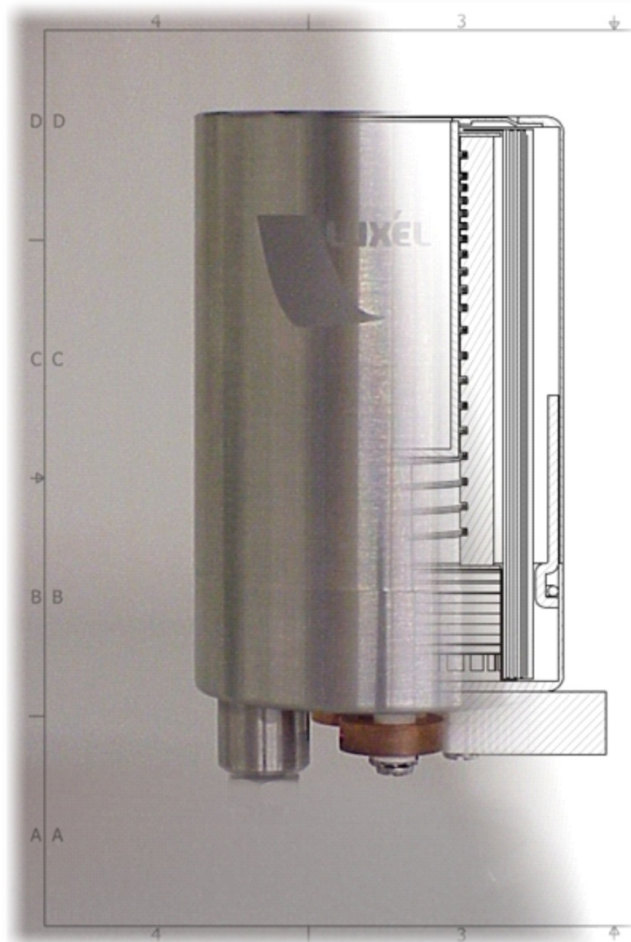
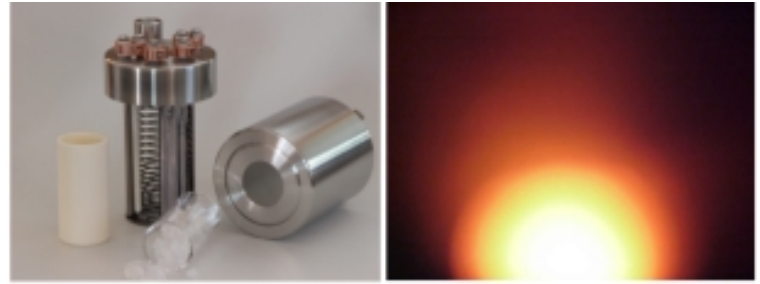


## **RADAK Furnace Installation and Operation Instructions**





## Installation

Thank you for your purchase of the RADAK vacuum evaporation furnace. To obtain the best results, we suggest the following points be observed.

1. Bolt the furnace in place using a ¼ -20 bolt in the mount coupling on the base. The evaporator should be mounted firmly enough so that the support does not change with attaching and removing the cover. This assures a consistent vapor distribution pattern. Excessive torque on the coupling should be avoided.
2. The furnace has been designed to function in any position. For evaporative use, mount may vary from vertical to horizontal as may be required for vapor distribution and retention of the evaporant. Downward evaporation of some material is possible through a special crucible insert. Luxel can assist you in designing a screen for retaining a sublimable material for horizontal evaporation.
3. RADAK furnaces have low voltage requirements compared to most evaporative sources. A 30A/40 VAC power supply is adequate. The furnace is also compatible with a 110 VAC source with a 4:1 step down transformer. Power connection between vacuum system feedthroughs and the furnace may be made with 10 AWG copper wire (Figure 2). Setscrews at the side of the base power terminals require a .062" (1/16") Allen wrench. *When inserting the power lead, take care to ensure the power lead does not extend far enough through the power terminal to make contact with the furnace body.*

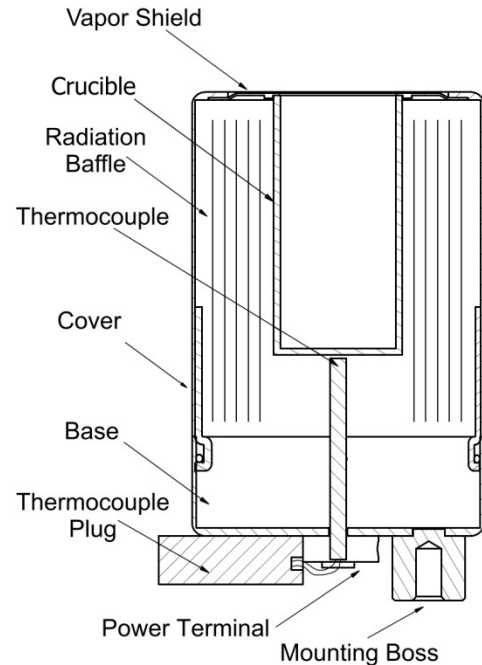


Figure 1 RADAK nomenclature.

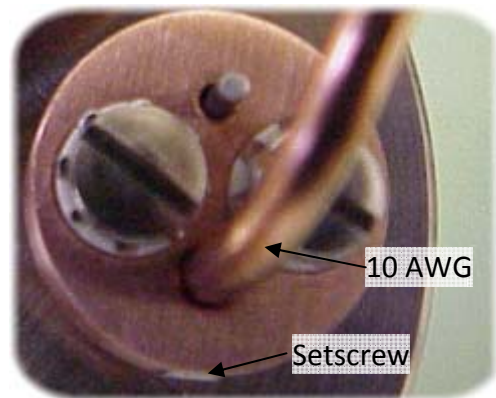
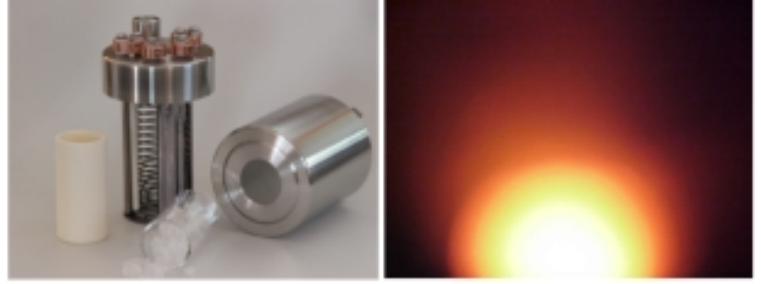


Figure 2 Power terminal connection.



4. At the vacuum chamber interface, outside of the vacuum chamber, verify proper installation by measuring continuity between the power terminals and ensure that no continuity exists between the power terminals and ground or between the power terminals and the thermocouple terminals.
5. The majority of installation problems involve the thermocouple/ thermocouple lead wire. Improper thermocouple installation can easily lead to furnace over temperature and can render the furnace unreliable or inoperable. Do not allow the lead wires to touch the furnace base, power lead wires, or each other. Ensure that the positive lead wire connects to the positive terminal and that the negative wire is connected to the negative terminal. Proper thermocouple polarity can be verified by directing a heat source such as a lamp or hot air gun on the thermocouple and observing a corresponding temperature increase on the attached controller readout. A decrease in temperature readout means the thermocouple circuit polarity has been reversed and the entire circuit should be re-checked and the problem corrected. Note: Never apply power to the furnace without first evacuating all reactive gasses.
6. Please be aware that the thermocouple junction in your RADAK furnace is extremely delicate. To prevent damage to the thermocouple junction, care must be taken to not twist the thermocouple when installing the cover.
7. To insert the crucible, remove the outer furnace cover by twisting counterclockwise (1) and lifting (2). Center the crucible in the furnace and insert until it's supported by the thermocouple (3). Align the top with the base, gently press down (4) and twist clockwise to engage the locking tines (5). When replacing the cover, check that the crucible is

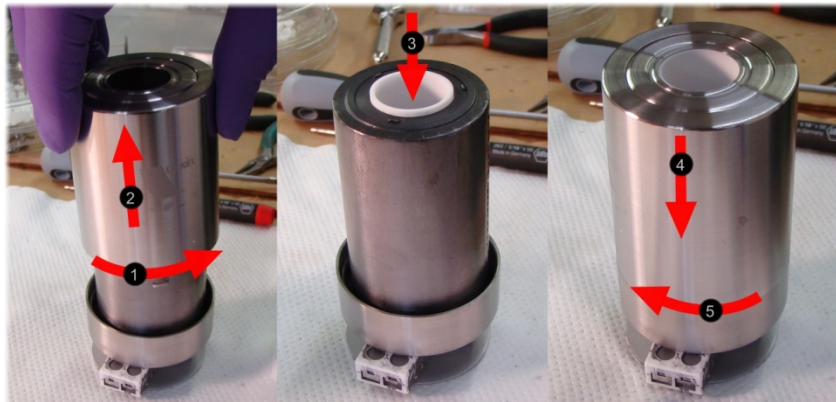
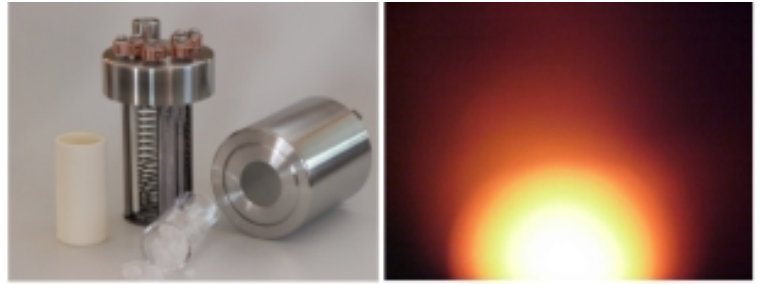


Figure 3 To replace the crucible, remove the outer cover, insert the new crucible, and re-install the outer cover.



centered with the molybdenum vapor shield to effect a proper seal. The crucibles are supported on a spring-loaded thermocouple and the crucible height is critical for making this seal. Crucibles with chipped or broken edges should be discarded.

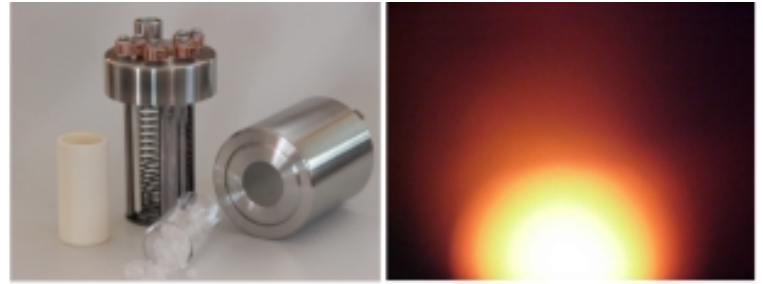
8. The furnace may be operated with the crucible nearly full of sublimable materials in the form of pellets or chunks. During an evaporation at constant power or temperature, the vapor distribution and rate will change with depletion. Best results for evaporation of chemical compounds are achieved with the crucible about half-full and depletions down to about one sixth full. Evaporations where vapor qualities such as dissociation, varying rate, or vapor temperature are not a factor can be carried to completion without any other consideration.
9. Few problems have been encountered with materials that sublime or materials with little structural strength, such as most salts. Special care must be taken when evaporating molten metals. Molten metals may be evaporated but if the residual charge is too large, the alumina crucible may be cracked upon reheating due to the difference in expansion coefficients. Luxel produces a line of crucible liners for molten metal evaporation and we encourage you to use one. Due to aluminum's super-wetting of crucibles, aluminum should not be evaporated from a RADAK except via a Luxel Al-Evap<sup>TM</sup> crucible. Molten aluminum will creep up the crucible, through the vapor shield, and attack the furnace interior. Damage caused by evaporation of aluminum, other than from an Al-Evap<sup>TM</sup> crucible is outside of the RADAK warranty. Please refer to our Crucible Selection Data Sheet for information on available crucibles and liners.

## Cleaning

The furnace is made of low-outgassing high-temperature materials. The furnace body is stainless steel with a molybdenum vapor shield. The interior is tantalum, molybdenum, tungsten, and high purity alumina. Cleaning, when necessary, should be restricted to the stainless-molybdenum cover and the alumina crucible. Cleaning methods will depend on the material to be removed, but acids, bases, and scouring materials, which do not strongly attack stainless, molybdenum, or alumina can be used. Cleaning of the multi-layer radiation baffle is not recommended beyond ultrasonic cleaning in hot water, followed by a rinse in clean solvent such as distilled isopropyl alcohol, to remove any water trapped in the multi-layer structure, followed by oven drying.



## RADAK Furnace Installation and Operation Instructions

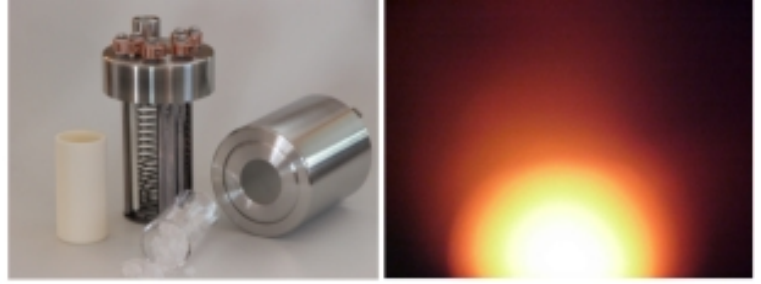


A word of caution about using acids to clean the furnace cover. The molybdenum vapor shield will be quickly attacked by most acids, therefore exposure to acid should be minimized. To remove the brownish oxide created by acid exposure, a quick immersion in  $\text{H}_2\text{O}_2:\text{NH}_4\text{OH}$ , 1;1, ( $\text{H}_2\text{O}_2$  is 35%,  $\text{NH}_4\text{OH}$  is 28-30% as  $\text{NH}_3$ ) will work.

### **WARNING**

Damage may result if RADAK furnaces are operated in excess of 40 volts to ground while at temperature above  $1100^\circ$ . Ionic conduction through ceramic insulation results in localized heating. For best and safest operation, control furnace power through an isolation transformer. Your RADAK furnace may be operated up to  $1500^\circ\text{C}$  (with type C thermocouple). Any higher temperatures are unwarranted.

Portions of the RADAK vacuum furnaces are constructed of tantalum metal, which is susceptible to damage by reactive to gases. Do not add gases other than noble gases to the vacuum system while the furnace is above  $350^\circ\text{C}$ , or tantalum parts will become brittle and weaken.



## **A few words that might save you quite a bit of time and money ...**

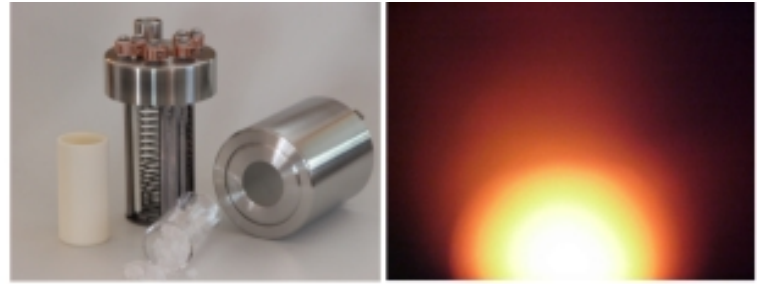
Until connections have been verified through operation, we recommend exercising considerable caution during initial commissioning. A few extra minutes now can save hours of avoidable repair.

When you first add power to a RADAK, it's advisable to have a second method to verify the furnace is heating. This is especially true for systems with multiple furnaces where crossing thermocouple or power leads can lead to the controller powering one furnace but monitoring temperature on another. Two ways to verify the furnace is heating other than the thermocouple indication is visual observation of the crucible and monitoring system pressure. Once the furnace reaches several hundred degrees, a glow should be observable. If the furnace has been exposed to air prior to heating, some moisture will likely remain on the furnace internals despite high vacuum levels in the vacuum chamber. Once the furnace begins to heat, this water is driven off and can be observed via pressure gauge or residual gas analyzer (RGA). The response of the pressure gauge will likely be considerably faster than direct observation.

Always run the furnace with a crucible installed. The crucible can be empty (this is how they are tested prior to shipping) but the crucible is needed for temperature measurement.

There is a significant difference in response between quartz crucibles and alumina crucibles. The quartz crucibles are nominally transparent to the IR radiation emitted by the heating elements where the alumina absorbs somewhat better, especially in the lower temperature ranges. The result is the quartz crucible will be at a much lower temperature than the alumina for the same power. Note: The quartz crucible is transmitting the IR from the heating elements directly to the source material so temperature readings will be significantly lower for the same deposition rate when running a material out of a quartz crucible instead of the alumina crucible.

The first time you power your furnace, we recommend running in manual mode. In manual mode on Luxel controllers, the operator directly controls the power to the furnace. A good test power is 10%. If correctly installed, 10% will result in an increase in furnace temperature with no risk of furnace damage. If temperature does not increase, be sure to check the system pressure to rule out any issues with the thermocouple installation. If the temperature decreases, thermocouple polarity is reversed and the thermocouple circuit should be checked and the polarity corrected. Reversed polarity somewhere in the thermocouple circuit is one of the most common issues reported during initial installation; this is the reason for testing in

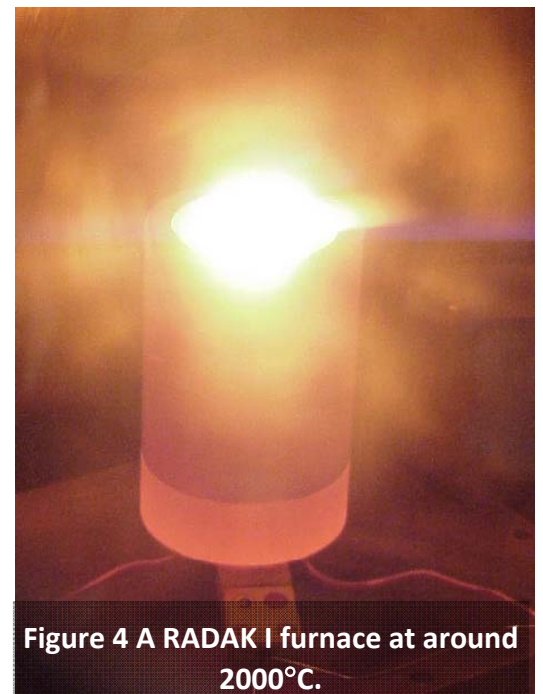


manual mode first. In automatic mode, the controller applies power to reach the temperature setpoint. If the thermocouple wires are reversed and the temperature decreases, the controller will increase power output, causing the indicated temperature to decrease further and so on.

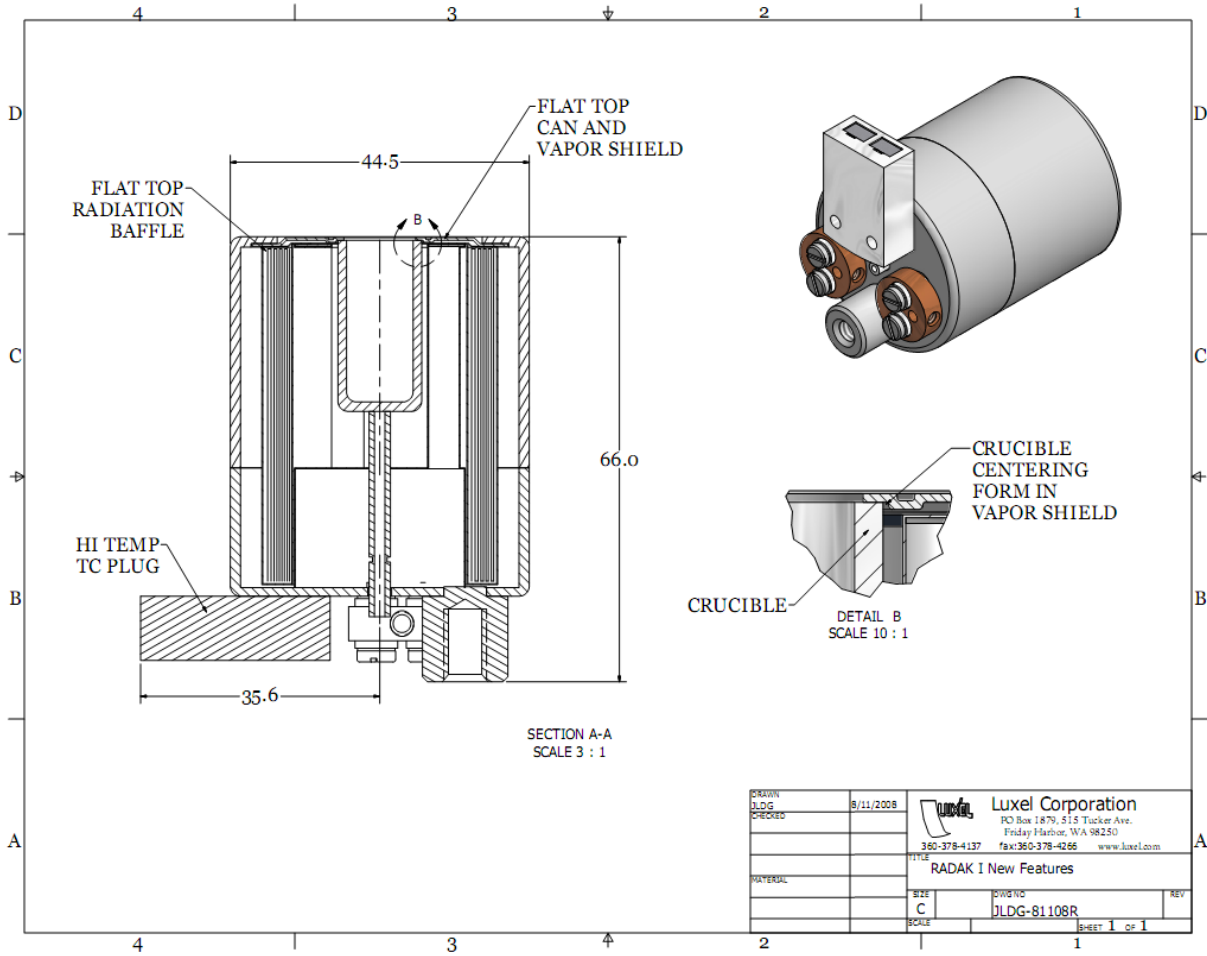
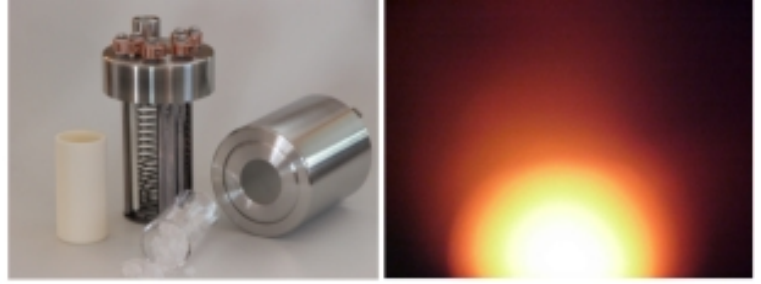
Figure 4 is an excellent example of a furnace run at too high a power. This furnace was run using automatic power control with either the thermocouple polarity reversed or with the controller set to the wrong thermocouple type. The picture was taken about 1 minute after power had been turned off. Needless to say, this furnace was destroyed. We do offer a furnace rebuild service which results in a like-new furnace but it's best to avoid the need if possible.

On a final note, to prevent oxidation of the filament, we recommend not venting the system until the furnace is below 100°C. Be careful when handling the furnace or crucible after venting, 100°C may be cool in RADAK terms but it's still sufficiently hot to burn.

If you have any questions or issues, please feel free to contact us at [radak@luxel.com](mailto:radak@luxel.com).

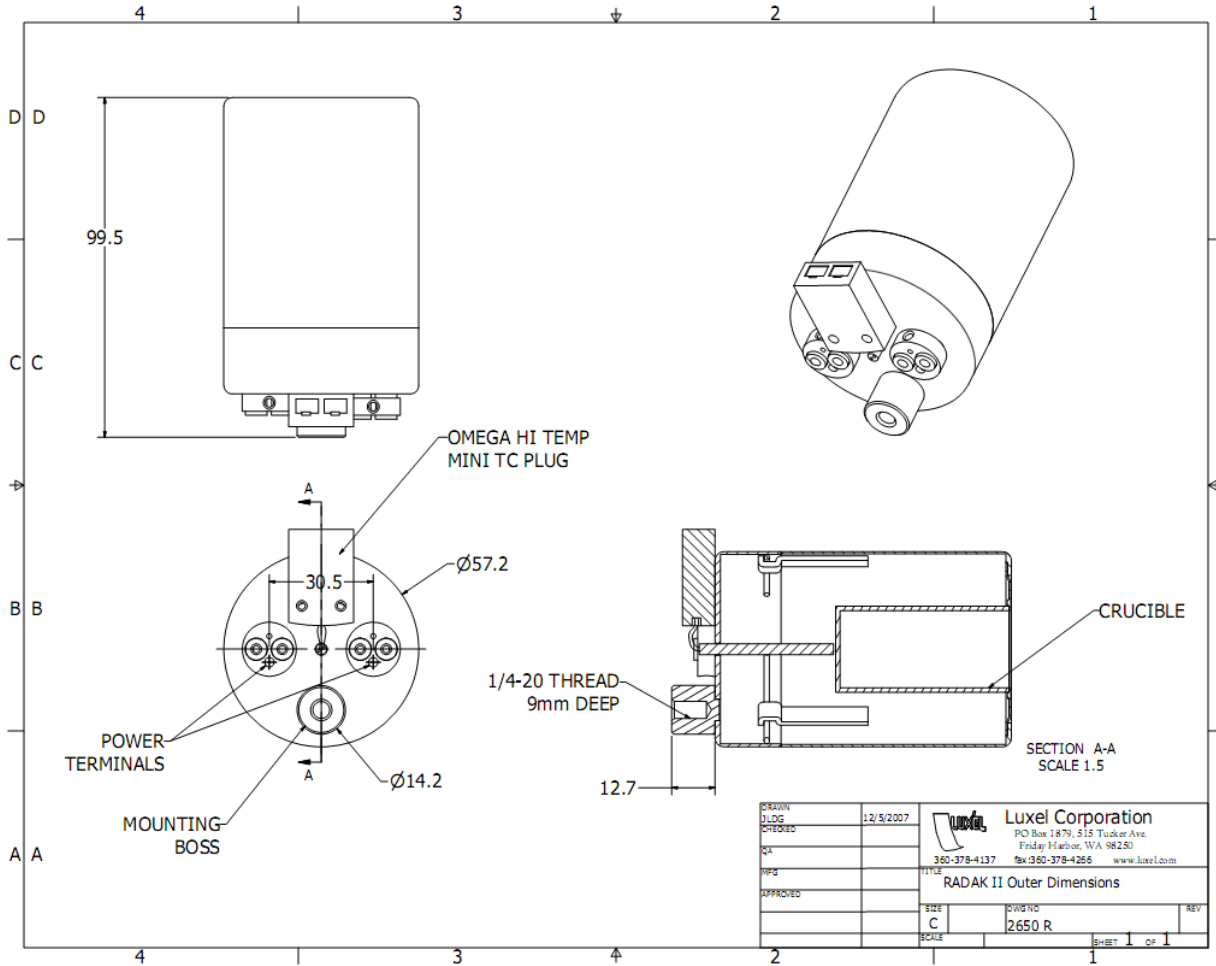
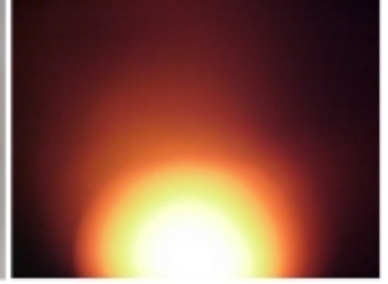


**Figure 4 A RADAK I furnace at around 2000°C.**



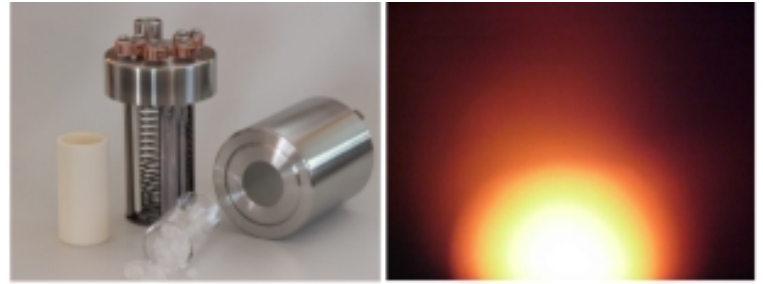


RADAK Furnace Installation and Operation Instructions





## RADAK Furnace Installation and Operation Instructions



### **RADAK GUARANTEE**

Your RADAK vacuum furnace is guaranteed, when used as directed, against defect due to materials or workmanship for 1 year from date of sale with certain reservations. Such reservations are:

1. The furnace core and thermal insulation are comprised of tungsten, tantalum and alumina. Exposure of these materials to certain gases or vapors at high temperatures has a degrading effect and will shorten their life. These gases and vapors are most notably, but not limited to, nitrogen, oxygen and water vapor. Such misuse will void this warranty.
2. Because the delicate installation is under the control of the user, no warranty is offered with respect to the thermocouple. In particular, no warranty is offered with respect to the tungsten:rhenium (Type C) thermocouple. The best techniques and materials are employed in fabrication of the thermocouple but certain materials, most notably zinc, will open the thermocouple junction for this particular alloy couple. Thermal controllers should provide for shutdown on thermocouple failure. Replacement thermocouples are available at nominal cost; they can be replaced by the user.
3. No warranty is offered with respect to crucible damage caused by mechanical or thermal stress due to charge material.

Damaged RADAK furnaces may be returned and inspected at Luxel to determine the nature of the damage. Repairs will be free within the warranty period if the damage is determined to have been caused by manufacturing fault.