Reduce Weld Porosity Defects on Line 3

Project Final Report

Status: Active
Group: Plant 1 - Detroit
Project Type: Lean Six Sigma
Project Level: Black Belt
Start Date: May 20, 2026
Target Completion: October 14, 2026
Report Generated: September 15, 2026

Executive Summary

Porosity on the Line 3 cross-member subassembly was reduced from a 4.8 percent baseline to 1.4 percent across the first 21 days of the control period, a 71 percent reduction and a shift of roughly half a sigma in process capability. Root cause analysis identified two dominant inputs rather than the operator error that had been assumed for two years: unregulated shielding gas flow decay caused by worn regulator diaphragms on both stations, and torch work angle drift introduced at every shift changeover because the setup relied on a visual reference rather than a fixture. Neither cause was visible in the existing data system, which is why three prior containment attempts failed to hold.

The measurement system was the first thing corrected. The initial Gage R&R on the visual inspection method returned 41 percent study variation, meaning nearly half of what the plant believed was process variation was actually inspector disagreement. Rebuilding the inspection method against a boundary sample set brought Gage R&R to 14.2 percent before any baseline data was trusted.

Annualized validated benefit is $672,500 against $113,700 in project cost, a first-year net of $558,800 and a payback period of 62 days. Finance signed the benefit calculation on 14 July 2026.

Project Charter

Problem Statement

Between January and April 2026, robotic MIG welds on the Line 3 cross-member subassembly failed visual and radiographic inspection for porosity at a rate of 4.8 percent, against a plant standard of 1.5 percent. The defect drove 1,940 scrapped subassemblies and 3,120 hours of manual rework grinding over the four-month window, at a cost of roughly $598,000 annualized. Porosity escapes also caused two customer containment events with Meridian Chassis in February and March, putting a $4.2M annual program at risk.

Goal Statement

Reduce the weld porosity defect rate on the Line 3 cross-member subassembly from 4.8 percent to 1.2 percent or lower by 31 July 2026, verified by a minimum of 30 consecutive production days of in-control performance on the p-chart, without increasing cycle time beyond the current 47-second takt.

Business Case

Scope: robotic MIG weld stations 3A and 3B on the Line 3 cross-member subassembly, covering the eight structural fillet welds inspected under work instruction WI-3320. In scope are shielding gas delivery, torch condition and setup, base material preparation, and operator changeover procedure.

Out of scope: the upstream stamping operation, weld stations on Lines 1, 2, and 4, and any change to the customer-approved weld schedule or joint design, which would require Meridian Chassis engineering re-approval and a PPAP resubmission.

Business case: porosity on this subassembly is the plant's single largest scrap contributor and the root of both open customer corrective action requests. Closing the gap protects the Meridian program, recovers roughly 6 percent of Line 3 capacity currently consumed by rework, and removes the manual grinding operation that generates the cell's highest ergonomic risk score.

Methodology: DMAIC. Financial benefits validated by Plant Finance before close.

Project Team

Maria Delgado — Creator
Angela Boyd — Associate Leader
Luis Ferrara — Team Member
Marcus Webb — Project Leader

Metrics

Primary Metric: Weld Porosity Defect Rate

Unit: % | Baseline: 4.8 | Current: 1.4 | Target: 1.2

Achievement: 94% of target

Secondary Metrics

Weld Porosity Defect Rate — Unit: % | Current: 1.4 | Target: 1.2
Shielding Gas Flow Variation — Unit: CV % | Current: 4.2 | Target: 5
Torch Angle Deviation — Unit: degrees | Current: 2.6 | Target: 3
First Pass Yield — Unit: % | Current: 98.6 | Target: 98.8
Rework Hours per 1,000 Units — Unit: hours | Current: 16.2 | Target: 14

Financial Summary

COPQ (opportunity): $1,150,000
Benefits: $672,500 — 58% of the opportunity · $630,500 captured

Hard Benefits: $577,500 **Soft Benefits: $95,000** **Total Costs: $113,700** **Net Hard: $463,800**

Benefits

$384,000/yr — Scrap elimination. 1,940 scrapped subassemblies annualized at $198 material and processing cost each, reduced by 71 percent. Verified against the scrap ticket system for the control period and signed by Plant Finance on 14 July 2026. [Cost Savings · Hard (Captured)]
$172,500/yr — Rework labor elimination. Manual grinding and re-weld dropped from 62.4 to 16.2 hours per 1,000 units, valued at fully burdened cell labor of $37.20 per hour across annual volume of 100,200 units. [Cost Savings · Hard (Captured)]
$74,000/yr — Overtime avoidance. Line 3 ran an average of 6.2 hours of Saturday overtime per week solely to recover schedule lost to rework. Overtime on this cell has not been scheduled since week 3 of the control

period. [Cost Avoidance · Soft (Captured)]
$21,000/yr — Recovered capacity. Removing the rework loop returns roughly 6 percent of Line 3 available runtime. Booked conservatively at 25 percent of theoretical value pending confirmed customer demand for the additional volume. [Revenue Increase · Hard (Estimated)]
$21,000/yr — Ergonomic risk reduction. Manual grinding carried the highest ergonomic risk score in the cell and was associated with two recordable hand and wrist injuries in the prior 24 months. Valued at the plant standard recordable incident cost applied to the reduced exposure hours. [Safety Impact · Soft (Estimated)]

Costs

$68,000/yr — Inline shielding gas flow meters with alarm setpoints at stations 3A and 3B, plus the torch work angle setup fixtures and installation labor. Capital request CR-2026-114, approved 22 June 2026. [Capital Expenditure (Actual)]
$23,400/yr — Incremental annual cost of the upgraded heavy-duty contact tip and diffuser sets over the previous consumable specification, net of the reduced replacement frequency achieved by the defined 4,000 arc-second interval. [Operating Expense (Actual)]
$12,800/yr — Operator and process owner training on the revised changeover procedure WI-3320-R4. 240 hours across three shifts at fully burdened labor rate, including the boundary sample recalibration session for the inspection team. [Operating Expense (Actual)]
$9,500/yr — External metallurgical lab services for radiographic verification of the pilot samples and the independent Gage R&R validation of the revised inspection method. [Other (Actual)]

Solution & Improvements

Four changes were implemented after pilot validation on station 3B:

1. Inline shielding gas flow meters with alarm setpoints at both stations, replacing the flow gauges that read regulator output rather than actual delivery at the torch. Regulator diaphragms moved to a scheduled 90-day replacement in the CMMS rather than run-to-failure.

2. A hard setup fixture for torch work angle, replacing the visual reference mark. Changeover angle deviation dropped from a 6.8-degree mean to 2.6 degrees, and the spread collapsed almost entirely.

3. Revised changeover procedure WI-3320-R4 with a five-point verification sequence performed and signed at every shift start, including a gas flow reading recorded on the shift log.

4. Upgraded torch consumables to a heavier-duty contact tip and diffuser set with a defined replacement interval at 4,000 arc-seconds, replacing replacement-on-visible-wear.

The pilot ran on station 3B for 14 days while 3A continued as an untouched control. Paired comparison of the two stations over the pilot window returned $p < 0.001$, confirming the improvement came from the changes rather than from the Hawthorne effect or normal variation.

Controls & Sustainability

The process is monitored on a p-chart of daily porosity defect rate, reviewed at the 6:00 AM tier one meeting by the weld cell lead. Control limits were recalculated from the post-improvement data and are locked until the next annual review.

Response plan: a single point beyond the upper control limit or seven consecutive points above the center line triggers an immediate stop, a gas flow and torch angle verification against WI-3320-R4, and escalation to the manufacturing engineer if the check passes without explaining the signal. Two consecutive out-of-control days

escalate to the Director of Operations.

Secondary monitoring covers shielding gas flow CV, which is trended weekly from the flow meter data logger, and torch angle deviation, which is recorded at each changeover on the shift log and audited monthly.

Process ownership transfers to the Line 3 weld cell lead at the Control tollgate. Layered process audits were added to the plant LPA schedule at a weekly cadence for the first quarter, dropping to monthly thereafter. Control plan CP-3320 and PFMEA revision 6 are both updated and released in the document control system.

Milestones

' Idea — August 6, 2026 [Done]
' Project Intake — August 10, 2026 [Done]
' Tollgate — Project Approval — August 11, 2026 [Done]
' Define Phase — August 20, 2026 [Done]
' Tollgate — Define Phase Review — August 21, 2026 [Done]
' Measure Phase — September 3, 2026 [Done]
' Tollgate — Measure Phase Review — September 4, 2026 [Done]
' Analyze Phase — September 17, 2026 [Done]
' Tollgate — Analyze Phase Review — September 18, 2026 [Done]
' Improve Phase — October 1, 2026 [Done]
' Tollgate — Improve Phase Review — October 2, 2026 [Done]
%Ë Tollgate — Control Phase Review — October 12, 2026 [Not Started]
%Ë Close — October 14, 2026 [Not Started]
%Ï Control Phase — October 14, 2026 [In Progress]

Lessons Learned

1. Fix the measurement system before trusting any baseline. The first Gage R&R returned 41 percent study variation. Every containment attempt over the previous two years had been aimed at a defect signal that was close to half inspector noise, which explains why none of them held.

2. The obvious suspect was wrong. Operator technique was the standing assumption on this line, and it was the first thing every prior team tried to correct through retraining. The data cleared it. Both dominant inputs were equipment and procedure gaps that no amount of retraining would have addressed.

3. Keeping station 3A untouched as a control during the pilot cost two weeks and was worth it. It converted a plausible improvement into a defensible one, and it is the reason the Meridian corrective action was accepted without a follow-up audit.

4. Replicate before closing. Stations on Lines 1 and 4 run the same regulator and torch configuration and are candidates for the same fix. A replication project has been submitted to the intake queue and is expected to carry a similar benefit at a fraction of the analysis cost, since the root cause work is already done.