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# THE SOLAR SPOTLIGHT



A QUARTERLY PUBLICATION BY SOLAR ATMOSPHERES

## AVOIDING THE HORNET'S NEST



The CF-18 Hornet fighter is being modernized to extend its usefulness to 2017.

Solar Atmospheres of Western Pennsylvania took on a challenge from Magellan Aerospace, Mississauga, Canada.

The all titanium afterburner casing for the CF18 Hornet Fighter (*G.E. F404 Engine*) is at a stage of its manufacturing where it requires vacuum thermal stress relieving. However, the casing must be thermally processed in the vertical position (60" tall and 40" diameter) to minimize distortion. The vacuum chamber must be very clean and be capable of deep vacuum levels

( $1 \times 10^{-6}$  torr or lower) to minimize discoloration and alpha case. Before Solar came alongside Megellan, these requirements proved to be a challenge.

Meticulous planning between Magellan and Solar took place before the casing left Magellan's load dock, such as:

1. How was the material machined? (oil or water based coolants)
2. How will the part be cleaned?
3. Approval of Solar Atmospheres thermal cycle.
4. Packaging to prevent the part from getting dirty on its trip to Solar.

The results of the 20-hour plus process were very successful. The casing remained light bright and stayed dimensionally stable.

These communications demonstrate the value of proper planning for cycle development and furnace preparation. Consequently, both companies' goals were achieved.

Mike Johnson, Sales Manager, Solar Atmospheres, Western PA

## 36 FOOT FURNACE INSTALLED

Since the start of Solar Atmospheres of Western PA seven years ago, the constant expansion and development of the plant has fallen on the shoulders of Bob Sandora, Vice President of Operations. Bob would be the first to say what has become an annual installation of furnaces and biannual building expansion is a team effort, with all hands on deck. However, the facilitation and coordination of all activities largely comes out of his office.

The constant stream of projects, including initial plant start-up, two plant additions, new office building, numerous furnace installations (including three 24 foot furnaces and the new 36 foot furnace) is only the beginning of the work. Each new furnace and each plant addition comes with a new list of on-going building and maintenance projects. This kind of work is not for the faint-of-heart or those short on endurance.

The latest project, the new 36 foot Solar Manufacturing furnace, now has the title of "World's Largest Commercial Vacuum Furnace." Adding one more 12-foot section to the 24 foot design has made this production

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**SOLAR**  
ATMOSPHERES



## FURNACE INSTALLED

*continued from page one*

furnace a unique tool for the metal working industries. Using Solar's patented car loading design, the double door furnace not only has the capacity to provide quick turnaround, loading one truck while the other is in the furnace, but can handle 150,000 lbs. on the 36 foot hearth.

Bob oversaw the building of a separate, but connected building to house the new furnace. Totalling 20,000 square feet (100 x 200 feet), the new building has a 24-inch-thick reinforced concrete floor under the large furnace and 36 foot long load trucks. With its own transformer and water and helium recovery system, the addition will be able to operate efficiently and somewhat independently from the rest of the 65,000 square foot plant and offices.

Processes done in the new furnaces include stress relieving, annealing, degassing, hydriding, solution treating and aging, homogenizing, vacuum creep forming and plastic forming. If anyone has a 36 foot assembly to braze, now it's possible!

## QUALITY APPROVALS ON-LINE

Quality Approvals are available on Solar's web site. Go to [www.solaratm.com](http://www.solaratm.com) and click on Quality System and then on the approval you need to examine.

Customer approvals available for Eastern and Western PA include: ISO 9001-2000 / AS9100-2004, Boeing, GEAE, GE Aviation, Rolls Royce, Pratt Whitney, Lockheed Martin, Howmet Castings, Northrop Grumman, Aircraft Braking Systems.

## SUSTAINING 5-S

Eight months ago, Solar Atmospheres started implementing the intensive lean manufacturing concept of Five-S, which encompassed both our Souderton and Hermitage, PA locations. Five-S concepts embrace simple visual techniques that help improve quality, scheduling, productivity and safety. The Five-S System is a series of activities designed to improve workplace organization and standardization, with the goal of reducing waste in all aspects of the operations. These activities are described as follows:

**Sort** all the tools, items, etc., in the work area, and sort out all unneeded items.

**Set** in order the remaining items; set limits; create temporary location indicators.

**Shine** and inspect - through cleaning.

**Standardize** by implementing visual displays and controls.

**Sustain** the gains through self-discipline, training, communication and total employee involvement.

To sustain the value of this program, all Solar employees are encouraged to be vigilant every day for ongoing improvements. At every level within the company, all employees must remind themselves and those around them to maintain the improvements and to identify and implement further improvements. The following are a few practical ways to sustain what has been accomplished and to progress further:

*Take 10 minutes near the end of each day to clean and reorganize work areas.*

*On a periodic basis identify and plan the implementation for further improvement of the work areas.*

*Discuss your improvement ideas with co-workers and supervisors for consensus in developing an implementation plan.*

Five-S also needs to be discussed at shift change meetings, management meetings and other communication forums to keep this new culture "evergreen" as we perform our work.

Ken Bauhof, Vice President of Special Projects

*"Sustaining" through tool placement on shadow-board*



## Carburizing Application

In November, Solar Atmospheres hosted an educational seminar on the advancements and benefits of vacuum carburizing with high pressure gas quenching. One attendee, Chalmers & Kubeck, Aston, PA, was convinced Solar's vacuum carburizing knowledge and experience would add significant value to their customers' parts.

Chalmers & Kubeck (C&K) is one of the nation's largest independently owned contract manufacturers for customized equipment. They specialize in CNC manufacturing, engineering services, repair, and maintenance for a wide variety of industries. Their gear division builds and repairs gears and gear drives.

The picture (page five) is a sun pinion manufactured by from AISI 4320 material by C&K. The sun pinion is part of a planetary speed increaser that connects a low speed water wheel to an electric generator for a hydro-electric plant in South Carolina.

The construction of the dam dates to the early 1800's, when a water wheel provided mechanical power for driving machinery in a textile mill. Today, a new water wheel (called a "runner") and the addition of the planetary drive produce the necessary speed to power an electric generator.

*continued on page five*

# VACUUM — PART I

## What Is It, Why Do We Use It ?

An employee who understands the “big picture” has a greater appreciation of how they contribute to the success of their organization. Understanding generally improves motivation and can thereby improve productivity and quality. If there is one subject that contributes to the big picture of what Solar does, it is “vacuum”. Consequently, Mike Moyer, Corporate Quality Manager, has been giving all employees an educational talk on *vacuum* to provide understanding and appreciation for the uniqueness of the services provided by Solar Atmospheres.

### *Vacuum...What is it?*

Making the point that vacuum and atmospheric pressure help define each other, Mike referenced the textbook definition of vacuum which is “a region of space in which the pressure is significantly less than atmospheric pressure.” The breadth of such a definition hints at the unachievable nature of a “perfect” vacuum, outside of theory. “Vacuum,” thus, is a fairly “loose” term used to describe a particular type of *pressure*. Solar’s furnaces utilize an efficient, multi-stage pumping system, lowering the pressure to significantly below atmospheric pressure, thus they are “vacuum furnaces.”

### *Vacuum...Why Do We Use It?*

When heat treating metals, if air is present in significant volume it has a con-

taminating effect on the metals. Therefore, the atmosphere in the furnace needs to be controlled during high-temperature processing. Air contains about 78% nitrogen and about 21% oxygen, and both gases have undesirable reactions with most metals when heated high above ambient temperature. Oxygen causes OXIDATION, and nitrogen causes NITRIDIZATION (also known as nitriding).

Vacuum furnaces reduce the pressure of the furnace atmosphere, thereby reducing the potential to realize oxidation and nitriding. A simple form of oxidation is one that we all know - rust on steel. Oxidation is a process in which a substance loses electrons to oxygen. Generally, the higher the temperature the more readily this happens. Severe oxidation of steel results in a loss of carbon from the surface of the steel which can result in a poor quality part, and potential failure in service. This is a fairly common problem in other types of heat treatment.

It is nearly impossible, however, to unintentionally decarburize steel in a vacuum-controlled low-pressure environment, as there is insufficient oxygen to steal electrons from the material. Sometimes oxidation is beneficial for anodizing aluminum or steam treating of steel, but most of the time it is detrimental as in decarburization of steel and alpha



case on titanium. Nitrogen is the other contaminant that can cause unwanted metallurgical changes. At elevated temperatures the nitrogen in the air reacts with certain metals, forming surface nitrides. Nitriding may be done on purpose as in the durable titanium-nitride coating found on steel drill bits, but that requires a carefully controlled process. Accidental nitriding from air is undesirable; it may form a very hard, brittle surface layer, especially on titanium parts.

So the benefits are obvious: control the air to control oxidation and nitriding, and lowering the pressure into a vacuum is the best way to effectively control the air. The next Spotlight will feature Part Two in this series on vacuum, *How Do We Measure It?*

*Mike Moyer, Corporate Quality Manager*

## Technology Update

The Solar Technology Group continues to pursue new and improved vacuum heat treating processes.

As the low torr carburizing production process brings in steady customers, the technology team continues to investigate its application to high tech specialty alloys and P/M materials.

We recently reported our studies on low torr gas nitriding and on the hydriding and dehydriding of refractory metals at a major trade conference, and are currently working on gas nitriding and solution nitriding as new production processes.



*Solar laboratory furnace*

The Solar technology team – consisting of a Ph.D. metallurgist, corporate metallurgist, Ph.D. chemist, and an electrical / mechanical engineer – offer unique perspectives on vacuum heat treating processes and their effect on the metallurgical properties of metal parts and powders. The team frequently works closely with existing and new customers to help improve or develop heat treating processes to meet customer specifications.

With the availability of two state-of-the-art R&D lab furnaces, process development can be accomplished prior to running full production loads. Analysis of metallurgical characteristics is routinely done in Solar’s state-of-the-art metallurgy laboratory.

# METAL TREATING INSTITUTE



On Monday February 25<sup>th</sup>, Solar Atmospheres of Western Pennsylvania, Hermitage, PA hosted a facility tour dedicated to vacuum heat treating for the Metal Treating Institute (MTI), Y.E.S. students. MTI is the national heat treating association of almost 300 companies (see mission statement). YES, Young Executive Series, is a management program developed by MTI for their members' management personnel.

The group was able to tour the entire facility consisting of 12 vacuum furnaces running full production cycles. Pictured is the entire group standing in front of the latest furnace addition. The vacuum furnace is a 36' long, car bottom loading with 150,000 lb. pay load capacity. It is currently being installed in a

new 20,000 square foot addition to the Solar plant. It will be fully operational May, 2008.

Student and company affiliations represented were: Barry Faulkner, Aberfoyle Heat Treating; Frank Scully, General Metal Treating; John Ochenas III, Geo Corp.; Jason Deibel, Heat Treating Technologies; Jason Witten, Heat Treating Technologies; Gary Lopus, Penna Flame Industries; David Rodgers, Thermal Dynamic Services; Sean Driscoll, Thermal Vac Technologies; Tom Morrison, Metal Treating Institute.

Tour guides from Solar Atmospheres of Western Pennsylvania were Bob Sandora, Vice President of Operations, Kevin Bekelja, General Manager, and Mike Johnson, Sales Manager. Representing Solar Atmospheres, Souderton, Pennsylvania were Roger A. Jones, Corporate President, and Jamie A. Jones, General Manager. ✨

## MTI Mission

**To enhance and improve the productivity and profitability of the heat treating industry.**

## Mission

*The Mission of Solar Atmospheres is to add significant value to our customer's operations by thermally treating parts, principally in a vacuum environment, with an unwavering commitment to honesty in all relationships.*

*We will strive to fulfill this mission while...*

- ◆ *performing our work with an emphasis on quality and responsiveness*
- ◆ *Operating with an awareness and appreciation of the value of our customer's parts while in our care*
- ◆ *Forever looking "forward" in the area of technical capabilities*
- ◆ *Demonstrating a willingness to "accept the challenge"*
- ◆ *Providing and maintaining a work environment that is safe, clean and reflects our respect for human dignity.*
- ◆ *Providing our employees with an opportunity for personal growth, challenge and reward*
- ◆ *Maintaining a workplace that is environmentally friendly*
- ◆ *Sustaining long-term growth and profitability*

## HEAVY LOADS

Big weldments often come through the doors at Solar. Eastern PA recently heat treated two 4140 (chromium molybdenum) steel weldments, each weighing 11,000 lbs. Using a 12-foot-long horizontal loading Solar Manufacturing furnace, with a 50,000 lb. capacity, Solar normalized and tempered the weldments to achieve specific yield strength, while minimizing distortion through controlled heating and cooling.

The weldments measured 54 x 34 x 84 inches, with section thicknesses ranging from 2 to 6 inches. The configuration required vacuum thermal processing in order to prevent structural cracking. Critical to this goal, Solar strategically placed six workload thermocouples in the various weldment sections. Uniform heat treating of the



large part was accomplished with strategically planned pre-heat steps, a uniform soak at temperature, and a controlled 2 bar quench.

Tri Kris Fabrication, Lansdale, PA, was very pleased with the heat treating and will pro-

cess more weldments of this type at Solar. The part is a component in a large tensile testing machine that tests braided steel cable for shipbuilding applications.

A furnace listing from laboratory sized to Solar's large load truck furnace can be found on the web site under heat treating with a click on the side bar. For any further questions, contact sales at either Solar plant. ✨

*"It 's easy to have faith in yourself and have discipline when you're a winner, when you're number one. What you've got to have is faith and discipline when you're not yet a winner." Vince Lombardi*

# Tanks for Space

Two years ago, the *Spotlight* reported that tanks used for space were heat treated at Solar. This type of work continues, but with different materials and for larger tanks. Since repair trips are not usually an option, space technology requires manufacturing and processing expertise. Solar Atmospheres, Souderton, was able to respond to the processing requirements of space tank manufacturer ARDE of Norwood, NJ. ARDE has manufactured over 4000 spaceflight and missile tanks and required heat treating capabilities to improve production and meet metallurgical specifications destined for space.

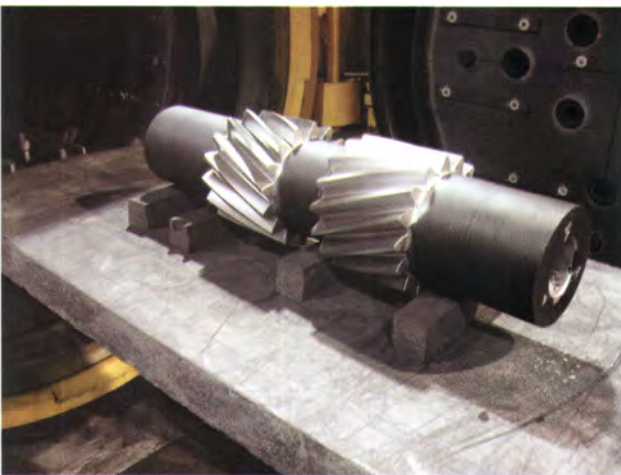
Several heat treating challenges made Solar a preferred vendor. The tank size required large vacuum furnaces and a very controlled quenching rate. Solar's heat treating cycles have been developed and standardized to solution anneal and age harden ARDE's Inconel tanks. For another application, aluminum (6061) thin-walled tanks were solution treated with a 6-bar helium quench. The material is normally water quenched, but these tanks would float if water quenched.

With tanks ranging in size up to 5 feet long with a 40 inch diameter, Solar's large vacuum furnaces (now up to 36 foot long) enable multiple tank processing. The processing cycle exceeds 20 hours in length, so the large furnaces provide excellent turnaround and processing efficiency.



To attain metallurgical specifications (AMS 2774), vacuum heat treating provided precise temperature and quenching to solution anneal and age harden the Inconel tanks. The technical challenge is to quench and not crush the thin-walled tanks because of pressure differentials in the chamber and cylinder. An influx of argon gas must be carefully controlled because the cylinders have a small orifice that restricts the ability of the vessel to equalize with the surrounding pressure. Controlling of the gas influx can be done manually, but Solar managers developed an automated system to guarantee consistency and mistake-proof the process. ✨

## CARBURIZING APPLICATION



*Vacuum carburized, post process, sun pinion gear*

*continued from page*

The 225 lb. pinion, needs selective carburizing, so a stop-off paint was applied to the shaft in order to prevent carbon diffusion, or carburizing on the shaft surface, enabling further machining. The paint is seen as the black substance on the post-process gear.

The requirements for the gear were 0.090" – 0.110" effective case depth and a surface hardness requirement of 58-62 HRC. Vacuum carburizing with higher temperatures reduces furnace time for the deep case depth, as compared to the lower temperatures in traditional atmosphere carburizing. The vacuum carburizing process also improves the root to pitch ratio to approximately 90% over the estimated 60% for atmosphere furnaces. The finished properties of the gear met Chalmers & Kubeck's requirements with improvement on distortion and overall quality. ✨

The Solar Spotlight is a quarterly publication of Solar Atmospheres

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“Anyone who says businessmen deal in facts, not fiction, has never read old five-year projections.”

Malcolm Forbes

## Upcoming Trade Shows

**EASTEC**  
ADVANCED PRODUCTIVITY EXPOSITION

Eastern States Exposition Center  
May 20-22, Springfield, MA  
Booth # 2100

Aeromat Exposition  
June 24 - 25, 2008  
Austin Convention Center  
Austin, Texas USA  
Booth #311



**POWERMET '08**  
June 8-12  
Washington DC  
Booth #



For a 2008 show listing,  
go to [www.solaratm.com](http://www.solaratm.com).  
and visit *Upcoming Events*