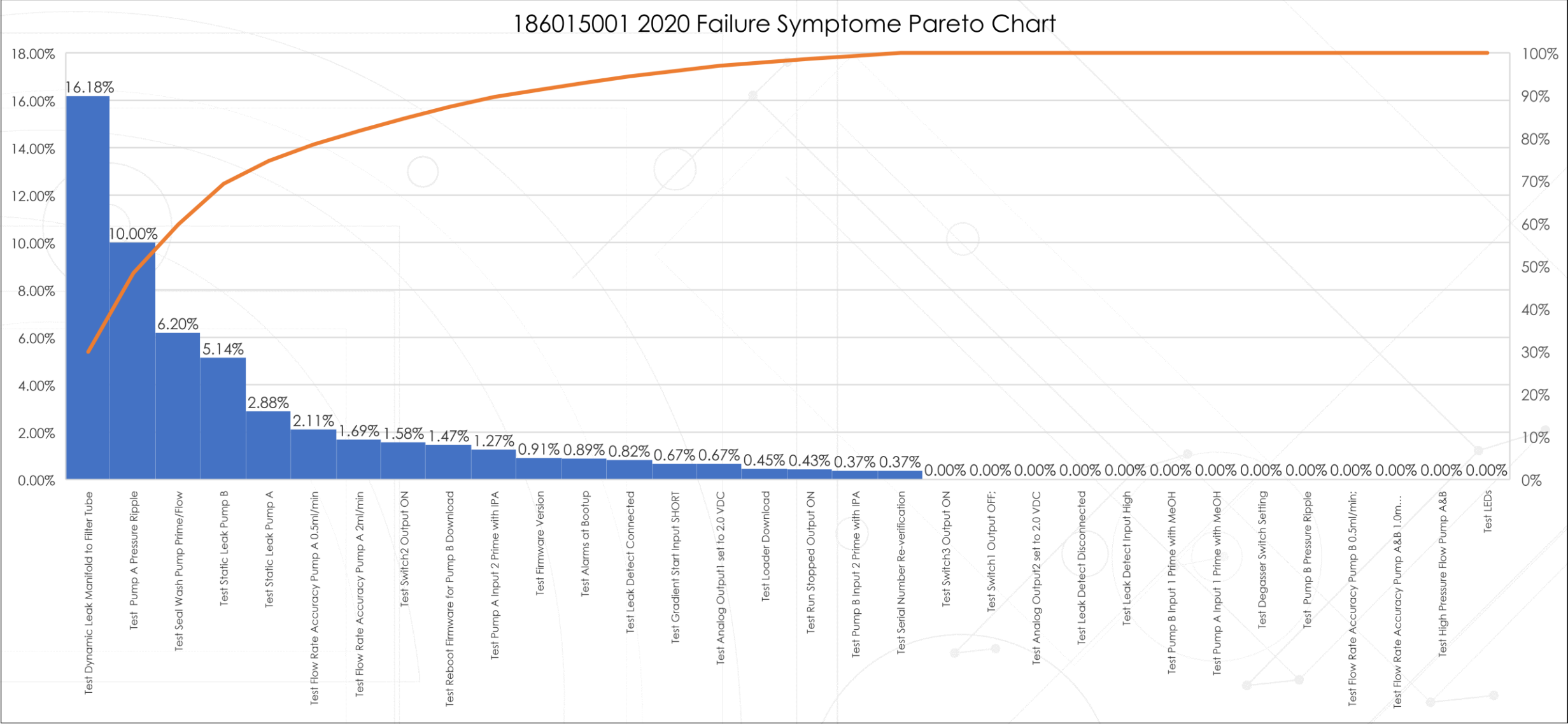


• As of 11 Nov 2020

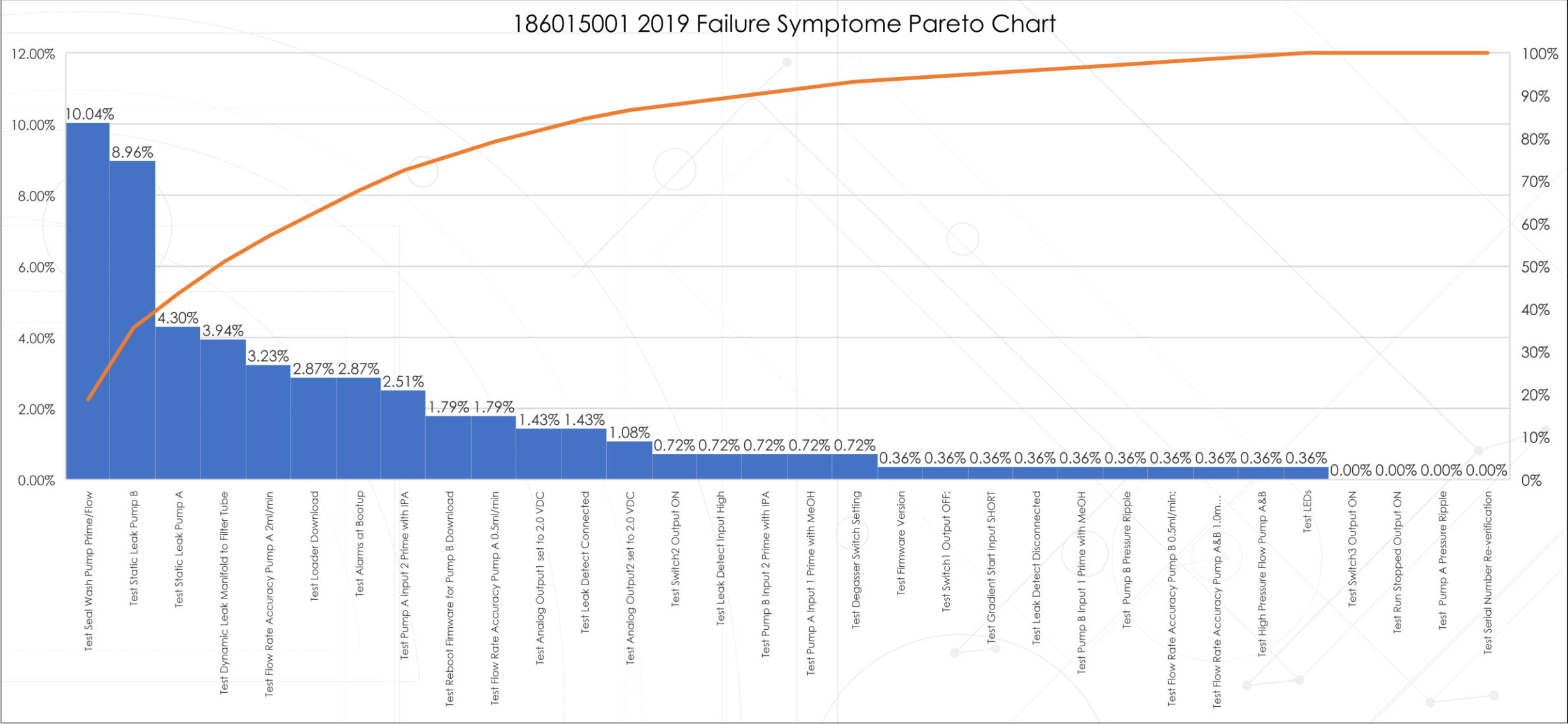
QSM Plus – 2019 Failure Pareto



BSM – 2020 Failure Pareto



BSM – 2019 Failure Pareto



flex.

Thank You

