



Mechanical & Fabrication

TECHNICAL GUIDE

Data Center Liquid Cooling Piping Systems

Product Brief on APEX 1.5D Bent Piping
& Lap Joint Flaring for Modern Data Centers

Developed by ASME-certified specialists, this guide delivers practical engineering takeaways to reduce 60–80% of welded & mechanical joints, maintain ASME B31.3 compliance, replace conventionally designed piping systems with prefabricated pipe kits & modules, and preserve original hydraulic design assumptions, improving reliability, uptime, and lifecycle performance.

**SA-312 Sch 10 304L/316L Stainless Steel • ASME B31.3 Process Piping • 1.5D Bending
+ Lap Joint Flaring**

Eliminate Points of Failure

Stop Welding-Start Bending

| The Situation

Data centers are engineered for continuous uptime, making cooling infrastructure a mission-critical system. In most facilities, much of the liquid cooling piping, including the secondary loop piping, is constructed using conventional methods based on Sanitary Tube butt-weld fittings and welded ferrules with clamps and flanges, utilizing a mix of specialized orbital welding equipment & operators and highly skilled stainless steel pipe welders. While this approach is the current standard practice, it introduces a significant number of failure points, construction complexity and long-term reliability concerns.

| The Challenge

For example, a typical secondary loop design with sanitary tubing includes hundreds of welded elbows, flanges, and o-ring clamped joints. Each joint represents a potential leak point and failure risk, an increase in installation labor and inspection requirements, greater pressure loss and hydraulic inefficiency, and higher exposure to schedule delays and rework.

These issues contribute to elevated TCO for facility owners, system performance inefficiencies for design engineers, and extended weld hours and permitting requirements for EPC contractors.

Engineering Approach: APEX is an ASME-certified pipe & module fabrication shop with more than 60 years of experience in cold-formed pipe bending, lap joint (Van Stone) flaring, and engineered spool systems. This guide presents an alternative for data center liquid cooling piping systems using SA-312 Sch 10 304L/316L stainless steel pipe with factory-formed 1.5D bends and flared lap joint connections assembled into prefabricated piping kits and shippable modules.

65%–85%

Fewer Welded & Mechanical Joints

Higher MTBF and fewer single points of failure

40%–70%

Fabrication Cost Savings

Fewer fittings, fewer weld hours, fewer inspections

30–40%

Faster Installation

Reduced hot work and shorter commissioning
timelines

Less NDE

No Onsite Welding or Passivation

Less QA tracking, Less Field Hour Risk Exposure, Less
Cleaning

These improvements are achieved without altering design assumptions. Because the bends maintain a 1.5D centerline radius—the standard in ASME B31.3 designs—they integrate into conventional layouts without requiring redesign, recertification, or recalculation.

Product Differential for Data Centers

| Reliability & Resiliency

Higher System Uptime: Reducing the number of pipe joints lowers the chance of leaks and failures, increasing Mean Time Between Failures (MTBF). Prefabricated pipe kits or modules simplify repairs, reducing Mean Time to Repair (MTTR).

Supports N+1 & 2N Redundancy: Eliminating unnecessary joints removes hidden single points of failure, thereby strengthening overall system resiliency.

Minimized SLA Risk: Preventing even a single leak protects against unplanned outages, avoiding SLA penalties and lost revenue that can reach \$500K-\$1M per incident.

| Efficiency & Performance

Optimized Hydraulic Flow: 1.5D bends maintain the same effective radius as standard elbows, providing uninterrupted flow and less turbulence, reducing localized pressure loss without requiring pump redesign.

Lower TCO: Fewer gaskets and mechanical connections mean less maintenance, fewer torque checks, and fewer replacement parts. Flared lap joint connections are inspectable and retorqueable in place.

| Safety & Schedule

Reduced Hot Work Exposure: Prefabrication significantly limits onsite welding in white space areas, decreasing permitting requirements and fire watch labor. All bends and flared lap joints require zero field welding.

Streamlined QA/QC: With fewer field welds, there are fewer hydrotest boundaries and NDE inspections, simplifying documentation and accelerating project closeout. Bends and flares are exempt from radiographic examination.

Faster Time-to-Revenue: Installations are 30-40% faster than traditional methods, keeping projects on schedule and speeding up commissioning. Lap joint flanges rotate freely — bolt holes always align, no field adjustment needed.

Data Center Market & Application Alignment

Tier III & Tier IV Uptime Requirements

APEX bent and flared piping directly reinforces the uptime and resiliency standards of Tier III and Tier IV data centers:

- **Fault Tolerance:** Fewer welded & mechanical joints mean fewer potential leak points in the loop.
- **Concurrent Maintainability:** Reduced maintenance intrusions minimize operational disruption and downtime risk.
- **Schedule Adherence:** Faster mechanical installation and commissioning support Tier certification timelines.

With fewer failure modes and faster delivery, APEX enables facilities to achieve significantly greater uptime while lowering TCO.

Fits Every Data Center Model

- **Hyperscale:** Accelerates deployment with repeatable prefabrication, minimizes hot work, supports rapid expansion.
- **Colocation & Multi-Tenant:** Reduces leak risk and protects SLA-backed uptime commitments.
- **Enterprise:** Controls CAPEX and OPEX with fewer components, fewer maintenance cycles, longer service life.
- **Edge & Modular:** Solves space constraints and aggressive schedules with compact routing and prefab compatibility.

Proven Across the Entire Facility

APEX 1.5D bent piping with lap joint flaring improves reliability, performance, and lifecycle cost across all major piping systems:

- **Primary Cooling Headers & Risers:** Smoother hydraulic flow, fewer welds, compatibility with conventional design practices.
- **Condenser Water Systems:** Reduced risk of outdoor gasket failures in exposed environments.
- **Mechanical Rooms & Corridors:** Precision bends simplify routing in congested spaces without requiring redesign.
- **Pump Skids & Modular Units:** Prefabricated bent-and-flared spools integrate seamlessly with modular construction strategies.
- **Support Utilities:** Ideal for boiler loops, fuel oil, compressed air, and critical service lines.

Engineering Takeaway: APEX 1.5D bent piping with lap joint flaring reduces mechanical joints and welds across all major systems, cutting leak paths, installation time, and lifecycle maintenance. It supports Tier III/IV uptime by improving fault tolerance and enabling concurrent maintainability, all while accelerating deployment for hyperscale, colo, enterprise, and modular builds.

Spool Assembly Comparison

Scenario: 6" header with 2" branch drops — SA-312 Sch 10 304L stainless steel secondary cooling loop spool assembly. Based on actual APEX fabrication data.

Attribute	Conventional Method A270 Sanitary Tube + Orbital Weld	APEX Method SA-312 1.5D Bend + Lap Joint Flare
Pipe / Tube	6" & 2" A270 304L sanitary tube	6" & 2" SA-312 Sch 10 304L pipe
Fittings	10 - sanitary BW elbows	Zero — 1.5D continuous bends
Orbital / Butt Welds	18 - orbital butt welds	Zero
Total Welds	16 - orbital + 2 - nozzle welds = 18 welds	2 - nozzle welds
End Connections	4 - ferrules + 4 - sanitary clamps	4 - flanged connections (150# RFSO bolt-up)
Potential Leak Points	22	6
NDE / X-Ray Required	16 (every orbital weld)	Bends & flares exempt (nozzle only)
Purge Gas	Required at every weld (x18)	Nozzle weld only x 2
Orbital Weld Equipment	Required	Not required
On-Site Weld Cleaning	Required at every weld (x18)	Required for 2 welds offsite
Pressure Rating	150-200 psi (clamp limited)	275 psi @ 100°F (150# ANSI flange)
DESIGN-PREMIUM MATERIALS	SANITARY TUBE FITTINGS ORBITALLY WELDED	SA312 SCH 10 PIPE MECHANICALLY POLISHED
PRECISION SHOP FABRICATION	ORBITAL WELDING - SPECIALLY TRAINED WELDERS	STANDARD PIPE SHOP FABRICATION
TOTAL INVESTMENT VALUE	\$4,780.00	\$2,616.00

The APEX Advantage™: Same Steel, Same Routing — 45% Cost Savings on this assembly | 73% Fewer Leak Points (22 → 6) | Zero Field Welds | Higher Pressure Rating (275 psi vs. 150-200 psi)

Project-Level Impact: On a 59-assembly project, conventional fabrication totals ~\$1.7M vs. APEX at ~\$726K — a savings of \$979,000. Savings of 54% on SFN branch assemblies. This data reflects actual APEX fabrication analysis for a hyperscaler data center secondary fluid network.

1.5D Bends vs. Welded Elbows

Fitting Type	Typical K-Value	Notes
APEX precision cold-formed 1.5D bend	0.8-0.9	Smooth continuous radius, no seam discontinuities, equal or better performance vs. standard elbows

Engineering Takeaways

Hydraulic Neutrality

APEX 1.5D bends maintain the same centerline radius as standard elbows. No pump resizing, layout recalculations, or hydraulic revalidations required.

Lower Turbulence = Lower Loss

Cold-formed bends eliminate welded fittings, reducing localized turbulence. This predictable geometry trends to the low end of the K-value range, unlike field weld fittings elbows with potentially inconsistent id weld profiles.

Drop-In Design Compatibility

By adhering to ASME B16.9 and ASME B31.3 conventions, APEX bends seamlessly integrate into existing design packages, eliminating the need for special fittings, redesign, and specification deviations.

Zero-Weld Flange Connections

Lap joint (Van Stone) flared ends per ASME B31.3 §306.4.2 create Type C stub ends directly on the pipe. The loose 150# backup flange rotates freely for bolt-hole alignment. No welding at the flange connection — just bolt, gasket, and torque to spec. This is the lowest installed-cost flange connection available.

APEX

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Ready to Put APEX on Your Next Project?

Connect with our team and see how we can deliver the same results for you.

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