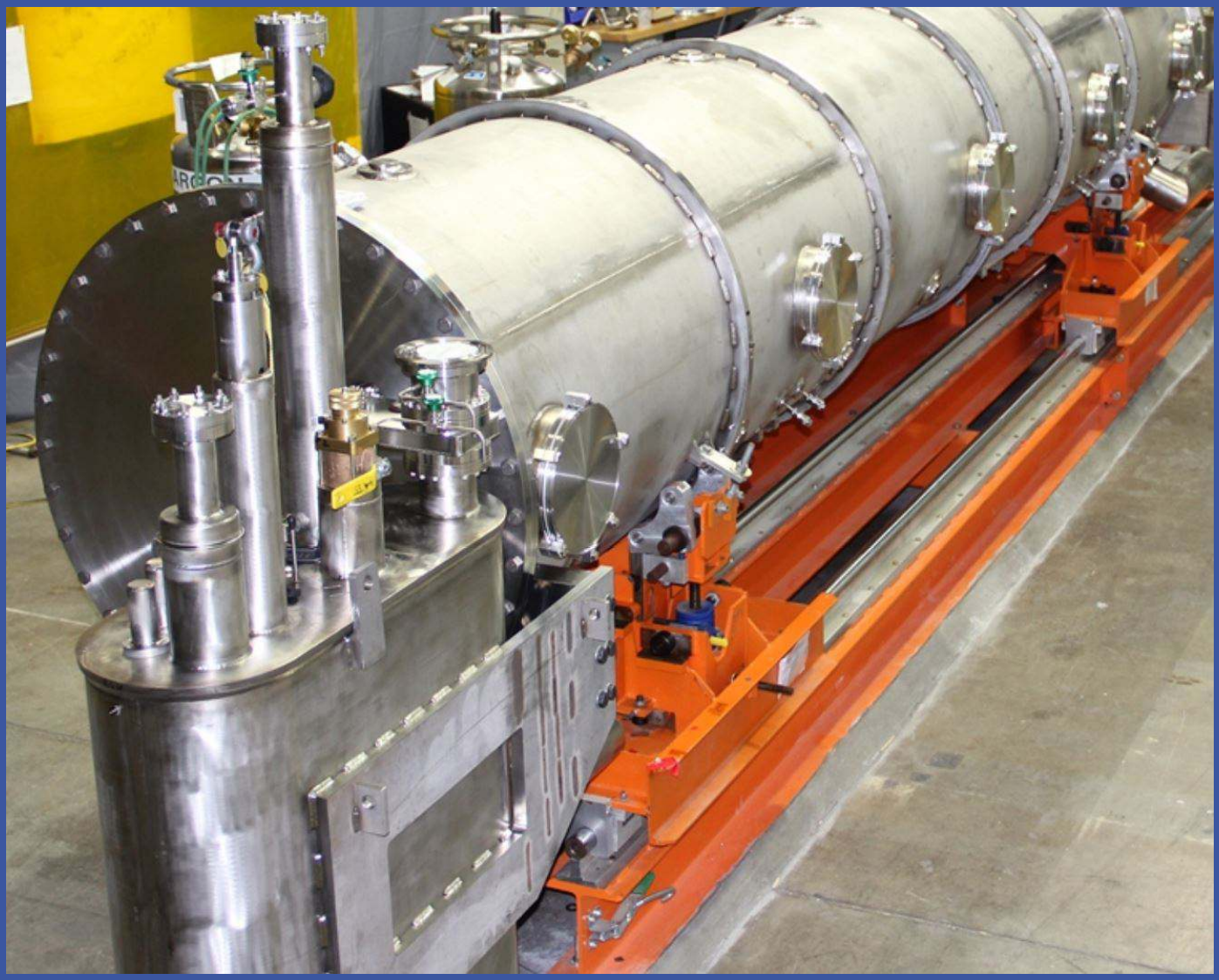
# HOW TO SPECIFY AND BUILD CUSTOM AND PRECISION FABRICATIONS



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## Custom & Precision Fabrication Definition (KTC)

Keller's custom precision fabrication service manufactures non-standard structures, vessels, fabrications, equipment and assemblies for demanding industrial and research applications.
Materials utilized include carbon steel, stainless steel, aluminum, high nickel alloys, and various exotic materials. Processes involved typically include tight-tolerance five axis machining, welding, surface treatment, precision post-weld machining, assembly, inspection and testing. Special care is taken to comply with industry standards or regulations, as applicable.

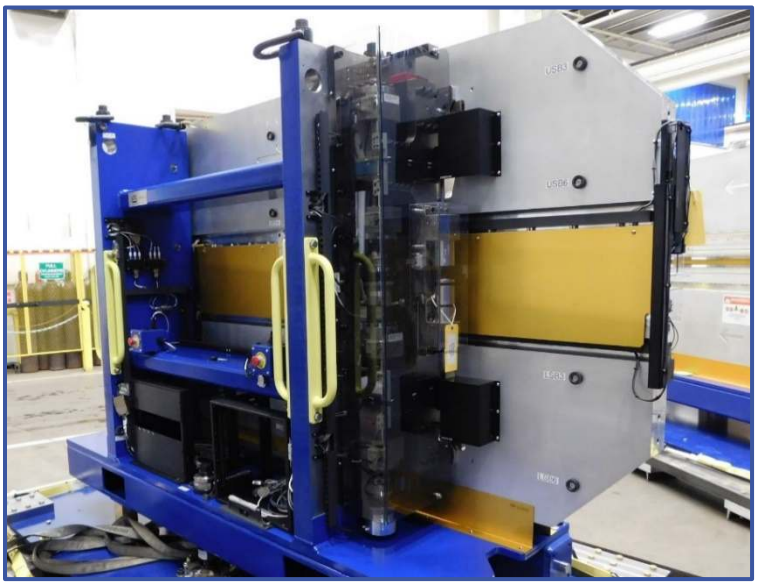
## Precision Fabrication Specification

A custom or precision fabrication can be useful for anyone with a need for a piece/ part, assembly, or system. KTC's projects range from customers looking to flesh out a basic idea to those with fully fledged designs complete with approved CAD models and drawings. Once you determine that a precision fabrication project is necessary for you, the process begins by obtaining a quote.

To do this, you'll need to put together a documentation package, and submit a Request for Quote (RFQ). The full scope of that package will vary based on the completeness of the design, but each package will at minimum need to contain a CAD model and/ or drawings, as well as your timeframe and the number of units needed.

KTC works with three main types of projects in the custom and precision fabrication area. The most common is Build-to-Print. In this scenario, the design is complete with certified CAD model and drawings, material callouts, and required tolerances. In a Build-to-Print package, you are certifying that everything fits together with dimensions and tolerances (possibly GD&T). When you submit a complete Build-to Print document package in your RFQ, you will receive a very detailed project plan and firm quote.

The second type is Design-and-Build. KTC Engineering can create a model from your drawings, which could be a stack of old blueprints, or a collection of PDF files. These won't necessarily have feature call- outs, and will likely require a lot of back and forth communication to ensure the design meets the customer's needs. For this type of RFQ, you will receive a price to complete the design, a budgetary price for the fabrication, and schedule.



The final type of RFQ is for instances in which the customer has a rough idea of what they require. In this case, Keller Technology can work with you to flesh out a design, budget and project plan. Once the necessary technical documentation is produced, a firm quote for the design work and a budgetary build cost and schedule can be provided.

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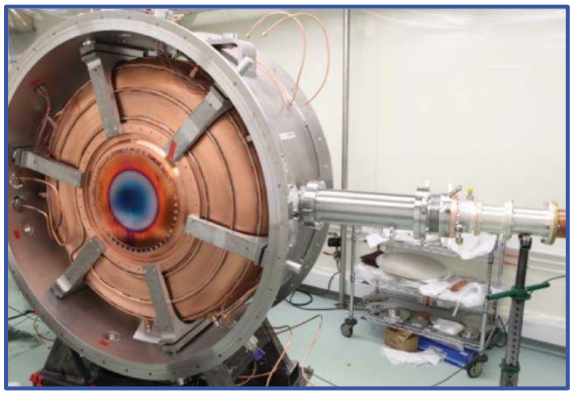
## Summary of Requirements for your RFQ

- **Document Package Types**
  - **Build-to-Print:** Certified CAD model with verified, dimensioned drawings for each piece/part, all necessary tolerances, and material specifications.
  - **Design-and-Build:** Dimensioned drawings of the piece/part, and as much information regarding tolerances, features, and materials as possible
  - **Scoping:** Design idea with as many details as possible
- **Timeframe:** Scheduling, key dates, and project milestones




## Precision Fabrication Construction

Once a quote is agreed upon and a contract is signed, the precision fabrication project can begin. KTC utilizes several tools and processes to facilitate the fabrication and deliver a satisfactory product to the customer. The process begins by setting up first article inspection (FAI) criteria and checklists that will be used throughout the project to ensure adherence to the specifications outlined in the final contract document package.

Through these, KTC can verify that all materials, parts, and assemblies meet the customer requirements, and are presented to the customer during final acceptance. These inspections happen through the remaining steps and are a critical component of precision fabrication.

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While talking about documentation and inspections, it's important to note that KTC has attained ISO 9001 and ISO 13485 Quality Management System Certification's for general manufacturing and for manufacturing machinery for medical devices. A quality management system is a collection of policies, processes, procedures, and records that defines the set of rules KTC will utilize to create and deliver outstanding products and services while adhering to all applicable regulations and requirements. Certification to the ISO standards ensures that internationally recognized best-practices are met, and that all elements needed for success are implemented into the quality management system.

**ISO 9001** outlines seven Quality Management Principles:

Customer Focus, Leadership, Engagement of People, Process Approach, Improvement, Evidence-Based Decision Making, and Relationship Management.

**ISO 13485** builds on the guidelines in ISO 9001 with additional documentation and safety requirements for the manufacture of medical devices.

Before machining work can begin, KTC must obtain materials. These can be customer- supplied or Keller-sourced, but they will be inspected upon arrival to ensure they meet all necessary certifications and specifications provided in the document package.

The Parpas XS 63 five-axis gantry machining center is a valuable addition to Keller Technology Corporation's (KTC) comprehensive machine shop. Five-axis movement makes the Parpas an ideal choice for machining hard-to-reach surfaces and deep cavities.

In addition to high speed and the ability to perform heavy-duty machining on hard materials (steel, Inconel, titanium, etc.), the CNC milling tool machines highly complex shapes with a single setup.

Features Include:

Three (3) interchangeable heads

- Roughing straight milling head
- Universal indexing right angle head
- Universal five-axis high speed milling head

Very large working envelope

- X-axis travel = 236”
- Y-axis travel = 118”
- Z-axis travel = 59”

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The next step in the process is to prepare the software and tooling to facilitate machining. There are three main software packages that KTC utilizes to prepare for machining.

- **SolidWorks** is a CAD package that is used for modeling and fixture design.
- **Mastercam** is a CAD/CAM package that is used to program the CNC machines
- **Vericut** is a simulation package that leverages the Mastercam program to simulate CNC machining. It can find errors and areas of inefficiency by simulating both tool path motion and the material removal process.

Once the CNC programming and simulations are complete and materials have arrived, machining and welding can begin. KTC utilizes 5-axis CNC mills, which enable the machining of extremely complex parts through the ability to move a part or tool along five different axes simultaneously. These machines are highly efficient, often accommodating single-setup machining, and can achieve better access to part geometry.

## KTC's suite of 5 -axis machine tools.

| 5-Axis Mill | Table Travel | Vertical Travel | Max Spindle Rotation Speed | Other Notes |
|---|---|---|---|---|
| Parpas XS63 | X axis = 236"<br>Y axis = 118" | Z axis = 59" | 20,000 RPM | Two Spindles |
| Vision Wide FA-4127 | X axis = 161"<br>Y axis = 106" | Z axis = 39" | 12,000 RPM | Tool Magazine, 1 Pallet |
| DMC 210 U | X axis = 82"<br>Y axis = 82" | Z axis = 49" | 12,000 RPM | Tool Magazine, 5 Pallet |
| DMC 210 U FD | X axis = 82"<br>Y axis = 82" | Z axis = 49" | 12,000 RPM | Tool Magazine, 5 Pallet |
| DMC 210 U RPS 5 | X axis = 82"<br>Y axis = 82" | Z axis = 49" | 16,000 RPM | Tool Magazine, 5 Pallet |
| DMC 160 RS 6 | X axis = 62"<br>Y axis = 62" | Z axis = 43" | 12,000 RPM | Tool Magazine, 6 Pallet |
| DMC 160 U | X axis = 62"<br>Y axis = 55" | Z axis = 43" | 12,000 RPM | Tool Magazine, 2 Pallet |
| DMC 125 U duoBlock | X axis = 49"<br>Y axis = 49" | Z axis = 39" | 12,000 RPM | Tool Magazine, 2 Pallet |
| DMC 125 P | X axis = 49"<br>Y axis = 34" | Z axis = 31" | 10,000 RPM | Tool Magazine, 1 Pallet |

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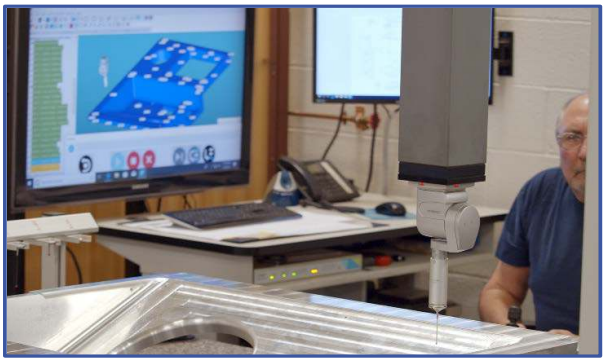
KTC offers both manual and robotic welding services. Robotic welding systems offer highly repeatable results at great efficiency, while manual welding allows flexibility for one- off tasks. KTC utilizes a Lincoln System 55 Automated Robotic Welding Cell for its automated welding needs.

At some point amidst machining and welding, it is likely that at least some of the parts will need to undergo stress relief or reduce hardness before the manufacturing process can continue. KTC has the capability to utilize heat via a furnace for thermal stress relief and tempering, as well as a VSR 8000 vibratory stress relief system which utilizes mechanical vibration energy to redistribute internal stresses.

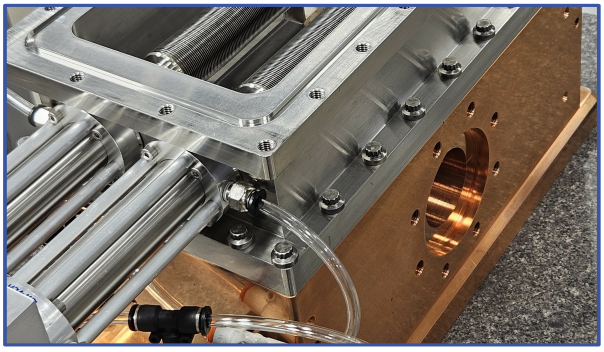
Once parts are machined and/or welded, the next phase of the process takes the components to an assembly bay or controlled environment room for final precision assembly. KTC maintains a 1200 square foot controlled environment that meets ISO Class 7 thresholds for projects that require clean-assembly. Cleanroom classifications are based on measurement of the quantity and size of particles in a volume of air to determine its cleanliness. Air cleanliness is achieved by cycling air through HEPA filters a certain number of times per hour. In an ISO class 7 clean room, the air will be filtered on average 30 - 60 times per hour. With these air changes, the ISO 7 environment will result in the following concentration limits of particles (particles/m3 of air): ≥0.5 µm = <352,000, ≥1 µm = <83,200, and ≥5 µm = <2,930).

Following assembly, KTC utilizes coordinate measuring machines (CMM) and laser tracker technology to perform final alignment and measurements. A CMM utilizes a probe to sense discrete points on the surface of an object. The probe can be mechanical, optical, laser, or white light.



**Current CMM systems at Keller include:**

- Global Advantage Coordinate Measuring Machine
- Zeiss DB 1200 Coordinate Measuring Machine
- Leica AT402 Laser Tracker
- API Tracker 3 Ultra-Portable Laser Tracking System



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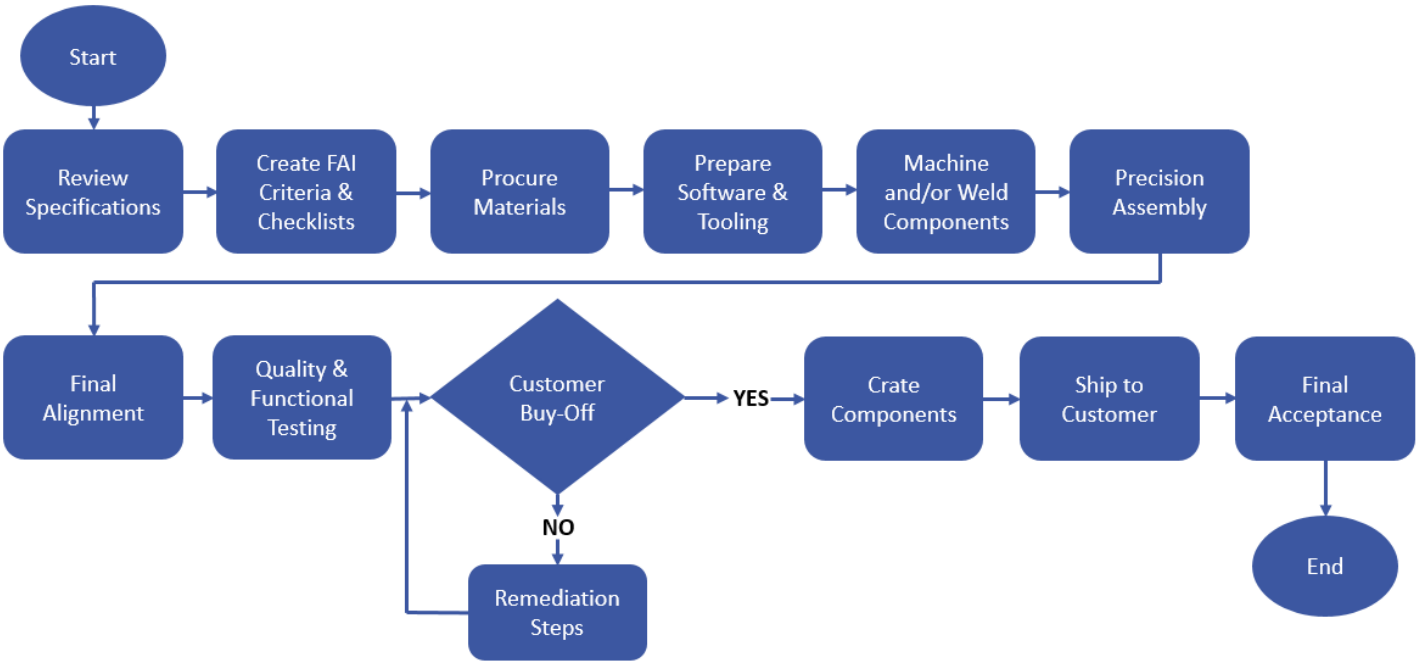
Quality and Functional Testing are the next steps in the process. Here the final assembly is rigorously examined to ensure it meets all the performance requirements outlined in the document package. The customer may also participate in these tests if they have the desire to do so.

The tests required will vary based on the project, examples include:

- Dimensional inspection
- Helium leak testing
- Base pressure vacuum testing
- RGA testing
- Pressure testing
- Hydro testing
- Dye penetrant
- Non-destructive testing, such as x-ray inspection of welds
- Surface finishes
- Seal surfaces
- Functional/performance testing (application specific)

Once the assembly passes all internal inspections, and performance testing – if applicable, it is presented to the customer for buy- off. The customer will be provided with documentation and reports from the inspections and tests, and must approve that the custom fabrication meets all specifications. Assuming all goes well, the final assembly will be custom crated and shipped to the customer virtually anywhere around the world. Some level of disassembly will likely be required for the parts to travel safely. KTC is available for reassembly and testing support after delivery to achieve final acceptance.

The Precision Fabrication steps have been condensed into a general project flowchart for ease of reference. This flowchart highlights the main steps in the process that are common to all projects. Your individual project will likely require more detailed steps that aren't listed in this graphic.



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# ABOUT US

## Long History Built on Quality Performance

Keller Technology Corporation was founded in 1918 as the Duplex Buffing Machine Company–which offered custom and standardized buffing machines, as well as general machine shop services. The company grew as a general machine job shop servicing the local industries of metropolitan Buffalo, New York, and was renamed J & A Keller Machine Company, Inc. Over the next 40 years, the company grew both in size and capabilities providing machine assembly building and manufacturing services to customers located throughout the United States. Upon entering the ’80s, the name was changed to Keller Technology Corporation to reflect the company’s expanding global scope of operations and capabilities.

Presently operating from facilities in Buffalo, New York–Charlotte, North Carolina and affiliates in Daegu, South Korea–Keller Technology offers a range of Build-to-Print, Design & Build and Contract Manufacturing services for a wide variety of high-technology industries. Our corporate mission is focused upon total reliability, providing our customers quality performance, value, schedule adherence, and technical compliance. Keller Technology Corporation remains a family owned and managed corporation with fifth-generation participants, supported by a skilled and talented staff of professionals. Contact us to learn more about how we can help build your next custom machine.

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