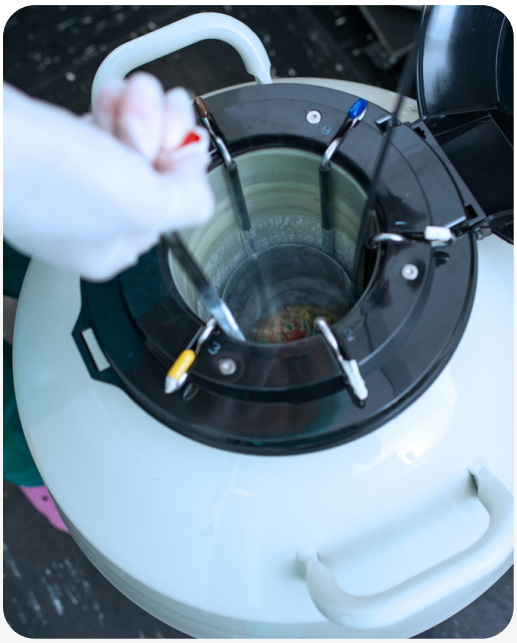
DPI INC.
PRECISION MACHINING

CRYOGENICS CASE STUDY

Eliminating Welds, Leak Paths, and Tolerance Risk in GM Cryocooler Helium Cylinders



For more than thirty years, DPI has partnered with a leading cryogenics OEM manufacturing Gifford–McMahon (GM) cryocoolers and cryopumps. Their early helium cylinders were produced as multi-piece welded assemblies, using separate tubes, flanges, and multiple weld joints — each one a potential helium leak path in an ultra-demanding environment.

DPI collaborated with the customer to convert these welded assemblies into single-piece machined components, ultimately consolidating both helium stages into one fully machined, one-piece 304 stainless cylinder. The redesign removed every internal weld, dramatically improved long-term reliability, and simplified the entire manufacturing workflow.

THE CHALLENGE: WELDED ASSEMBLIES WITH BUILT-IN RISK

Legacy GM cryocooler cylinders required:

- Two flanges
- Four tubes
- Multiple welds per assembly
- Numerous leak points for ultra-small helium molecules
- Weld distortion, porosity, and alignment issues
- Labor-intensive fabrication and inspection

In cryogenic systems, helium leak integrity is mission-critical. Even microscopic weld defects can create performance drift, long-term inefficiency, or premature failure.

2800 Turnpike Drive Hatboro, PA 19040
P: 215.953.9800

PHASE 1: DPI'S BREAKTHROUGH TO SINGLE-PIECE CYLINDERS

DPI's first redesign replaced multi-piece welded assemblies with single-piece machined cylinders produced from 304 stainless bar stock.

Key Benefits:

- Dramatic reduction in leak paths
- Improved stage-to-stage alignment
- Higher structural consistency
- Fewer welds required in the final assembly
- Lower scrap and reduced rework
- Improved cryocooler performance and stability

This phase set the foundation for decades of reliable production and deeper engineering collaboration.

2800 Turnpike Drive Hatboro, PA 19040
P: 215.953.9800

PHASE 2: ONE-PIECE MULTI-STAGE CYLINDER THROUGH DFM COLLABORATION

After years of proven success, DPI and the customer pushed the design further using Design for Manufacturing (DFM) principles.

Together, they engineered a next-generation solution that:

- Consolidated the 1st-stage and 2nd-stage cylinders
- Machined both stages from a single solid piece of 304 stainless
- Eliminated every weld joint between stages
- Achieved previously weld-dependent geometries through machining alone

The result was a fully machined, multi-stage cryogenic cylinder with zero internal leak paths and significantly enhanced reliability.

2800 Turnpike Drive Hatboro, PA 19040
P: 215.953.9800

ADVANCED MACHINING CAPABILITY: PRECISION TOLERANCES & ULTRA-FINE FINISHES

One of the most significant engineering achievements in this partnership is DPI's ability to deliver:

- 8–12 Ra surface finishes in deep, narrow cylinder bores
- ±0.0004" tolerances held across the full bore length
- Machining only, no honing, no lapping

This level of precision is:

- Beyond what most machine tool OEMs expect their equipment to achieve
- Beyond the capability thresholds many cutting tool manufacturers specify
- Traditionally considered possible only through specialized finishing processes

DPI achieves these results repeatedly through:

- Tight process control
- The right machining platform
- Highly optimized tooling and toolpaths
- Decades of accumulated cryogenic machining expertise

This capability is a core differentiator for DPI, and a critical reason cryogenic OEMs trust us with their most sensitive components.

2800 Turnpike Drive Hatboro, PA 19040
P: 215.953.9800

RESULTS

Leak Path Elimination

- Multi-piece cylinders: numerous
- helium leak risks
- One-piece cylinders: all internal leak paths removed

Reliability & Performance

- Superior helium containment
- Improved thermal uniformity
- Greater structural integrity under cycling

Manufacturing Efficiency

- No welding between stages
- Simplified inspection
- Less scrap, less rework
- Lower total assembly cost

Production Capability

- Precision bores with 8–12 Ra finishes
- ±0.0004” tolerances held consistently
- No secondary finishing processes required

Production Capability

- Precision bores with 8–12 Ra finishes
- ±0.0004” tolerances held consistently
- No secondary finishing processes required

CONCLUSION

By transforming welded, multi-piece GM cryocooler cylinders into single-piece machined components, and by achieving ultra-tight tolerances and surface finishes through machining alone, DPI set a new standard for cryogenic manufacturing reliability and performance.

This decades-long engineering partnership demonstrates DPI's core strengths in DFM collaboration, advanced machining capability, and disciplined process development. DPI continues to support this customer's evolving cryogenic platforms and remains a trusted manufacturing partner in the global cryocooler and cryopump market.

215.953.9800

www.dpicnc.com

215.953.1540

2800 Turnpike Drive Hatboro, PA 19040
P: 215.953.9800