

IN-HOUSE VS. OUTSOURCED HEAT TREATING

The Ultimate Guide



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DATAGINEERING AT WORK.

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EXECUTIVE SUMMARY

Is in-house or outsourced heat treating better for your operations? This is the single question asked by all manufacturers who require heat treating for their parts. And the truth is, there's no one-size-fits-all solution.

For OEMs and suppliers who already have equipment and are outgrowing their current capacity, there may be an urgent need to handle overflow. In this case, the question becomes, will the need for increased capacity last? How likely is ROI on your capital investment?

For those without an established in-house operation, on the other hand, there may be too many unknown factors to make an informed decision. Investing in your own furnace may seem like the more economical solution, but smart businesses will ask: What's the risk?

In this guide, we provide an unfiltered view of the costs of heat treating to help you make informed decisions for your company.

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PART 1

THE COSTS OF IN-HOUSE HEAT TREATING

Some of the costs of running your heat treating operations in house are obvious: capital expenditures of purchasing equipment, renting space, and hiring someone to run the furnace. However, there are many costs to in-house heat treating that aren't as apparent. And to make a smart business decision, all these factors should be considered.

We will cover several areas of commonly overlooked costs, including labor, technical expertise, support and maintenance, safety, insurance and depreciation, furnaces and auxiliary equipment, facilities, operations, and environmental concerns.

PART 2

BUILDING A RELIABLE TEAM

You may have already factored in the cost of hiring a furnace operator, but there are other professionals you will need to ensure the quality and accuracy of the heat treatment of your parts. Here's what you need to build a well-rounded heat treating team:

- Furnace Operator
- Supervision
- Metallurgical Support
- Mechanical Support
- Quality Control

In addition, hiring any employee comes with a slew of

not-so-obvious costs that extend well beyond their salary. According to the U.S. Small Business Administration, the true cost of an employee is typically 1.25 to 1.4 times their annual salary. You'll incur these costs in the form of benefits, training, and certifications, to name a few.

Metallurgical Expertise

Heat treatment isn't simply heating up and cooling off metal parts. Some cycles are complex, requiring extensive controls, monitoring, and problem solving. Today, most materials in use require specialized processes for optimal heat treating. If new materials are selected for your parts, it would be challenging to meet specifications without metallurgical support.

So, you'll be faced with a decision: can you afford to bring on the metallurgical support in house? Many manufacturing operations cannot justify the cost of a dedicated metallurgist. However, any commercial heat treater worth their salt will have a team of metallurgists and quality control professionals dedicated to the problem solving, monitoring, and adjustments we mentioned earlier.

Safety Awareness

It's no secret that heat treating operations comes with risks. Furnaces operate at temperatures higher than hazardous incinerators, and they are often full of explosive gasses in close quarters with thousands of gallons of oil. It would be a gross understatement to say that safe operation, strict compliance with operating procedures, and knowing how to respond to an emergency are critical.

The safety systems on your furnaces need to be tested and repaired regularly. Many repairs require expertise in dealing with high-voltage systems, and they must be performed within enclosed spaces.

When performing heat treating in your facility, a catastrophic failure is always a possibility. A heat treating accident can result in injuries, property damage, and even loss of life of your team members. Businesses that operate without a team of the proper heat treating experts are taking a huge gamble.

PART 3

THE MINIMUM COST OF LABOR

Say you're a manufacturer who operates 24/7 and runs furnace operations on all three shifts. What are the costs?

	Furnace Operators	Supervisors	Metallurgists/ Process Engineers	Mechanics	Quality Manager	Quality Control Techs
Base Pay for One Person	\$18/hr	\$72,000/yr	\$90,000/yr	\$28/hr	\$90,000/yr	\$18/hr
Base Pay for All Shifts Combined	\$108,000/yr (1st, 2nd, 3rd)	\$216,000/yr (1st, 2nd, 3rd)	\$90,000/yr (1st shift)	\$168,000/yr (1st, 2nd, and 3rd)	\$90,000/yr (1st shift)	\$72,000/yr (2nd and 3rd)
Actual Costs (Base Pay x 1.25)	\$135,000/yr	\$270,000/yr	\$112,500/yr	\$210,000/yr	\$112,500/yr	\$90,000/yr
Total Estimated Annual Cost of Labor*	\$930,000			<p>*This estimate is intended to illustrate the potential cost of a small in-house heat treating team. Labor rates will vary by location and size of your team.</p>		

PART 4

SUPPORT & MAINTENANCE

You have probably factored routine equipment maintenance into your budget for in-house heat treating, which is critical to your ability to produce repeatable results from your processing. Like any piece of manufacturing equipment, heat treating furnaces begin to wear and deteriorate from the moment they are put into operation.

You can count on repairs to refractory, replacement of high-temperature alloy components, and maintenance of electrical, hydraulic, and pneumatic systems, in addition to routine replacement and recalibration of sensors. Plus, as heat treating standards evolve and IT advances, control systems can become obsolete and require extensive updates.

As if all of this wasn't enough, truly effective heat treating requires support beyond furnace maintenance. You'll need plant engineers for equipment upgrades and improvements and equipment calibration services to make necessary adjustments, along with the storage space and budget to keep spare parts on hand. And when you're unable to achieve the results you need, you have to be prepared to bring in outside consultants to help adjust your process and keep pace with production.



\$1,500 FEE + \$200/HOUR
cost for outsourced testing

\$100,000+ AVERAGE COST
of furnace rebuild

PART 5

OPERATIONAL COSTS

You know furnaces don't run for free, but energy costs are only the beginning of what it takes to run them. Other costs to consider include:

- Atmosphere gasses
- Quench oil
- Cleaners
- Equipment overhaul
- Parts
- Quality control supplies
- Rework and spoilage
- Material handling
- Personal protective equipment

Furnaces & Auxiliary Equipment

Heat treating furnaces are rarely standalone pieces of equipment. Usually, they require support equipment for material handling and loading, water or air-cooled cooling systems for quenchants, and storage facilities for quenchants. You'll also need to consider atmosphere generators and/or bulk gas storage solutions for nitrogen, argon, hydrogen, or other gasses used for atmosphere and gas quenching. Finally, most parts also require pre- and post-cleaning for a complete heat treating process.

Average footprint of equipment for common furnace configurations:

- Vacuum + Cooling \approx 500 ft² / furnace
- Belt Furnace \approx 2,500 ft² / furnace
- IQ Furnace + Oil Cooler \approx 265 ft² / furnace
- Temper \approx 65 ft² / furnace

By using valuable plant space for heat treating, you may be incurring opportunity costs. If you could replace your heat treating equipment with another machine tool, what would that mean for your capabilities, efficiency, and throughput?

Facilities

Facility-related costs of in-house heat treatment don't stop at the floor space required for equipment or storage costs for materials. Heat treating in house leads to facilities management challenges. Furnaces run hot and dirty, which can cause deterioration of ceilings, floors, and walls. Within your ventilation systems, deterioration can begin to occur quickly if you are constantly running furnaces.

PART 6

ENVIRONMENTAL FEES

Waste oil disposal, quench oil spill cleanup, and facility air quality permits and fees should be expected expenses in heat treating operations. If you've been heat treating for some time, then past years can be used as benchmarks to plan for future expenses. What's also important to consider is your organization's disaster plan or what may happen in the event of environmental contamination originating from your facility.

Environmental Contamination Can Have Disastrous Results

One gallon of refined oil lubricant can contaminate 100,000 gallons of groundwater.

\$25,000 per day fine for negligently discharging oil or hazardous substances into bodies of water or drinking sources in the U.S.

Standards, Certifications, & Audits

Heat treating requires more than getting the processing right to yield parts that meet specifications. Whether in-house or outsourced, heat treating teams are responsible for meeting more than 30 form completion deadlines for 12 regulations in order to remain compliant with government heat treating standards.

These regulations include OSHA's Hazard Communication Standard and the EPA's regulations regarding used oil,

underground storage tanks and water treatment, RCRA small quantity generators, and the Clean Air Act. There are also standards governing confined space entry, hazardous material handling, equipment lockout/tagout, emergency response, and plant air quality.

Maintaining compliance with these complex regulations and certifications can be a full-time job. And once you earn the required certifications and comply with standards, you must maintain them.

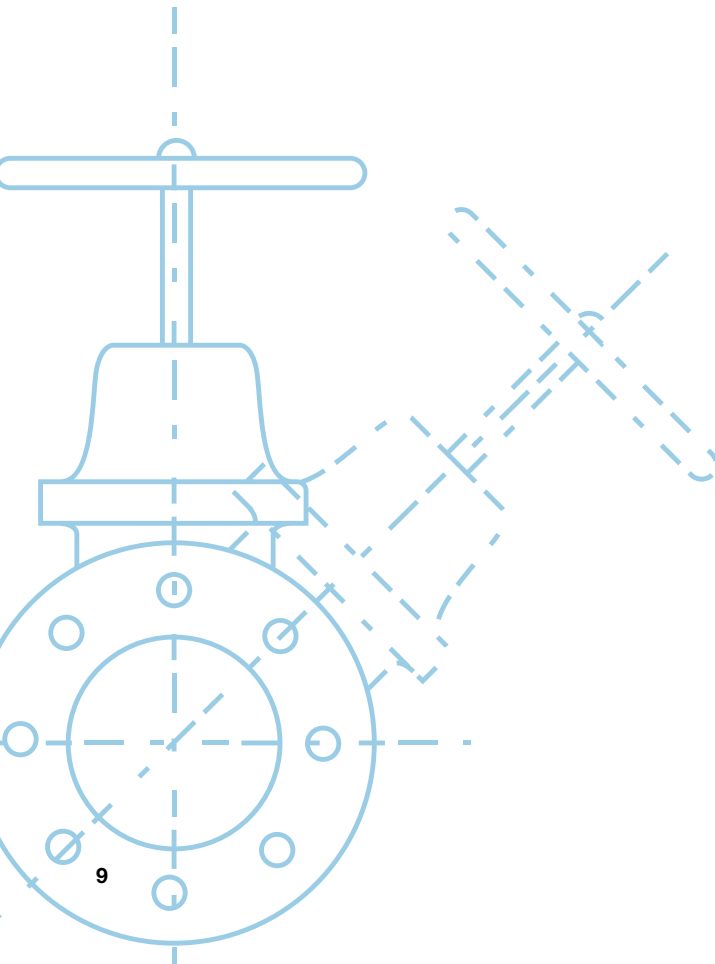
PART 7

THE OUTSOURCED ADVANTAGE

All of the costs and regulatory complexity associated with in-house heat treating can drain your financial resources and distract you from continuous improvement, innovation, and customer service.

For business owners who have already made investments in in-house heat treating, making the switch to outsourcing allows them to:

- Focus on their core business
- Distance themselves from complicated regulations
- Sell heat treating equipment
- Reduce capital expenditures
- Reduce operations costs
- Mitigate the risk of environmental accidents
- Simplify their maintenance program



Without in-house heat treating draining resources, companies who outsource are left with more time to focus on the core purpose of their businesses. Strategic heat treating partnerships can be a huge competitive advantage, no matter your industry.

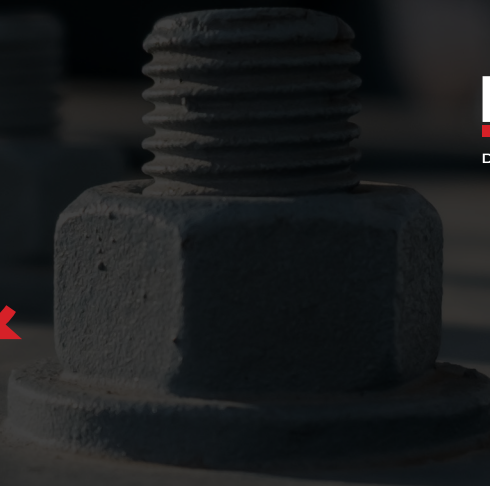
Expanded Capabilities and Equipment Variety

One key benefit of working with a commercial heat treater is having access to a wide range of processes and metallurgical expertise. Commercial partners are able to invest in more equipment and larger teams while still being able to operate efficiently and accurately.

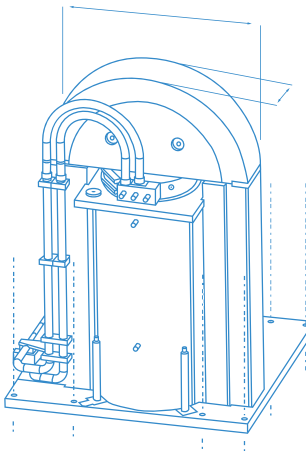
50+ NADCAP
Furnaces



PAULO'S EQUIPMENT & CAPABILITIES



Hot Isostatic Press



Max Working Area Size:

- 24.5"W x 68"H

Max Capacity:

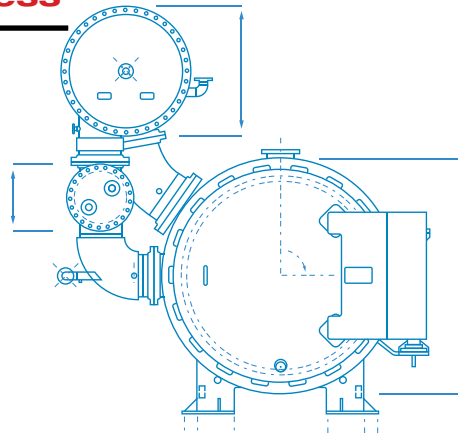
- 4,409 lbs

Temperature:

- 2,552 °F

Atmosphere:

- Argon



Vacuum Furnace

Max Working Area Size:

- 72"L x 30"W x 36"H

Max Capacity:

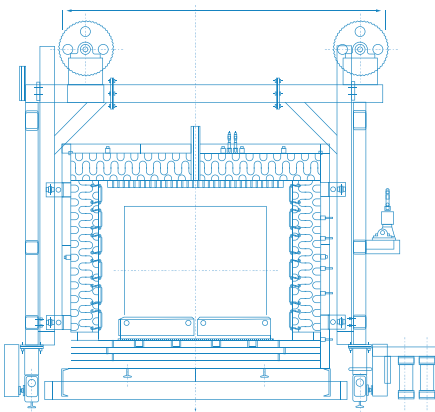
- 8,000 lbs

Temperature:

- 300 - 2,500 °F

Atmosphere:

- Nitrogen/Argon



Air Furnace

Max Working Area Size:

- 62"L x 48"W x 48"H

Max Capacity:

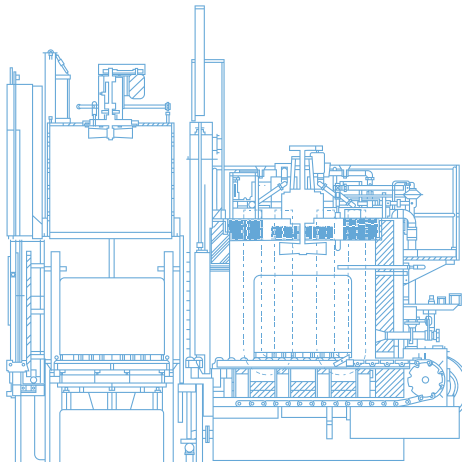
- 4,000 lbs

Temperature:

- 1,250 - 2,250 °F

Atmosphere:

- Air



Integral Quench Furnace

Max Working Area Size:

- 48"L x 43.5"W x 38"H

Max Capacity:

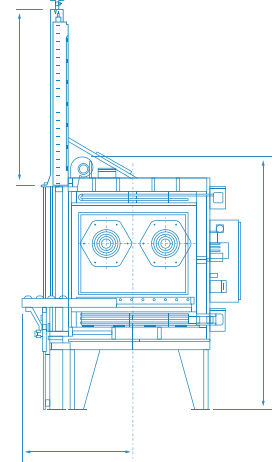
- 3,500 lbs

Temperature:

- 900 - 1,750 °F

Atmosphere:

- Endothermic Gas



Cryogenic Deep Freeze

Max Working Area Size:

- 48"L x 36"W x 36"H

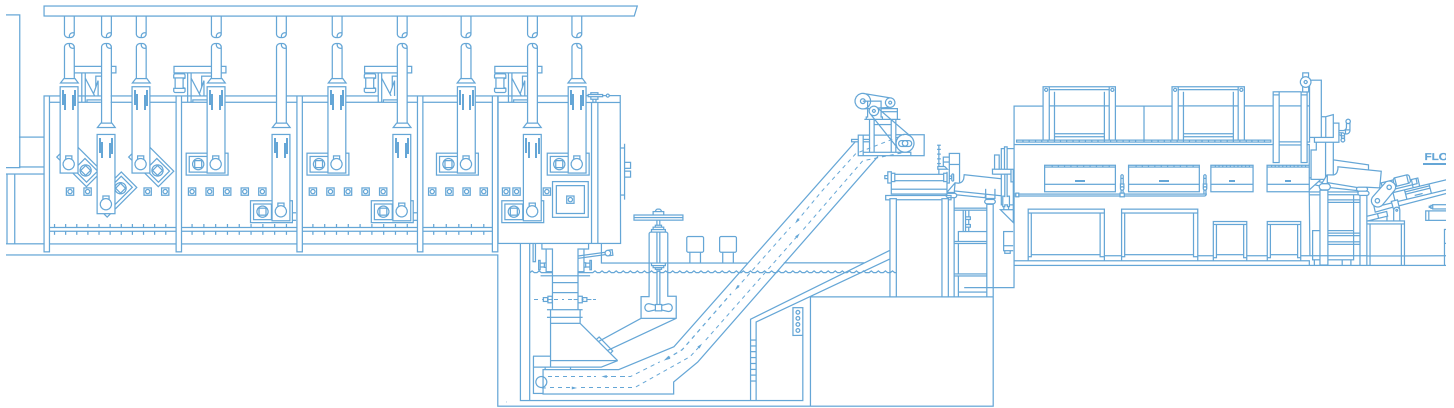
Max Capacity:

- 8,000 lbs

Temperature:

- -300 °F

PAULO'S EQUIPMENT & CAPABILITIES



Continuous Belt Furnace

- | | |
|-------------------------------|---------------------|
| Max Working Area Size: | Temperature: |
| - 60"W x 6"H | - 1,450 - 1,750 °F |
| Max Capacity: | Atmosphere: |
| - 4,250 lbs/hr | - Endothermic Gas |

Continuous Austemper Furnace (Salt Quench)

- | | |
|-------------------------------|---------------------|
| Max Working Area Size: | Temperature: |
| - 60"W x 6"H | - 585 - 1,650 °F |
| Max Capacity: | Atmosphere: |
| - 3,000 lbs/hr | - Endothermic Gas |

Capabilities

Heat Treating

- | | |
|--|---------------------------|
| - Annealing | - Precipitation Hardening |
| - Austempering | - Solution Treating |
| - Carburizing and Case Hardening Solutions | - Stress Relieving |
| - Carbonitriding | - Through Hardening |
| - Cryogenic & Deep Freezing | - Vacuum Heat Treating |
| - Ferritic Nitrocarburizing | - Vacuum Nitriding |
| - Flattening & Straightening | |
| - Gas Nitriding | |
| - Martempering | |

Brazing

- Hydrogen Brazing
- Screenprint Brazing
- Vacuum Furnace Brazing

Metal Finishing

- Black Oxide Coating
- Blasting
- Zinc Phosphating
- Zinc Plating

PART 8

SMART HEAT TREATING PARTNERSHIPS

Experienced heat treating companies have undergone and planned for all of the contingencies outlined in this guide. Because heat treating is their core business, they are usually better equipped to handle all aspects of running a successful heat treating operation.

Expenditures for the gas, electricity, environmental compliance, labor, maintenance, and replacement parts are incurred above and beyond your usual operations cost when you perform heat treating in house. However, these costs represent the core of the business for commercial heat treating companies, so they are able to optimize their processes better than in-house operators. In addition, heat treating companies can run furnaces at full loads for long periods of time, offering a more economical alternative for companies with a small or fluctuating part volume.

Automation and Quality Control

Another critical benefit of working with some commercial heat treaters is automation and quality control. Advanced heat treating partners will make investments in technology to make their processes more accurate and efficient than ever—which equates to shorter lead times without compromising quality.

At Paulo, we've made significant advances in the world of heat treating to provide unparalleled efficiency, accuracy, and visibility to our customers. Our proprietary technology automatically controls and regulates our furnaces according to your parts' recipes, significantly reducing the chance of human error.

Advanced Data Collection

A good heat treater will also go well beyond standard requirements in the rate at which processes are being monitored. For example, AMS2750E requires that measurements are taken at least 6 times per cycle with no longer than 15 minutes elapsing between measurements. At Paulo, that's nowhere close to enough for us or for our customers. We take measurements at least every 15 seconds (and every single second in some applications) for every process we run at Paulo to give our quality team members and our customers complete visibility—and the assurance that their parts were run according to their exact specifications.

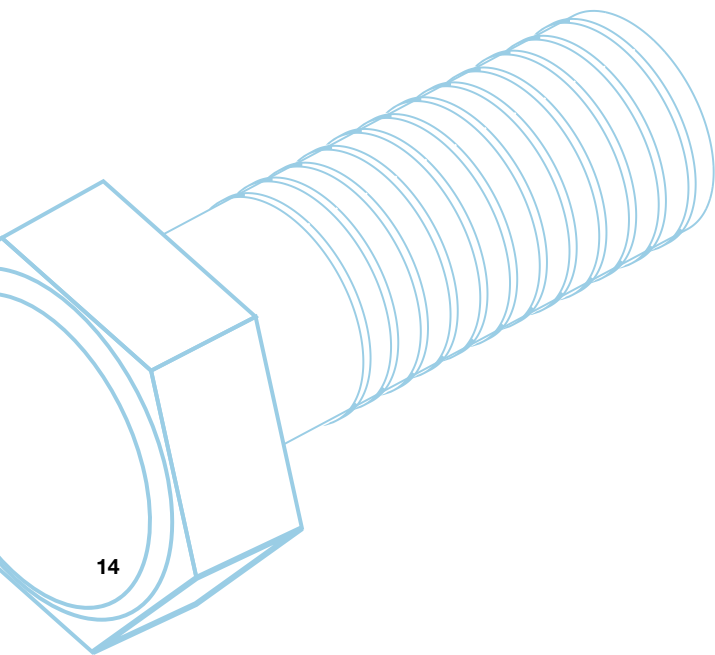
We've also found that advanced data collection paired with a collaborative partnership opens the door for unparalleled paths for R&D projects when proving new specs and translating them into efficient production models. Our metallurgical team has a long history of working closely with aerospace and automotive OEMs to bring new innovations to life in a relatively short period of time.

Contingency Planning

While a heat treater's range of process capabilities and certifications are critical qualifiers when looking for a partner to trust with your parts, it's also important to consider what systems they have in place to adapt to your needs.

- These are questions you should be asking commercial heat treaters before you partner with them:
- How quickly can you get new approvals?
- How quickly can you take emergency orders?
- Can you rapidly scale up to keep pace with fluctuating production?

Contingency planning is an important aspect of the partnerships we form at Paulo. No matter how many projects we take on, we ensure that we have the systems in place and the capacity to handle emergency runs or overflow orders.



ADVANCED HEAT TREATING, AT THE READY

We maintain a wide range of certifications and approvals to be there when OEMs and tiered suppliers need us most. And if we don't have the approval you require, we have the systems in place to quickly obtain them. Included here is a partial list of our current [certifications and approvals](#).

Certifications

CQI-9



Approvals

- Boeing
- Toyota
- Tesla
- Rolls Royce
- Pratt & Whitney
- Lockheed Martin
- Honeywell
- Honda
- GM
- Gulfstream
- GE Energy
- GE Aviation
- Ford
- Deere
- Cessna
- Blue Origin

TRUST YOUR PARTS TO PAULO

With a large network of experienced metallurgists and heat treating experts and advanced heat cycle data capabilities, we're prepared to help you maximize your in-house productivity and the quality of your parts.

Connect with a Paulo expert today to start a quote and launch your next heat treating project.

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