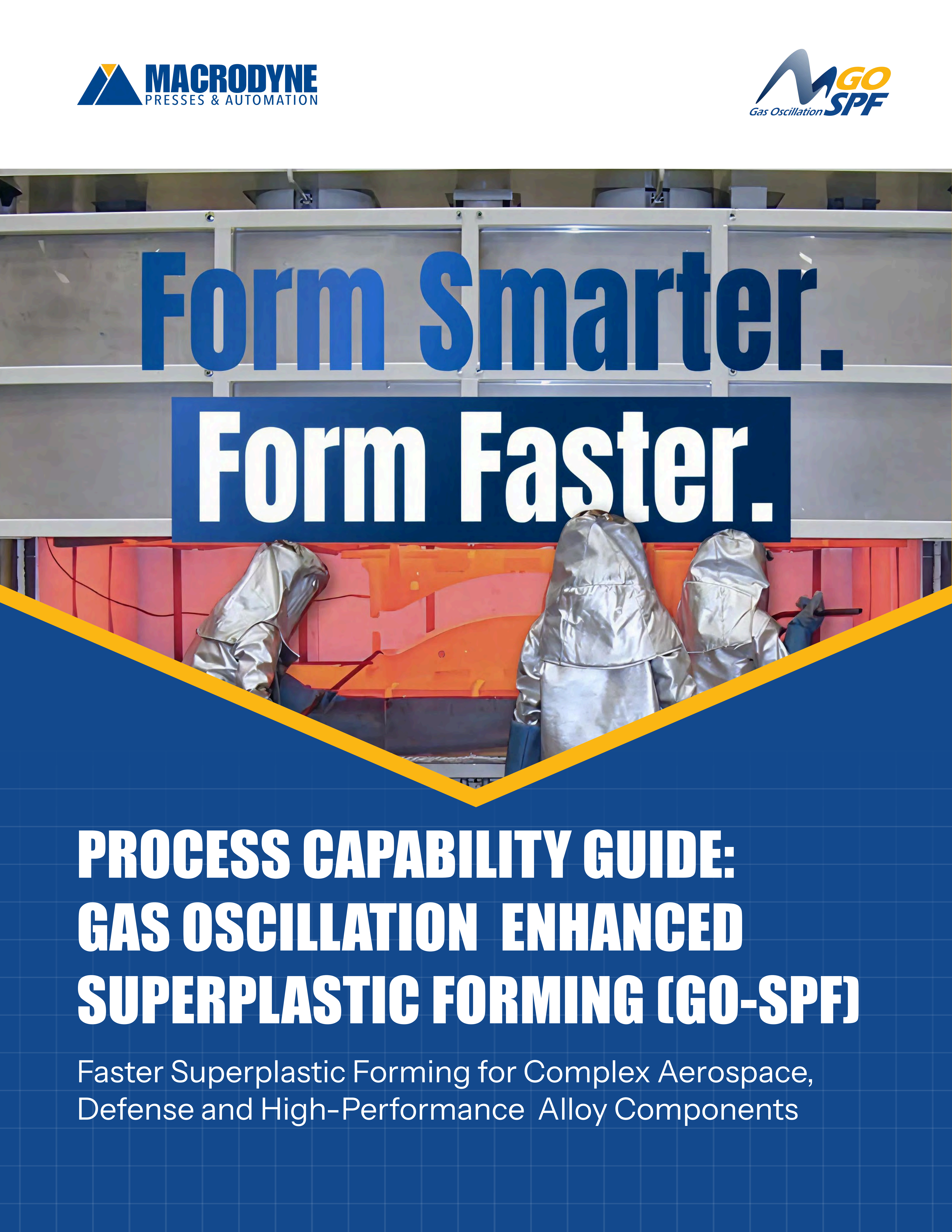




Form Smarter.
Form Faster.

**PROCESS CAPABILITY GUIDE:
GAS OSCILLATION ENHANCED
SUPERPLASTIC FORMING (GO-SPF)**

Faster Superplastic Forming for Complex Aerospace,
Defense and High-Performance Alloy Components

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Executive Summary

Superplastic forming has long been valued for its ability to produce complex, lightweight, high-strength components from difficult-to-form alloys. That capability is especially important in aerospace and defense, where manufacturers increasingly rely on titanium and other high-performance alloys to reduce weight, consolidate parts and produce demanding geometries with fewer manufacturing steps. In these applications, superplastic forming can reduce part count, limit joining operations, support tighter packaging and open design paths that conventional forming methods cannot reach.

But conventional SPF carries a cost: time.

Long forming cycles, high process temperatures, part-thickness variation and tooling constraints can limit throughput exactly when manufacturers need more capacity. That is why we developed **Gas Oscillation Enhanced Superplastic Forming**, or **GO-SPF**.

GO-SPF keeps the core advantages of SPF while improving the forming environment itself. Instead of relying only on static or slowly changing gas pressure, GO-SPF introduces controlled gas-pressure oscillations inside the forming tool. These pressure fluctuations help the material deform, then allow partial stress relief during the forming cycle. The result is faster forming, improved material flow and better thickness control, while the reduced thermal exposure helps limit oxidation, reduce grain coarsening and improve final part quality in complex titanium and high-performance alloy components.



Process Snapshot

- **Process:** Gas Oscillation Enhanced Superplastic Forming (GO-SPF)
- **Core mechanism:** Controlled waves of gas pressure are generated inside the forming tool, repeatedly pushing and releasing the material during superplastic forming.
- **Primary materials:** Aluminum, magnesium, titanium, other exotic metallic alloys, and some speciality ceramics.
- **Key system controls:** Accurate and repeatable argon gas pressure, multi-zone temperature control, precision gas management and high-speed data acquisition.
- **Documented trial result:** In Ti-6Al-4V trials at 900 C, GO-SPF reduced forming time from 60 minutes with conventional SPF to 23 minutes while improving forming quality, including better forming completeness in critical regions and a finer post-formed microstructure. In separate AA5083 aluminum trials using 1.40 mm material at 450 C, GO-SPF also demonstrated a 6× shorter forming cycle than conventional SPF under the same trial conditions.
- **Target applications:** Aerospace, defense, automotive, heavy truck/bus, medical, architectural, marine and other applications requiring complex lightweight formed components.

1. Why GO-SPF Matters Now

Section Summary

- Aerospace and defense manufacturers need more throughput without relaxing quality expectations.
- Conventional SPF enables complex geometry, but long forming cycles can create production bottlenecks.
- GO-SPF helps manufacturers keep the design benefits of SPF while reducing the cycle-time penalty.
- For qualification-driven applications, GO-SPF also helps address key material concerns such as oxidation risk, grain stability and thickness control in formed titanium components.
- The technology is most relevant when part complexity, light-weighting, alloy performance and production pace all matter.

Aerospace and defense programs are pushing forming operations harder than ever. Components need to be **lighter, stronger** and **more geometrically efficient**, while production teams are expected to shorten lead times, increase output and maintain repeatable part quality.



The capacity pressure is clear across the market. **Boeing projects demand for nearly 44,000 new commercial airplanes by 2043**, while Boston Consulting Group has identified casting and forging supply chains as a major constraint for commercial and defense aerospace, with late deliveries and long lead times holding up production and aircraft readiness (*Boeing, 2024; Juliano et al., 2024*).

On the defense side, the U.S. Government Accountability Office has reported that **the defense industrial base will need surge production to replenish Department of Defense weapon stocks and meet increased demand.** GAO also identified long lead times for supplier parts and raw materials across multiple weapon programs, including one missile program where electronic-part lead times increased from 19 months to 34 months within two years (*U.S. Government Accountability Office, 2024*).



That same urgency is visible in major platform and weapons programs. **The Department of the Air Force has moved to increase B-21 Raider annual production capacity by 25%,** U.S. policy is prioritizing domestic drone manufacturing expansion, and Lockheed Martin reported 191 F-35 deliveries in 2025 as the program continues to operate at high production volume (*Secretary of the Air Force Public Affairs, 2026; The White House, 2025; Lockheed Martin, 2026*).

GO-SPF addresses one piece of this broader production challenge: how to form complex sheet-metal components faster, with better process control, without giving up the lightweighting, part-consolidation and geometry advantages that make SPF valuable.

For process engineers, the question is technical: Can the material form faster without failure, excessive thinning or unacceptable stress distribution?

For manufacturing leaders, the question is operational: Can the process produce more acceptable parts per shift, reduce bottlenecks and support program ramp-up?

For qualification teams, the question is material integrity: How does the process affect surface condition, microstructure, cavitation risk and final mechanical properties, including thickness consistency, strength and hardness?

GO-SPF is designed to answer all of these questions.



2. The Problem GO-SPF Solves

Section Summary

- Conventional SPF can form complex geometries, but long cycle times often limit practical production throughput, especially in aerospace-grade titanium forming.
- Attempts to increase forming speed in conventional SPF often come at the expense of thickness control and part consistency.
- High forming temperatures and long thermal exposure increase both process cost and material-quality risk.
- These limitations affect more than cycle time alone. They also increase validation effort, qualification burden and production cost.

Conventional SPF is effective because it uses super plasticity: the ability of certain fine-grained metallic materials to undergo unusually high elongation before failure when formed under the right temperature and strain-rate conditions.

Under controlled conditions, superplastic materials can show elongations from **300%** to **1,000%** or more, making SPF a strong fit for complex, high-strength, lightweight components with fewer joints and welds (*Macrodyne Technologies Inc., n.d.-b*).

That advantage comes with strict process requirements. **SPF depends on precise control of temperature, gas pressure, strain rate and tool conditions to maintain stable material flow.** When the material is formed too aggressively, thickness distribution can become less uniform and part quality can deteriorate. When the process is kept conservative, cycle times can stretch and production capacity suffers.

GO-SPF was developed to ***reduce those constraints while preserving the value of SPF: complex geometry, high strength-to-weight performance, low springback and reduced part count.***

Known limitations of conventional SPF include: high working temperature, non-uniform thickness distribution at higher strain rates, slower manufacturing compared with stamping, warm forming and hydroforming, and wear or galling risks for heated materials such as aluminum (*Macrodyne Technologies Inc., n.d.-b*). Legacy SPF cycles may range from 15 minutes to eight hours, with high-energy ovens and non-uniform part thickness creating cost, quality and structural concerns (*Macrodyne Technologies Inc., 2025*).

These limitations become more significant in demanding aerospace applications, particularly in titanium forming, where long cycle times and extended thermal exposure increase both manufacturing cost and qualification burden.

For aerospace and defense manufacturers, these constraints show up in practical ways:

- **Capacity loss:** Long forming cycles tie up the press, tool and thermal system.
- **Delayed design validation:** Every trial, prototype or geometry change takes longer to prove.
- **Tooling pressure:** Complex shapes can require more involved tooling and more process development.
- **Qualification burden:** Longer thermal exposure increases concern around oxidation, microstructural stability, cavitation and final material consistency.
- **Inspection risk:** Local thinning, wrinkling or incomplete forming can create downstream rework.
- **Design compromise:** Engineers may simplify a part to make it formable, then pay for that compromise through added welds, fasteners, weight or assembly steps.

3. How GO-SPF Works

Section Summary

- GO-SPF adds controlled gas oscillation to the superplastic blow-forming process.
- The process applies baseline gas pressure while generating pressure fluctuations inside the forming cavity.
- These pressure fluctuations improve material flow while reducing stress buildup during forming.
- The oscillation strategy is matched to the part geometry, alloy behavior, and forming objective.

In conventional SPF, a heated sheet is clamped in a sealed tool and formed into the die by gas pressure. GO-SPF builds on this same forming approach by introducing an oscillatory pressure load into the gas-forming environment.

The patented method applies pressurized gas at a baseline pressure and then generates pressure fluctuations to that baseline inside the tool cavity (*Ryzer, 2020*). This oscillatory loading repeatedly applies and relieves pressure during deformation, promoting more stable material flow, reducing localized stress accumulation and improving thickness control during forming.

GO-SPF functions as a gas-dynamic forming system rather than a conventional static-pressure SPF process. Macrodyne applies **advanced compressible-flow engineering**, **supersonic flow physics** and **high-fidelity Computational Fluid Dynamics** to engineer the fluid architecture that drives the process.

The gas-delivery system is designed around transient supersonic jet behavior, shock-cell formation, expansion-wave dynamics and controlled pressure-wave propagation to generate a stable, high-intensity oscillatory pressure field with tightly regulated amplitude, frequency and waveform characteristics. This enables dynamic pressure loading to actively shape material deformation under superplastic forming conditions.

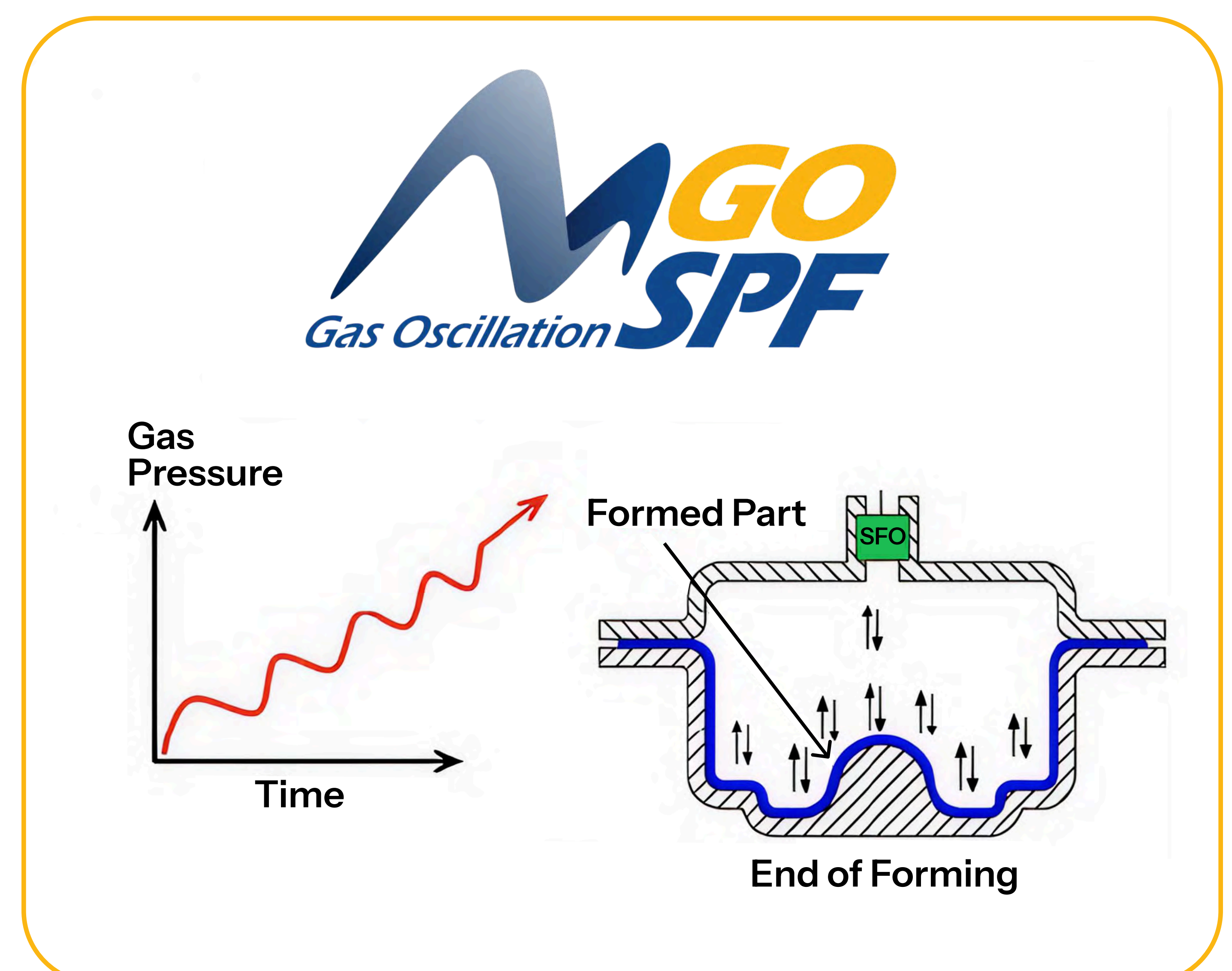


Because the oscillatory load is generated through a controlled gas-dynamic system rather than a fixed pressure curve, **GO-SPF can be tuned to the specific forming application.** Macrodyne couples the gas-delivery architecture with high-speed closed-loop PLC control, synchronizing gas flow, thermal conditions and real-time forming response throughout the cycle.

This allows pressure behavior and oscillation response to be precisely engineered around part geometry, alloy behavior and tooling configuration to optimize forming speed, thickness control and final part quality.

Most importantly, the performance gain is driven at the **press-system level** through integration of the press-side fluid oscillation unit, advanced gas delivery control and dynamic forming response, rather than through redesign of the forming die itself.

This allows GO-SPF to deliver **substantial process gains without requiring the customer to modify existing die geometry or core tooling**, significantly reducing implementation cost, tooling disruption and qualification risk.





4. Performance Data: Speed, Stress and Thickness Control

Section Summary

- In Ti-6Al-4V trials, GO-SPF reduced forming time from 60 minutes to 23 minutes while maintaining the same degree of part development in critical regions.
- Metallurgical analysis showed finer and more uniform post-formed microstructure in Ti-6Al-4V, including under matched thermal exposure, with no observed increase in cavitation.
- AA5083 aluminum trials confirmed the same faster-forming behavior, with substantially shorter cycle time and repeatable part quality.
- Across both titanium and aluminum, GO-SPF demonstrated faster forming without the expected penalty in thinning, cavitation or final part quality.

Titanium forming presents the strongest commercial case for GO-SPF, particularly in aerospace applications where conventional SPF is already well established but remains constrained by long cycle times, high thermal exposure, and narrow qualified processing windows.

Laboratory testing at 900°C first showed that superimposed oscillations improved Ti-6Al-4V formability at the material level, increasing elongation to failure by approximately 6–17% and improving strain-rate sensitivity by up to 25%. This demonstrated a broader usable forming window under superplastic conditions. (*Fuerth, Z et al., 2024*).

This material-level improvement was then validated at part scale in Ti-6Al-4V prototype forming trials using Macrodyne's R&D GO-SPF press. A representative part was formed in 23 minutes using GO-SPF, compared with 60 minutes using conventional SPF. Despite the substantially shorter cycle, the **GO-SPF part achieved comparable development in the critical section, maintaining similar forming gap and thickness distribution to the conventionally formed part.**



That result is important because cycle-time reduction alone is not enough in titanium forming. Faster forming only matters if the part still meets quality and qualification expectations. Post-forming SEM analysis showed that GO-SPF parts retained a finer and more uniform microstructure than conventionally formed parts, with approximately 30% finer grain structure in the direct process comparison. SEM observations also showed no increase in cavitation despite the shorter and more aggressive forming cycle.

Matched-time Ti-6Al-4V samples were also compared at the same total forming time of 28 minutes to isolate process effects from thermal exposure alone. Under equivalent thermal exposure, the GO-SPF sample still showed a finer microstructure, with average α grain size reduced by approximately 7% compared with the conventional SPF sample. This indicates that the oscillatory forming process itself contributed to grain refinement while limiting grain coarsening during forming.

AA5083 aluminum trials confirmed the same faster-forming behavior as well. In 1.40 mm AA5083 at 450 C, GO-SPF produced fully formed parts in approximately 90 seconds, while conventional SPF was not able to repeatably produce acceptable parts in less than nine minutes under the same trial conditions. (*Macrodyne Technologies Inc., 2025*). Additional aluminum trials and SEM analysis showed the same practical result seen in titanium: shorter cycle time, acceptable thickness control and no observed increase in cavitation despite faster forming.



As with any forming process, actual production gains will depend on:

- Alloy
- Gauge
- Geometry
- Forming temperature
- Tool design
- Pressure profile
- Oscillation strategy
- Acceptance criteria

Across titanium trials, material testing, microstructural analysis and aluminum validation, the conclusion is consistent: **GO-SPF improves forming speed without forcing the conventional trade-off in thinning, cavitation or final part quality.** The value is not just shorter cycle time. It is faster forming with better control over thickness, microstructure and qualification-relevant material integrity.



5. Material Range and Application Fit

Section Summary

- GO-SPF can be applied to all alloy systems already established in conventional SPF, including aluminum, magnesium, titanium, stainless steels, and nickel-based alloys.
- By improving deformation stability and reducing process sensitivity, GO-SPF broadens the practical forming window of established SPF materials and expands their production viability.
- This is especially valuable in aerospace and defense applications using titanium, stainless steel, and nickel alloys, and in automotive applications using aluminum and magnesium.
- Material selection and process qualification should be defined by alloy, part geometry, and production requirements.

GO-SPF can be applied to all alloy systems already established in conventional SPF, including widely used alloys such as Ti-6Al-4V titanium and AA5083 aluminum. By improving deformation stability, reducing localized thinning, and lowering sensitivity to thermal exposure, GO-SPF allows these same SPF alloy systems to be formed with greater process flexibility, broader material tolerance, and more consistent part quality.

In conventional SPF, material selection is often constrained by narrow forming windows, strict fine-grain requirements, and extended high-temperature exposure.

These constraints increase material cost and limit the practical use of SPF-capable alloys in production. **For example**, achieving higher forming rates at lower temperatures in Ti-6Al-4V typically requires ultrafine-grain sheets to maintain acceptable formability and final part quality. **Under GO-SPF**, comparable production rates can be achieved using coarser-grain Ti-6Al-4V while maintaining equivalent forming quality, creating a practical path to lower material cost and broader practical use of titanium SPF.



A similar limitation exists for nickel alloys such as Inconel 718, where SPF has historically been constrained by extreme temperature, pressure and grain-size requirements that have limited broader industrial adoption beyond laboratory-scale and niche demonstrations.

GO-SPF relaxes these constraints, improving the practicality of SPF-based forming for nickel alloys in production environments.

This increased material latitude is especially **valuable in aerospace and defense** applications, where components must meet demanding requirements for high-temperature performance, structural efficiency, corrosion resistance and qualification-sensitive manufacturing. Representative examples include **titanium airframe panels** and **engine bay structures**, nickel-alloy **combustor and compressor casings** in gas turbine engines, and stainless steel **aircraft ducting, thermal shielding** and corrosion-resistant **enclosures**.

In automotive and lightweight transportation applications, aluminum and magnesium are the most dominant GO-SPF material classes, where reduced mass, part consolidation and repeatable panel forming are primary design drivers.

Representative applications include: superformed aluminum body panels used in luxury and high-performance vehicle programs, as well as emerging electric vehicle platforms, along with lightweight structural closures and underbody components.

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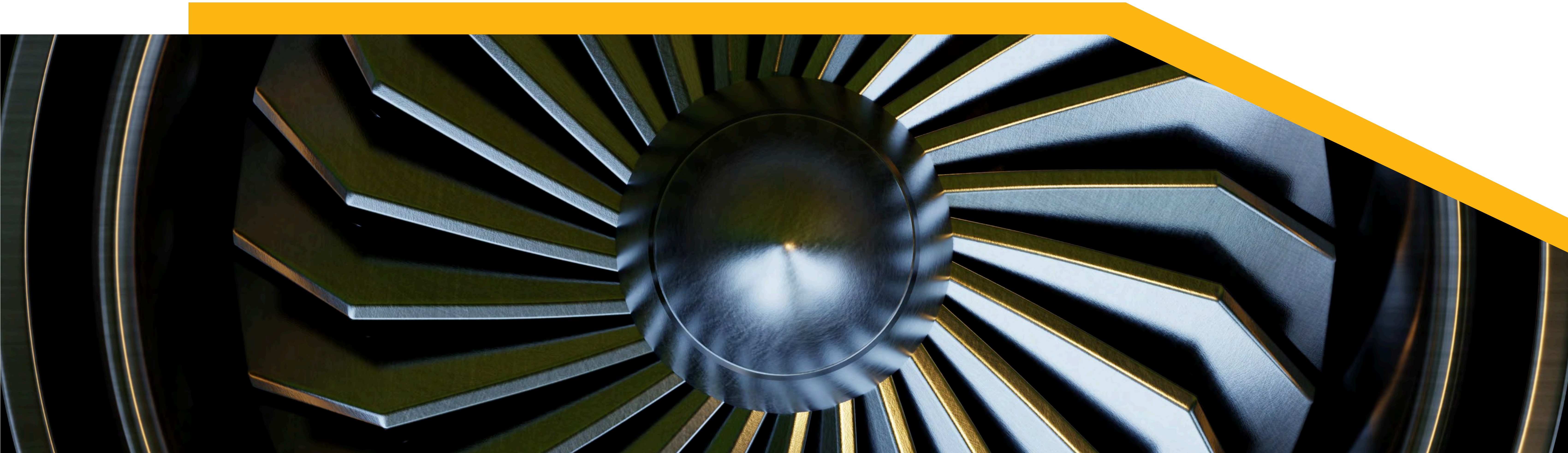
6. GO-SPF vs. Conventional SPF

Section Summary

- GO-SPF retains the part-consolidation and lightweighting benefits of SPF.
- The key process difference is controlled gas oscillation during forming.
- GO-SPF improves forming speed, material flow, strain-rate capability and thickness-control potential.
- For production teams, the value is higher throughput without giving up part complexity.

Capability Area	Conventional SPF	GO-SPF
Forming method	Heated sheet is formed into a die using controlled monotonic gas pressure.	Heated sheet is formed using baseline gas pressure with superimposed controlled gas-pressure oscillation.
Stress behavior	Material flow depends on temperature, pressure-time curve and strain-rate control.	Oscillatory pressure promotes more stable material flow and periodic stress redistribution during forming, improving deformation control (Ryzer, 2020).
Cycle time	Long forming cycles due to very low allowable strain rates (typically $\sim 10^{-4}$ to 10^{-3} s^{-1}), significantly slower than hydroforming or hot stamping. (Macrodyne Technologies Inc., n.d.-b).	Higher allowable strain rates enable major cycle-time reduction. For Ti-6Al-4V, operation up to $\sim 0.02 \text{ s}^{-1}$ significantly increases forming speed relative to conventional SPF. For AA5083, operation up to $\sim 0.2 \text{ s}^{-1}$ approaches the lower range of hydroforming and hot stamping, enabling much higher production rates while maintaining SPF-level formability. (Macrodyne Technologies Inc., 2025).
Thickness control	Non-uniform thickness can become a quality and structural concern.	GO-SPF supports more uniform thickness and reduced weak-spot risk across complex geometries (Macrodyne Technologies Inc., 2025).
Geometry	Strong fit for complex parts, but cycle time and thinning can limit what is practical.	Enables more complex-shaped parts, thinner parts and parts previously considered difficult or unmanufacturable (Macrodyne Technologies Inc., n.d.-a).

Capability Area	Conventional SPF	GO-SPF
Energy and Thermal Load	High working temperatures and long cycle times increase energy demand.	Shorter cycles and reduced thermal exposure can lower energy per part. (Macrodyne Technologies Inc., 2025).
Consumables	Coating requirements vary by material, geometry and forming conditions	Reduced cycle time and improved flow can lower consumable usage. (Macrodyne Technologies Inc., 2025).
System Capability/ Deliverables	Heated SPF press, gas pressure control, tool heating and process control.	GO-SPF press architecture with integrated gas oscillation, precision gas control, multi-zone temperature control, and high-speed data acquisition. (Macrodyne Technologies Inc., n.d.-a).
Die/Tooling Requirement	Requires high-temperature tooling with good thermal stability and surface protection. Tooling must accommodate long cycle times and is sensitive to coating performance and thermal exposure.	Uses similar high-temperature tooling as conventional SPF, with no fundamental change to die design. Improved material flow and shorter cycles can reduce coating demand, thermal exposure, and overall tooling wear, without requiring major tooling redesign.



7. Energy, Tooling and Total Process Efficiency

Section Summary

- GO-SPF delivers efficiency gains beyond cycle-time reduction.
- Faster forming can improve press utilization and increase parts per shift.
- Reduced thermal exposure lowers energy consumption and limits tooling wear, particularly in high-temperature alloys.
- Higher process efficiency reduces bottlenecks and improves overall production scalability.

Cycle time is the most visible GO-SPF advantage, but its impact is most significant when combined with reduced thermal exposure in high-temperature materials such as Ti-6Al-4V.

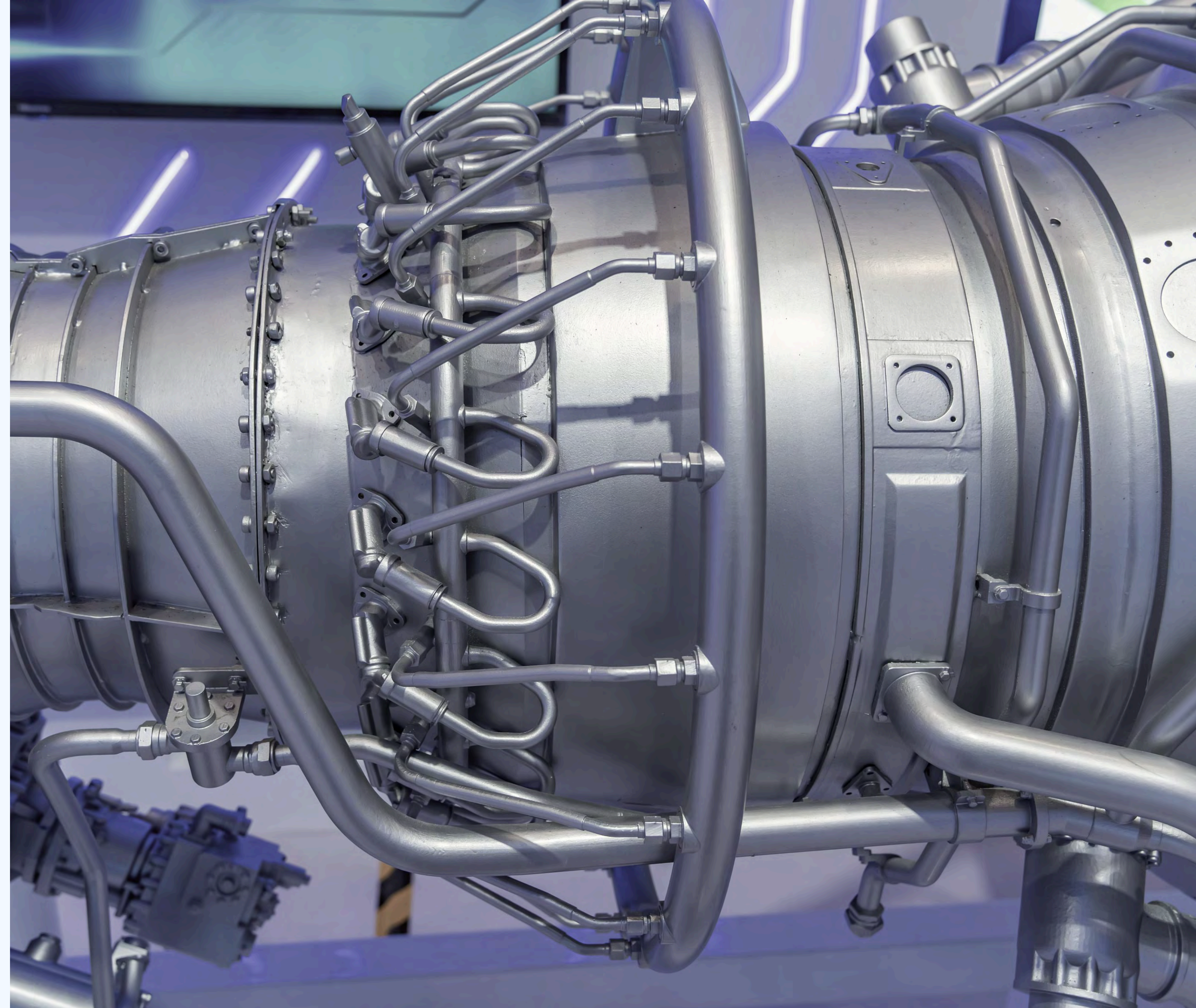
In conventional SPF, long dwell times at elevated temperature drive both energy consumption and tool degradation. By reducing forming time, GO-SPF lowers total thermal exposure per part, which reduces energy demand and limits thermal wear on dies and press components.

In Ti-6Al-4V trials, GO-SPF reduced forming time by approximately threefold while maintaining comparable forming quality and thickness distribution. This reduction in cycle time reduces furnace and platen heating power demand per part by approximately 65–70%.



This effect is particularly important in aerospace production, where titanium forming temperatures are high and tooling life is closely tied to cumulative thermal load.

Reduced exposure can extend die life, improve process stability over longer production runs, and reduce maintenance frequency.



Shorter forming cycles also reduce press occupancy. This increases parts produced per shift, improves utilization of existing equipment, and can delay or eliminate the need for additional press capacity. In production programs where SPF is a bottleneck, this improvement has a direct impact on capital efficiency and program scalability.

Aluminum trial results (AA5083) provide supporting evidence of reduced cycle time and improved process stability under GO-SPF. These results confirm that shorter forming cycles directly reduce thermal exposure per part, supporting lower energy demand and reduced thermal loading on tooling systems.

Improved formability under GO-SPF can enable more complex geometries to be formed in a single operation, potentially reducing the need for multiple forming steps or subsequent assembly operations in applicable designs

For production teams, these gains translate into:

- More parts per shift
- Improved press utilization
- Reduced bottlenecks during ramp-up
- Lower energy consumption per part
- Extended tooling and platen life under reduced thermal loading
- Greater flexibility for part consolidation and reduced downstream assembly



8. Compliance, Quality and Implementation Readiness

Section Summary

- Macrodyne supports aerospace and defense manufacturing requirements through ISO 9001:2015 registration, ITAR readiness, CAGE code credentials and NATO-aligned supply capabilities.
- GO-SPF systems can be specified around program requirements for safety, traceability, data capture, documentation and process control.
- For defense and aerospace programs, compliance planning should happen early so the press, controls, documentation package and qualification process are aligned from the start.
- Macrodyne's North American manufacturing base and U.S. facilities help support secure equipment delivery, commissioning and service for sensitive programs.

For aerospace and defense manufacturers, forming equipment is never evaluated on process performance alone. The technology has to fit the qualification environment around the program. That means quality systems, export-control requirements, procurement credentials, data handling, safety standards, documentation and long-term service support all need to be considered before the system is built.

Macrodyne maintains a formal Quality Management System that is ISO 9001:2015 registered.

ISO 9001:2015 provides an internationally recognized framework for managing quality, customer requirements, consistency and continual improvement (*International Organization for Standardization, n.d.*).

For aerospace buyers, this provides a strong foundation for supplier review, while additional program-specific requirements such as AS9100, CE, OSHA, CSA or customer-specific standards can be addressed during the specification and qualification process.

Macrodyne is also positioned to support secure defense and government procurement requirements. Macrodyne owns a CAGE code of LOKP1, which provides a standardized supplier identifier for government and defense procurement. Macrodyne Technologies Inc. is also listed under NCAGE code LOKP1 for doing business with international governments (*CAGE.report, n.d.*). For U.S. defense and export-controlled programs, ITAR readiness is critical. The International Traffic in Arms Regulations govern defense articles, defense services and related technical data, and the U.S. Directorate of Defense Trade Controls advises registered exporters, manufacturers, brokers and other defense-trade organizations to maintain compliance programs for controlled activities (*U.S. Department of State, n.d.*).

Macrodyne's North American manufacturing base and U.S. facilities support ITAR and NATO compliance, helping customers source press and automation systems for sensitive allied defense and military programs without relying on offshore parts or technicians.

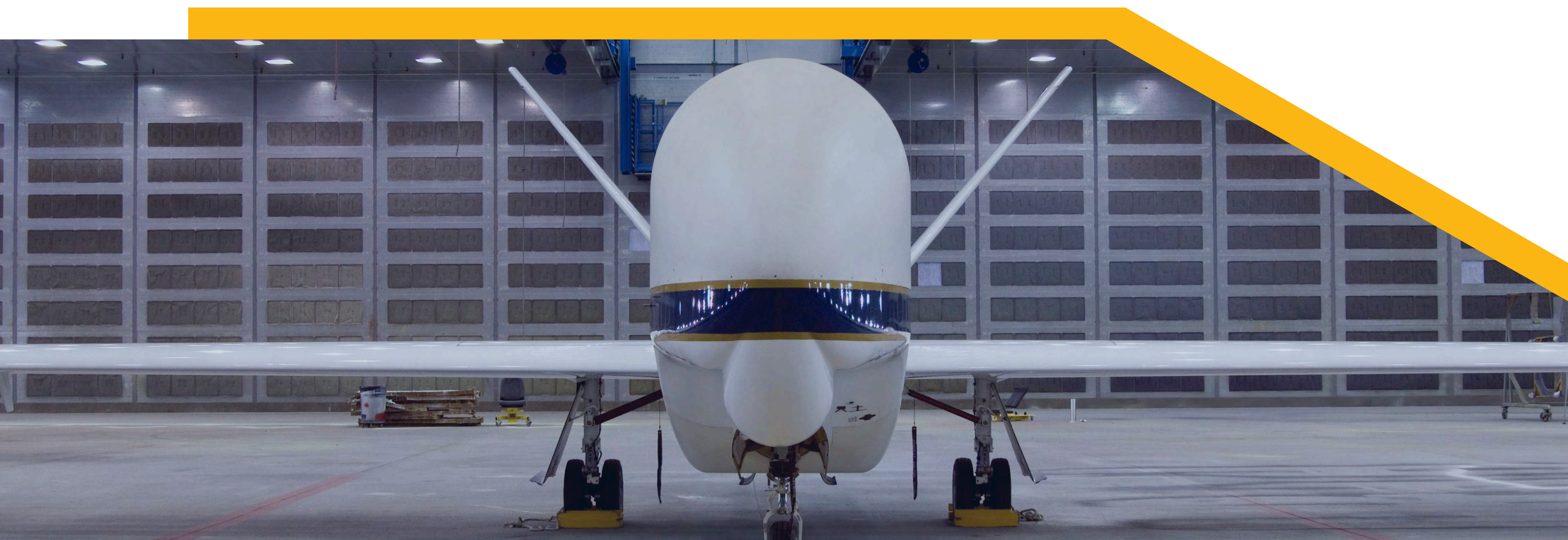
This compliance posture matters for GO-SPF because the system is not only a press. It is a process platform. The forming system, gas-management architecture, tool-heating strategy, pressure-control logic, data acquisition, safety systems and documentation package all need to support each program's unique production and audit requirements.

A GO-SPF system can be specified around requirements such as:

- Machine safety standards
- Electrical standards
- Recipe management
- Operator access levels
- Temperature and pressure traceability
- High-speed process data acquisition
- Remote diagnostics
- Preventive maintenance planning
- Factory acceptance testing and site acceptance testing
- Customer-specific qualification documentation
- Aerospace, Defense, Government Procurement or Export-control requirements

The core press architecture supports this level of process control. **GO-SPF presses use accurate and repeatable argon gas pressure and multi-zone temperature control, managed through the press control system.** Standard SPF press features can include precision gas management, high-speed data acquisition, heat shields, ceramic insulation, heated platens, cooling platens, rolling bolsters and remote diagnostics.

The right time to define these requirements is before the project moves into final equipment specification. Early compliance planning helps ensure the GO-SPF system is engineered for the quality environment, documentation expectations, inspection process, internal approvals and long-term production needs.



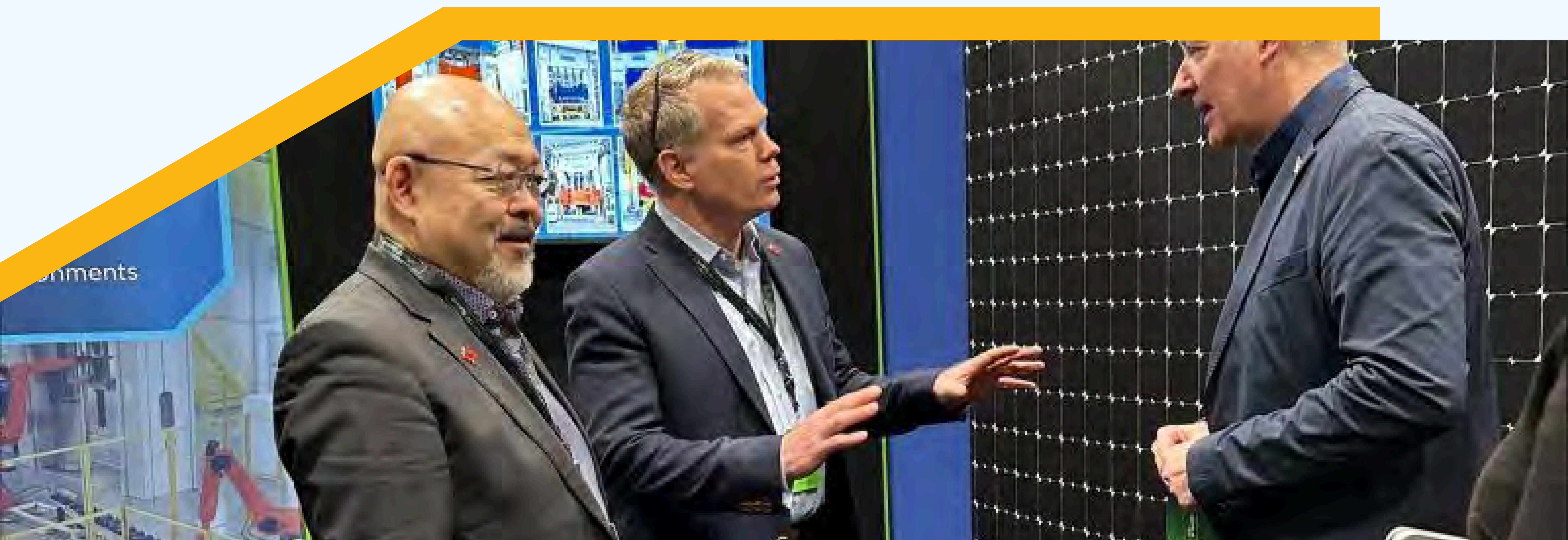
9. When to Evaluate GO-SPF

Section Summary

- GO-SPF should be evaluated when conventional SPF works technically but limits throughput.
- It is especially useful when geometry, wall thickness, alloy behavior and production pace are all critical.
- The earlier Macrodyne is involved, the more opportunity there is to optimize the forming strategy.

GO-SPF is a strong fit when a manufacturer is facing one or more of these conditions:

- SPF cycle times are limiting output.
- A complex geometry is forcing design compromise.
- Local thinning or inconsistent wall thickness is creating inspection risk.
- The production plan needs more SPF capacity, but adding another press is costly or space-constrained.
- A welded or fastened assembly could become a formed component.
- A lightweight alloy component needs better repeatability at higher production rates.
- A program is moving from prototype to ramp-up and the forming method needs to scale.





The best time to evaluate GO-SPF is before the part design is locked. Early review gives the engineering team more room to assess blank size, gauge, draw depth, forming temperature, pressure strategy, tool design and inspection requirements.

For a productive first conversation, bring:

- Alloy and material specification
- Sheet thickness or target gauge range
- Current forming method
- Current cycle time
- Target cycle time
- CAD model or part drawings
- Annual production volume
- Critical geometry requirements
- Allowable thinning or final thickness tolerance
- Surface-finish requirements
- Current scrap, rework or inspection issues
- Available utilities, floor space and plant constraints



10. How Macrodyne Configures GO-SPF for Your Application

Section Summary

- GO-SPF depends on the full forming system, not only the press frame.
- Macrodyne integrates press design, gas management, temperature control, data acquisition and application-specific engineering.
- Each GO-SPF system is built around the alloy, part geometry and tool design.

GO-SPF requires more than adding an accessory to a conventional SPF press. The gas oscillation system, tool, thermal environment, pressure control, control software and press structure **all need to work together.**

Macrodyne builds GO-SPF systems around the application. The gas oscillation mechanisms are customized according to part geometry, metallic alloy and tool design.

This engineering approach matters because **SPF performance is highly sensitive to process conditions**. The forming strategy must account for material flow, thinning risk, pressure response, tool contact, heat distribution and the production data needed to prove repeatability.

To support this, Macrodyne has developed proprietary GO-SPF modeling capabilities to simulate forming behavior prior to physical trials. This enables evaluation and refinement of pressure profiles, thermal conditions and material flow before tooling is committed, reducing development risk, minimizing trial iterations and improving confidence in part feasibility and process repeatability.

Macrodyne also operates an R&D GO-SPF press to support physical trials and process validation. This allows customers to validate forming strategies, optimize process parameters and generate qualification data prior to full-scale production, reducing development risk and accelerating program readiness.

The value of GO-SPF is not just that it forms faster. It gives engineering teams a way to **revisit parts that were previously too slow, too complex or too difficult** to form with conventional SPF alone.

For programs under schedule pressure, that can change the conversation from **“Can we form this?”** to **“How fast can we form this repeatably?”**



Want to Know More? Start With a GO-SPF Feasibility Review?

GO-SPF is not the right answer for every part, alloy or production environment. The best way to evaluate the opportunity is to **start with the specific forming challenge in front of you.**

Macrodyne can perform a **GO-SPF feasibility review** to determine whether the process is a strong fit for your component, material, geometry and production goals. That review can help your team understand where GO-SPF may improve cycle time, thickness control, material flow, energy use, tooling strategy or overall press utilization.

Bring us your **part geometry, alloy, gauge, production target and current forming constraints.**

We will:

1. Review the application
2. Identify the key process considerations
3. Help determine whether GO-SPF is the right path forward.

Talk to Macrodyne about a GO-SPF feasibility review.

Let's find out whether your next part can be formed faster, cleaner and with fewer process compromises.

[Speak with a GO-SPF Expert](#)



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Sichang Xu is a Process Engineer and R&D Engineer with more than 12 years of experience in advanced forming technologies, numerical simulation, and manufacturing process development. With a **PhD in Mechanical Engineering**, his background combines academic research with hands-on industrial engineering across aerospace, automotive, and defense manufacturing applications.

Sichang first became involved with Gas Oscillation Superplastic Forming (GO-SPF) in 2014 while working as a researcher at the University of Windsor. His work focused on developing supersonic fluid systems for GO-SPF, building CFD models to study gas oscillation behavior, and developing coupled solid-fluid numerical models to better understand material deformation during the forming process. His expertise spans gas dynamics, material behavior, heat transfer, and complex forming simulation.

At Macrodyne, Sichang supports advanced forming process development, tooling, simulation, and manufacturing system optimization. His engineering approach balances deep technical understanding with practical manufacturing realities, combining research-driven analysis with real-world production considerations.

He is particularly motivated by solving complex engineering problems and continuously learning new technologies, materials, and manufacturing methods. Outside of his professional work, Sichang enjoys exploring emerging technologies, simulation techniques, and technical research topics.

About Macrodyne Technologies

Macrodyne Technologies builds custom hydraulic and servo presses, automated press lines and die handling systems for manufacturers working at the edge of what standard equipment can do. For more than 30 years, Macrodyne has helped aerospace, defense, automotive, medical, industrial and consumer goods manufacturers solve complex forming and production challenges with custom press systems built around the part, the process and the production goal.

