# Compressor Test First Pass Yield Improvement

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## Abstract

This project was executed within a commercial aerospace maintenance and overhaul facility to enhance compressor overhaul performance by improving First Pass Yield (FPY) and Rolled Throughput Yield (RTY), by employing the DMAIC methodology. The SMART framework was applied during the Define phase to establish clear, measurable, and achievable objectives aligned with the improvement cycle. The team identified key inefficiencies related to equipment calibration, non-standardized troubleshooting, and productivity variation between shifts. Data from the Measure and Analyze phases indicated that five defect categories accounted for 80% of test failures, with imbalanced equipment calibration as the dominant cause. Implemented improvements included equipment recalibration, standardized troubleshooting protocols, pre-assembly inspections, and cross-training initiatives. Preliminary outcomes demonstrated FPY improvement to 50%, with reductions in three of the five primary failure modes, while ongoing monitoring under the Control and Sustainment phase will assess long-term stability, verify training efficacy, and monitor continued yield enhancement.

## Introduction

This project was set within the commercial aerospace aftermarket industry, specifically in a repair and overhaul (R&O) facility responsible for servicing returned compressor units. These units are received either at scheduled service intervals or following in-field failures. The R&O shop must perform these operations efficiently to meet customer demand and prevent commercial fleet downtime. The scope of this project was limited to compressor overhaul operations. The primary issue in compressor overhaul lies in the complexity of the assembly, troubleshooting, and testing processes. This variability leads to inconsistent outcomes, with first pass yield (FPY) rates frequently falling below acceptable thresholds. As a result, compressors often require multiple rework cycles, increasing operational costs and extending turnaround times (TAT), thereby impacting customer satisfaction and delivery performance.
The objective of this project was to increase the FPY and Rolled Throughput Yield (RTY) by reducing reliance on informal knowledge and minimizing process variability.

## Literature Review

**FPY** measures the percentage of units completed correctly the first time, while **RTY** quantifies the probability of defect-free passage through all process steps [1, 2]. The **DMAIC** approach (Define–Measure–Analyze–Improve–Control) supports structured improvement through data-driven root cause analysis and sustainability [3, 4]. The **SMART** framework (Specific, Measurable, Achievable, Relevant, Time-bound) ensures clear and attainable improvement objectives [5]. Together, FPY/RTY metrics, DMAIC discipline, and SMART goal-setting form the foundation for sustainable performance improvement in production environments.

## Methodology

### Define Phase

The project integrated **SMART goal setting** with **DMAIC problem-solving.** Goal is to increase FPY from 30% to over 65% and improve RTY through targeted process improvements. Progress was reviewed weekly through Gantt chart milestones and operator feedback.

### Measure Phase

During the Measure phase, the engineering team gathered data in several critical areas. This included validation of the initial capacity assessment, collection of historical FPY and Rolled Throughput Yield (RTY) records, and a review of inspection and test findings. Data pertaining to operator feedback was also gathered, alongside data regarding subcomponent reuse, repair, and replacement rates.

### Analyze Phase

Figure 1 shows the average FPY% for each month during this period. The average FPY% over this study period was 33% with 13 instances where FPY% dropped to 0%. Figure 2 shows shipment and delivery performance during the same study period. Direct correlation between FPY and shipment rates was observed. The average shipment volume was 6.5 units per month. Data reflected four instances where 0 units were shipped.

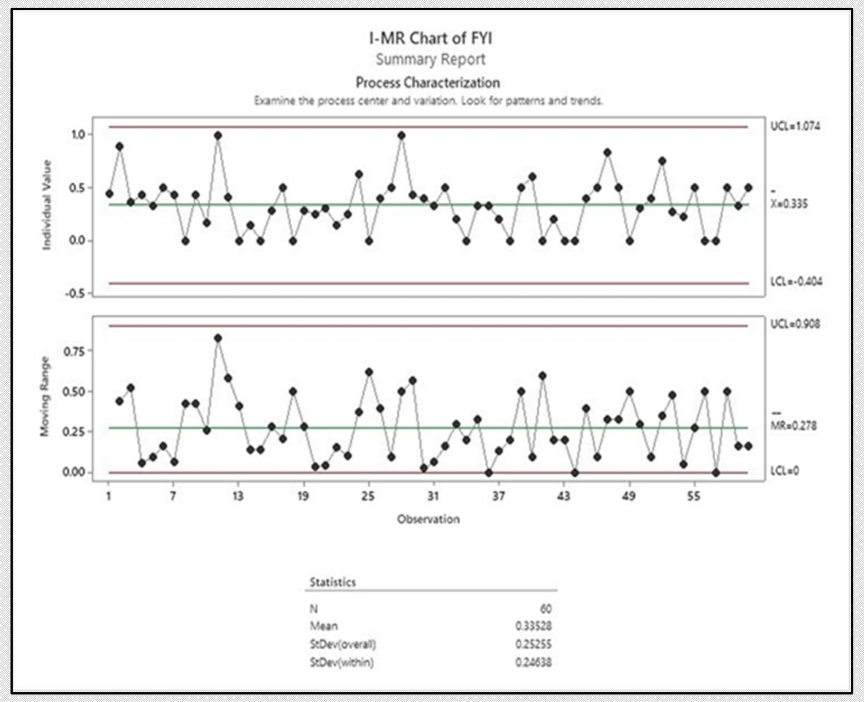


**Figure 1**
**Compressor Historic FPY% 2020- 2025**

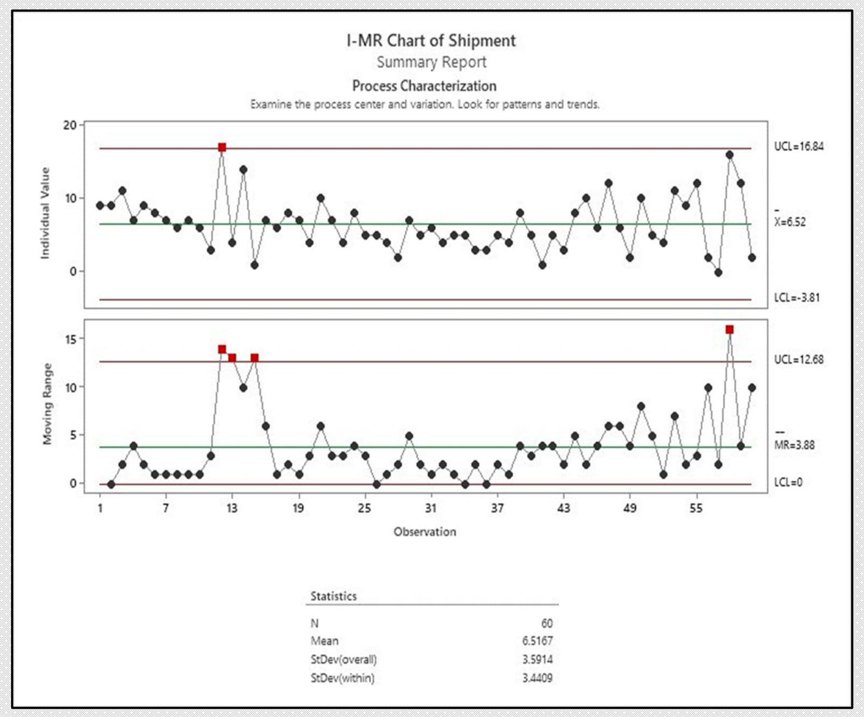


**Figure 2**
**Compressor Historic Shipment 2020- 2025**

A Pareto analysis was performed on data gathered from 97 units over the course of a 1-year period. Figure 3 revealed that five of eight defect types accounted for 80% of failures.

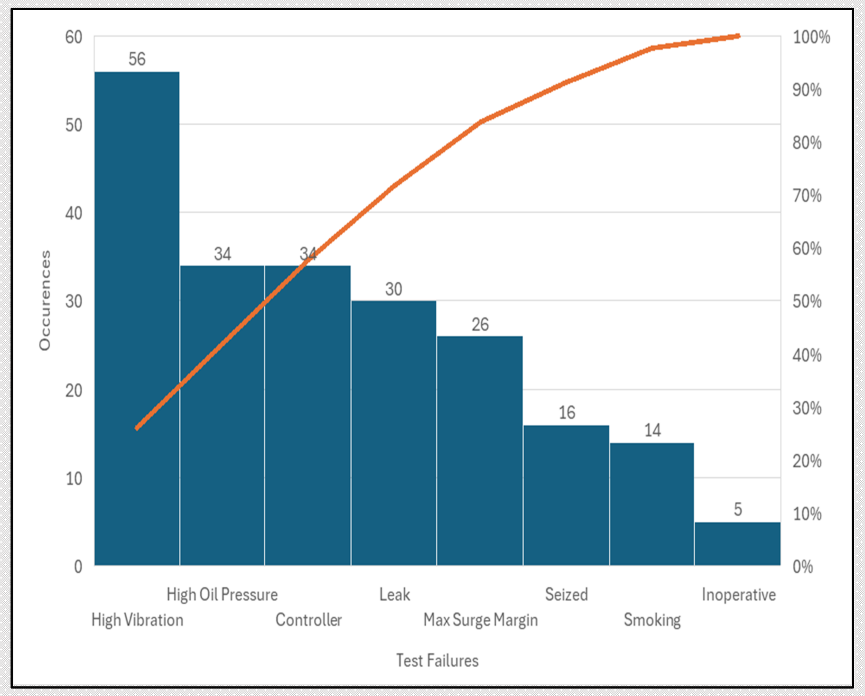


**Figure 3**
**Test Failure Occurrence 2024-2025**

Process validation further identified that the balancing machine for rotating components had deviated from vendor and process calibration requirements, directly correlating with Test Failure 1, as shown in Table 1. Additionally, assembler feedback enabled refinement of tolerance limits during assembly, resulting in marginally higher pass rates. The defect categories responsible for 80% of test failures were subsequently identified, quantified, and summarized in Table 1.

**Table 1**
**Test Failure Occurrence 2024-2025**

| | Test Failure | Probable cause |
|---|---|---|
| 1 | High Vibration | Balancing machine out of spec |
| 2 | High Oil Pressure | Worn components |
| 3 | Controller | Defective Controller |
| | | Incorrect assembly Procedure |
| 4 | Leak | Worn components |
| 5 | Max Surge Margin | Worn components |
| | | Incorrect assembly procedure |

### Improve Phase

Building on these findings, the Improve phase implemented the following key actions: calibrating the balancing machine to process standards, developing a comprehensive troubleshooting guide for the top five recurring issues, conducting targeted cross-training to align second-shift performance with first-shift standards, and introducing pre-assembly inspections for high-failure components to reduce rework and improve overall process reliability.

### Control and Sustainment Phase

Periodic process audits are currently being conducted to ensure continued alignment with improvement objectives. The engineering team is performing sampling to verify the effectiveness of documentation and confirm its sustained influence on yield improvement.

## Results

Performance data from the past month indicate immediate improvement in test failures 1, 2, and 4 driving the FPY% to 50%. Failure 1, primarily caused by out-of-spec balancing equipment, appears to have been eliminated, while failures 2 and 4 show progress following the introduction of detailed assembly documentation. In contrast, failures 3 and 5 have shown limited improvement, as they remain heavily dependent on operator knowledge.

## Conclusions

The project identified and addressed key drivers of low FPY and RTY in compressor overhaul operations. Through systematic data collection and analysis, the team isolated high-impact defect modes and implemented corrective actions focused on equipment calibration, process standardization, and workforce capability. Initial results demonstrate meaningful improvement in test performance, confirming that structured documentation and targeted training reduce variability and enhance process efficiency. However, some defect categories remain knowledge-dependent, requiring continued focus on technician development and process control. As the project enters the control and sustainment phases, ongoing monitoring will determine the long-term stability of yield gains and the effectiveness of implemented improvements in meeting delivery and cost objectives.

## Future Work

The effectiveness of the newly implemented troubleshooting resources will be evaluated during the Control and Sustainment phase to assess yield impact.

## References

[1] ASQ, "Quality rate (First-Pass Yield)," *ASQ Quality Glossary*. [Online]. Available: ASQ Standard Glossary (accessed Aug. 2025).

[2] "Estimating process yield," in *The Six Sigma Handbook*, Revised and Expanded, 2nd ed., McGraw-Hill, 2018, ch. 13, sec. 13.2.1.

[3] W. F. Pruitt, *The Certified Quality Engineer Handbook*, Quality Press, Milwaukee, WI, USA, ch. on DMAIC, 2025.

[4] T. Pyzdek and P. Keller, *The Six Sigma Black Belt Handbook (Six Sigma Operational Methods)*, 1st ed., McGraw-Hill, 2010, ch. 13.9.

[5] G. T. Doran, "There's a S.M.A.R.T. way to write management's goals and objectives," *Management Review*, vol. 70, no. 11, pp. 35–36, Nov. 1981.