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Report

Final Report for the AGC-1 Fabrication and Assembly Mockup

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Summary

This report describes the work performed on the AGC-1 fabrication and assembly mockups. As a result of internal programmatic reviews, NGNP is pursuing additional mockups to reduce the risk to the program and increase confidence in achieving programmatic goals. Three mockups are being pursued: (1) Operational Mockup Testing, (2) Fabrication Mockup, and (3) Assembly/Welding Mockup. Each of the mockups addresses different technical issues of the design. Data and lessons learned from the three mockups will feed into the final design. The mockups were performed to demonstrate the capsule could be fabricated and assembled to the design required to determine the irradiated graphite qualification data for the NGNP. The mockup has shown the in-core graphite experiment body, the heat shield and the broached outer boundary can be fabricated. Although inspection techniques still need to be qualified, fabrication of the components was successful.

The mockup has shown the capsule can be assembled to the design needed for the experiment. Detailed notes and photos were taken during assembly and will be use to develop detailed assembly procedures next fiscal year. Tooling was developed to assembly the graphite body, heat shield, and outer pressure boundary. Tooling that will come in contact with the graphite body or specimens will be replicated in non-metallic material for the actual capsule assembly. Experience was gained with external suppliers to determine limitations and lead times for future material purchases for the actual capsule.

A custom designed assembly bench was fabricated. Some errors in machining on the assembly bench limited availability of some features; nevertheless, the assembly bench performed as needed. Modifications to the assembly bench design will be pursued next fiscal year to mitigate the limited availability of features. The INL-designed weld head performed as required, but further optimization of the software controls would be beneficial to the actual capsule welding. The equipment was qualified and demonstrated the capability to meet the requirements in assembling and welding the capsule.

Numerous improvements were identified in the design, assembly, and welding of the mockup. The improvements will be implemented before the final design review of the capsule.

1. INTRODUCTION

1.1 Next Generation Nuclear Plant

The Next Generation Nuclear Plant (NGNP) Graphite Qualification Program is tasked with selecting a new nuclear grade graphite for use within a high-temperature gas-cooled reactor (HTGR) that will provide high temperature process heat for hydrogen production or other high temperature applications. This reactor will be graphite moderated and helium cooled. Presently there are two possible reactor designs; (1) prismatic and (2) pebble bed. Graphite is used to form the structural core of both reactor designs. Previous graphite types (i.e. H451) are not currently available and new nuclear-grade.

Our understanding of the mechanism of neutron irradiation damage in graphite is well developed. However, fundamental models relating specific structures at the micro and macro structural level to the irradiation behavior are less well developed; therefore, an extensive irradiation program is needed to develop models relating structure to the irradiation behavior for the new graphites of interest. The AGC-1 experiment is the first advanced graphite irradiation experiment that will test these new graphites.

1.2 Experiment Description

AGC-1 is the first of six capsules to be designed for the Advanced Test Reactor (ATR) and will be located in the south flux trap of ATR. This position was chosen because of the requirement for space above and below the core and the inherent high fast flux levels in the experimental position compared to other experiment positions in the ATR core.

The major objective of the AGC-1 experiment is to provide irradiation creep rate data and irradiated data for the new grades of graphite under consideration for the NGNP reactor. This requires matched pairs of stressed and unstressed samples to be irradiated to the same fluence and temperature. This is achieved by use of the axial flux symmetry in ATR to matched specimens within a vertical channel (i.e., the stressed specimens above the core centerline and the unstressed specimens below the core centerline in each channel). This arrangement is used to place six channels around the periphery of a graphite experiment body with a center channel available for non-stressed specimens. Additional graphite grades are located in the graphite bodies' center channel where no load will be applied. These graphites will be irradiated to determine the effects on thermal and physical properties.

Six pneumatic rams that are controlled with feedback from six in□line load cells apply the load. The load cell signal is processed by a digital controller, which in turn, drives a programmable pressure controller to increase or decrease the pressure to meet the required load. The experiment will be designed to maintain a narrow temperature band centered at 900°C temperature along the axial length of the experiment. This is achieved by using variable annular gas gaps where a mixture of helium and argon gas is employed to adjust conductivity of the sweep gas in the gaps. Fabricating the graphite body with an hourglass shape and the heat shield tube thickness with a reverse hourglass shape creates the variable gap. Near the top and bottom of the core, the flux drops exponentially, requiring larger gaps for increased heat transfer resistance and thicker heat shield thicknesses for increased gamma heat generation at the ends of the heat shield. There is a constant gap between the heat shield and the stainless steel outer pressure boundary. The outer pressure boundary has grooves broached into the wall to channel 1/16-in. gas lines and flux wires down the cold wall of the pressure boundary.

1.3 Test Configuration

As a result of internal programmatic reviews, NGNP is pursuing additional mockups to reduce the risk to the program and increase confidence in achieving programmatic goals. Three mockups are being pursued: (1) Operational Mockup Testing, (2) Fabrication Mockup, and (3) Assembly/Welding Mockup. Each of the mockups addresses different technical issues of the design. Figure 1 shows the logic and roles of each of the three mockups, the results of which will provide input to the final design. The Operational Mockup Testing is covered under PLN-2273, "Test Plan for the AGC-1 Operational Mockup." The assembly and fabrication mockups will be described in this test plan.

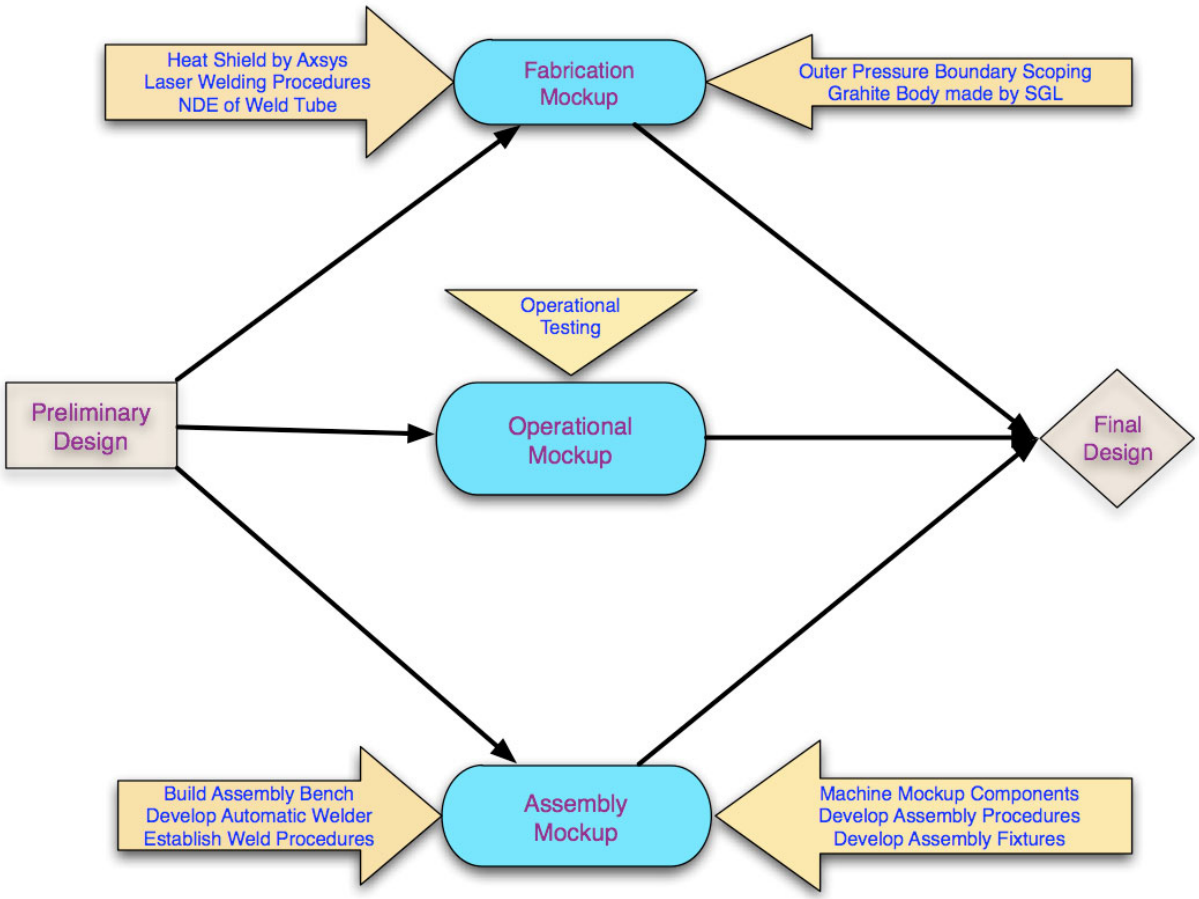


Figure 1. AGC-1 mockups.

1.3.1 Scope of the Fabrication Mockup

The fabrication mockup concentrates on three components that make up the core section of AGC-1. Component fabrication is pursued to demonstrate techniques and vendor capability to meet the required dimensions and tolerances. Fabrication of the graphite body was contracted to the SGL Carbon Group in

St. Mary's, Pennsylvania. The body is made from grade NBG-25, which is a fine grain, isostatically molded graphite of high strength.

Fabrication of the heat shield was awarded to Axsys Technologies in Cullman, Alabama. The heat shield was bored from five solid bars of Haynes 230 high nickel alloy (two 2-in. length tubes and three 16-in. tubes). Haynes 230 was chosen because of its high resistance to oxidation and carburization at high temperatures. These tubes were bored from solid bar to reduce residual and internal stresses in the metal. Fabricating the tubes from solid bar was chosen because traditional tube manufacturing induces residual stresses in the metal during manufacture. These residual stresses affect machining and can cause uncontrolled flexing in high temperature environments.

All five tubes have a constant outer diameter. The three 16-in. tubes have a variable inside diameter. Two of the tubes have a wall thickness of 0.025 in. at one end and tapers to 0.010 in. at the other end. The third tube starts with a wall thickness of 0.010-in. thick, tapers to a thickness of 0.005 in. in the middle, and increases back to a wall thickness of 0.010 in. at the other end. Very small lap joints are machined on the ends of the tube to form the joints that will be joined by laser welding. Laser welding will first be demonstrated with laser-welding procedures that will be developed in the next fiscal year for the process.

Two ultrasonic nondestructive inspection techniques will be investigated to see if an accurate measurement of the inside diameter taper can be made. One method uses a high frequency scanning transducer that was developed at the Idaho National Laboratory (INL). This method uses an immersion tank that is large enough for the 16-in. tubes. The tank cannot fit the entire welded tube. The other method is an eddy current probe, which uses a pencil transducer to measure the tapered thickness of the tube at a point.

For the outer pressure boundary mockup, two 1-ft tubes were bored from solid 304 L stainless-steel bar stock to reduce residual stresses. After boring, 13 grooves were broached into the inner wall of the tube. The tube was then welded and checked for straightness. This work was done at the ATR machine shops.

1.3.2 Scope of the Assembly Mockup

The assembly and welding mockup establishes the capability to assemble and weld a full-size AGC-1 capsule. The mockup activity will develop the assembly and qualified weld equipment for the full-size AGC-1 capsule. Welding the capsule will require design of an assembly bench that has the capability of adjusting the concentric alignment of the tubes. A tungsten inert gas weld torch, mounted on a horizontal rail with four-axis control, will be used to weld the stainless steel tubes. A small drive motor connected to a rubber wheel will drive rotation of the tubes during welding. Weld procedures exist at INL for welding stainless steel; therefore, only the actual settings on the weld head, the weld equipment, and the operators must be qualified to be considered an acceptable welding process at INL. This qualification process will be carried out next fiscal year.

Capsule components will be fabricated from actual materials or from simulated materials due to schedule and availability.

1.4 Objectives of the Fabrication and Assembly Mockup

The fabrication mockup will construct facsimiles of the actual graphite body, heat shield, and outer pressure boundary. Dimensions used to construct the components were based on the preliminary design review package. The actual final dimensions may change from dimensions used in these mockups. The intent of this mockup is to demonstrate commercial machining capability, internal INL machining capability, and laser welding capability and inspection procedures for the heat shield.

The assembly mockup will produce drawings for a full-scale capsule based on previous preliminary design drawings. The drawings will have necessary design modifications incorporated to assemble the full-scale capsule. Assembly and welding of the full-scale capsule will demonstrate that the capsule can be constructed from dimensions and tolerances on the drawings. All this information will be presented in a Preliminary Design Closeout meeting to be held next fiscal year.

2. SCOPE

2.1 Performing Organizations, Responsibilities, and Roles

The NGNP staff has ultimate design and review authority over the design of the mockup. The ATR experiment staff will design and execute the tests and record the data.

The SGL Carbon Group was contracted to machine the graphite core section of the mockup. Axsys Technologies performed machining on the Haynes 230 tubing. Outer pressure boundary work was performed by the ATR machine shops. Laser welding was performed at the INL Research Center in Laboratory C-20. Nondestructive examination work was performed at the North Holmes Laboratory and the INL Research Center Physics Laboratory.

2.2 Quality Level Determination

This work is being implemented under PLN-2021, “Quality Assurance Program Plan (QAPP) for the Next Generation Nuclear Plant Project (NGNP).” Based on PLN-2021, this work has been declared applied research. Applied research at the INL is defined as a process initiated with the intent of solving a specific problem or meeting a practical need. Successful results may be applied to a future development activity. Proof of principle usually occurs in the applied research stage, and with its more explicit objectives, warrants a set of milestones.

For all three mockups, a Quality Level 3 has been determined to apply by QLD ALL-000095. Justification for the Quality Level 3 determinations is documented in QLD ALL-000095.

Two items had a Level 1 direct quality level determination made by QLD ALL-000113. The items were the 304 L stainless steel bars used for the outer pressure boundary and the weld wire used in the welding of the assembly mockup. Both materials were assessed at Level 1 to ensure the materials could be used in the actual capsule and on the assembly mockup.

3. TEST METHODS AND SPECIFICATIONS

Table 1 shows INL drawings that provide dimensions and descriptions of components fabricated in the fabrication mockup. The mockup will be fabricated and assembled in the North Holmes Laboratory and other INL laboratories. Phases of the fabrication will be documented in laboratory notebooks maintained by the performers.

Table 1. List of drawings that provide dimensions and descriptions for the fabrication mockup.

Component	Drawing Number
636115	ATR Advanced Graphite Capsule (AGC) Assembly Mock-Up Pressure Boundary Blank Details
636116	ATR Advanced Graphite Capsule (AGC) Assembly Mock-Up Stainless Steel Component Details
636117	ATR Advanced Graphite Capsule (AGC) Assembly Mock-Up Graphite Component Details and Assemblies
636118	ATR Advanced Graphite Capsule (AGC) Assembly Mock-Up Assemblies
636119	ATR Advanced Graphite Capsule (AGC) Assembly Mock-Up Top Head Plug Details and Assembly
636120	ATR Advanced Graphite Capsule (AGC) Assembly Mock-up Heat Shield Details and Assembly
636121	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Facility Indexing Guide Unit Details and Assemblies
600425	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Welding and Inspection Equipment Installation
600426	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Welding Equipment Mounting Bracket Details and Assembly
600427	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Rotary Stage Mounting Bracket Details and Assembly
600428	ATR Advanced Graphite Capsule (AGC) Assembly Mock-up In-Core Pressure Boundary Machining Details
600429	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Assembly
600430	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Inspection Guide Details and Assembly
600431	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Miscellaneous Mounting Bracket Details
600433	ATR Advanced Graphite Capsule (AGC) Welding and Assembly Bench Welding System Grounding Bracket Details and Assembly
600434	ATR Advanced Graphite Capsule (AGC) Pneumatic Cylinder Test Stand Details and Assemblies

Drawings for the assembly mockup will be developed during fabrication and released as final drawings when the assembly mockup is completed.

3.1 Test Equipment Requiring Calibrations

Except for occasional use of a dial gauge, calipers, and inside micrometer to measure and verify dimensions, no measurement or test equipment is anticipated to be needed. The Materials and Fuels Complex quality inspectors will perform metrology on the welded heat shield based on submitted inspection forms. Nondestructive examination technicians will be responsible for their own calibration procedures.

4. DESCRIPTION OF FABRICATION MOCKUP ACTIVITIES

4.1 Graphite Bodies

A contract was awarded to SGL Carbon Group, Ltd in St. Mary's, Pennsylvania to fabricate the graphite bodies from NBG-25, an isostatically molded graphite. The graphite is a fine grain, high-strength nuclear grade graphite. Two other candidates were considered: AXF-5Q from Poco and PGIB from Graftech. The Poco grade was rejected due to a higher thermal coefficient of thermal expansion and Poco's lack of in-house machining capabilities. The Graftech grade was rejected due to availability. PGIB is a developmental nuclear grade of graphite that is not commercially available.

Because of the thin walls in the graphite bodies, fine grain and high-strength graphite is required to achieve desired machining tolerances without concerns for tear out and weak walls. Machining on large grain graphites can knock out large grains during machining, which leaves small potholes or fractures in the surface. Thin walls require at least 10 to 12 grains across the wall thickness for maximum strength; large grains do not allow that many grains across the thin walls. The graphite was machined to the drawings based on the preliminary design. The preliminary design used a three-piece graphite body while the final design will use a two-piece graphite body, eliminating the bottom piece. The SGL inspection report of the graphite components is found in Appendix A.

4.1.1 Design of Graphite Bodies

In consultation with SGL, the three graphite bodies were made from several shorter pieces and doweled and cemented together using graphitic cement. The cement must be fired at a high temperature to complete the bond between graphite pieces. This construction was chosen to ensure the specimen holes are straight over the entire length of each of the three graphite bodies. The challenge for SGL was drilling the specimen holes straight over the entire length of one of the graphite bodies. The challenge could be mitigated if the body was broken up into smaller bodies and then doweled and cemented. Figure 2 shows the joints and the annular dowels used to align the smaller pieces. Smaller blind holes in the graphite body are for the 1/8-in. thermocouples. Using annular dowels allows the thermocouples to be distributed around the graphite body.

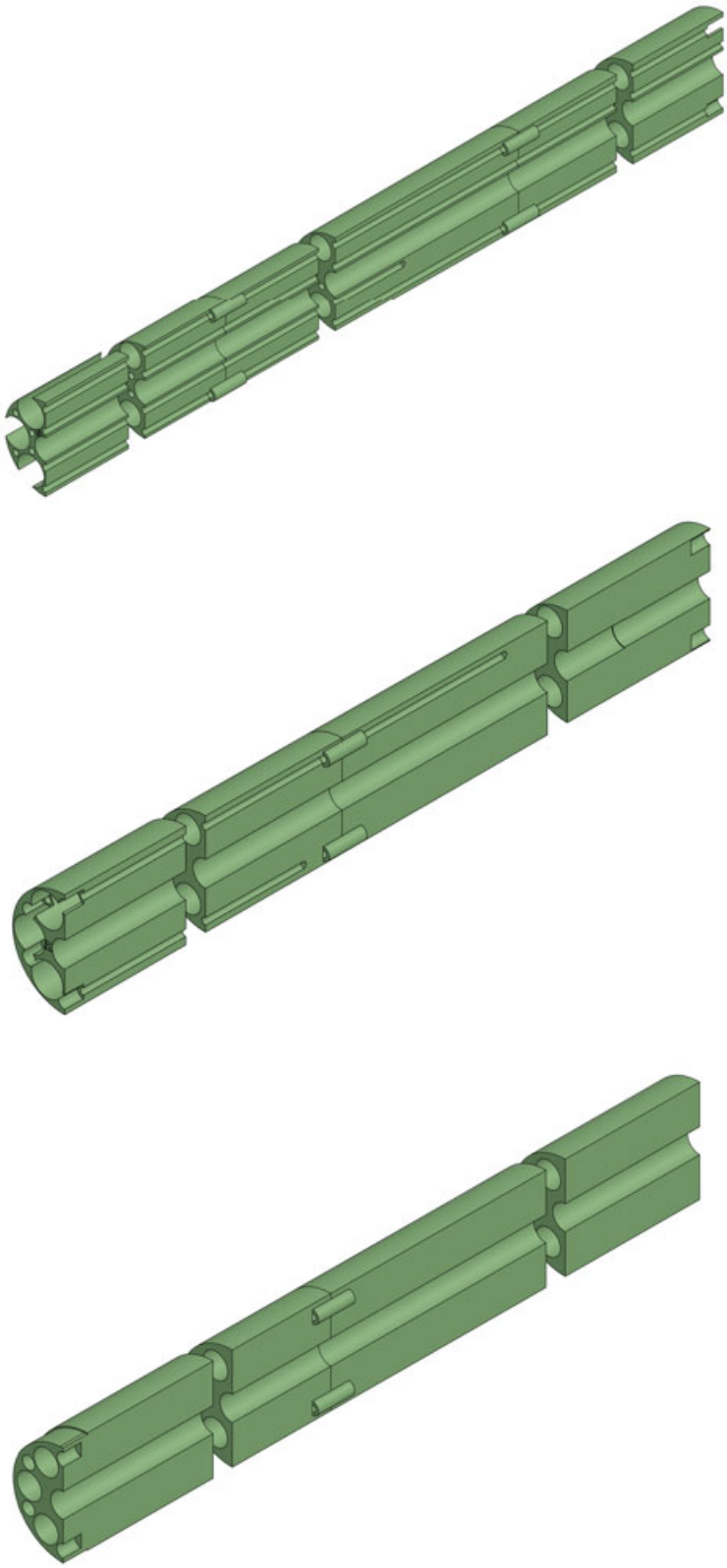


Figure 2. The top of core, bottom of core, and core support graphite bodies.

4.1.2 Receiving Graphite Shipment from SGL

Graphite components were received from SGL in a wooden custom crate via an expedited courier with no damage. Figure 3 shows the crate with the lid off, illustrating the arrangement of the graphite bodies.

Figure 3. Graphite components in shipping crate from SGL in St. Mary's, Pennsylvania.

Figure 4 shows some of the machining performed on the graphite bodies. The graphite body is a right circular cylinder with an outer diameter shaped like an hourglass, with a larger diameter in the middle and decreasing diameter toward the ends. It was during the machining on one of these ends when the wall became too thin and fractured.

4.1.3 Issues from Delivered Graphite

SGL informed the project during machining that a fracture occurred near the top of the graphite body, which resulted from the wall thickness that was too thin to be supported by the grain size of the graphite. Figure 5 shows the fracture in the upper graphite body. A discussion was held between the project and SGL engineers and an agreement was reached that further designs would not reduce the final design graphite body wall thicknesses less than 0.025 in.

Figure 4. The different configurations on the ends of the graphite bodies.

Figure 5. Machining defect on the upper core graphite body.

4.1.4 Final Inspections

Changes to the preliminary design have eliminated the third graphite body from the final design. The bottom in-core graphite body is representative of the machining required for the AGC-1 experiment. The bottom core section will be inspected for as-is dimensions against the drawings supplied to SGL for fabrication. The top core section has been redesigned in the final design to allow for thicker walls between the specimens and will not be inspected for as-is dimensions. New go/no-go gauges will be purchased in the next fiscal year to measure the holes in the graphite body.

4.2 Heat Shield

The heat shield's function is to maintain a constant sweep gas gap between the outer pressure boundary and a variable sweep gas gap between the graphite body and the heat shield. The gaps set up the means to control the temperature in the experiment by using a mixture of helium and argon sweep gas. The heat shield's variable thickness is used to generate gamma heating, which assists in control of the temperature in the graphite body. The heat shield is machined from a solid bar of Haynes 230 with extremely tight tolerances. The assembly is constructed from five pieces. Each piece has a lap joint that aligns the parts for laser welding. A wire EDM or lathe is used to remove metal around the edge of the pieces to form the lap joint (see Figure 6). Figure 7 shows how the heat shield will be assembled over the graphite body. The heat shield is partially assembled by performing three of the four laser welds as depicted in Figure 7. The heat shield is welded into two pieces, allowing the graphite body to be loaded on one side and the other heat shield piece to slide over and be welded. This operation captures the graphite inside the heat shield and restricts the graphite from sliding out the heat shield. The final laser weld is performed, which completes the assembly. A lap joint was chosen because the laser would not have to penetrate completely through the joint to join the pieces. The heat shield does not retain any pressure; therefore, the joint only has a structural function. If the laser weld penetrated the heat shield, then the graphite body could be damaged.

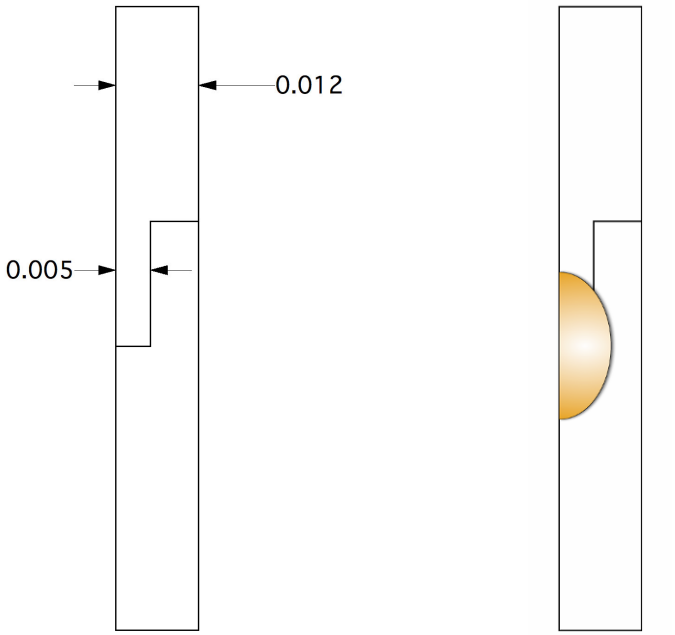


Figure 6. Lap joint for heat shield laser welding.

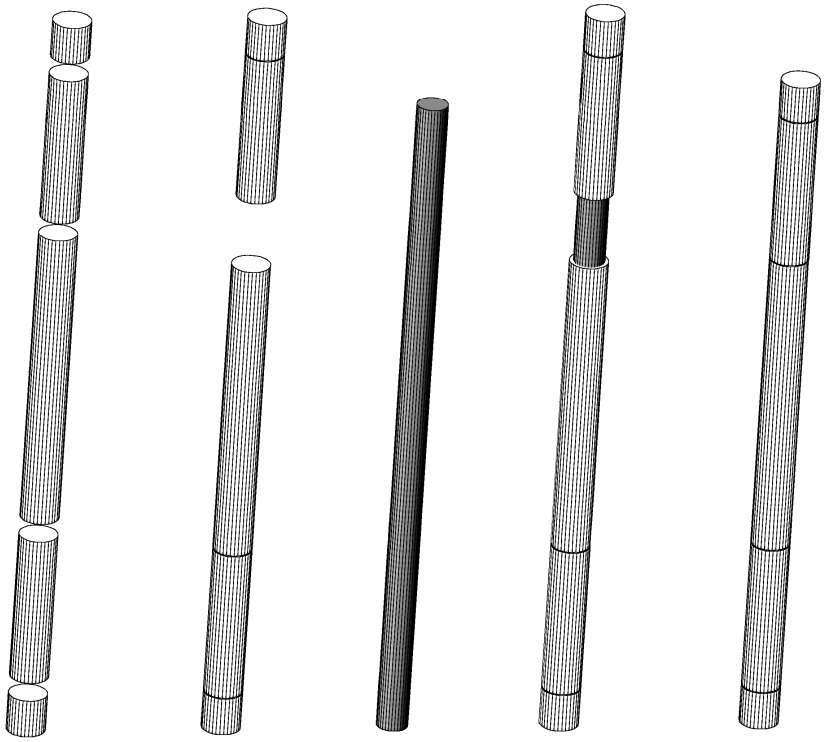


Figure 7. Welding sequence for the heat shield over the graphite body.

Figure 8 shows a test weld of the laser system using a 0.010-in. thick coupon with a lap joint. The weld penetrates into the backing piece but does not penetrate all the way through both pieces.

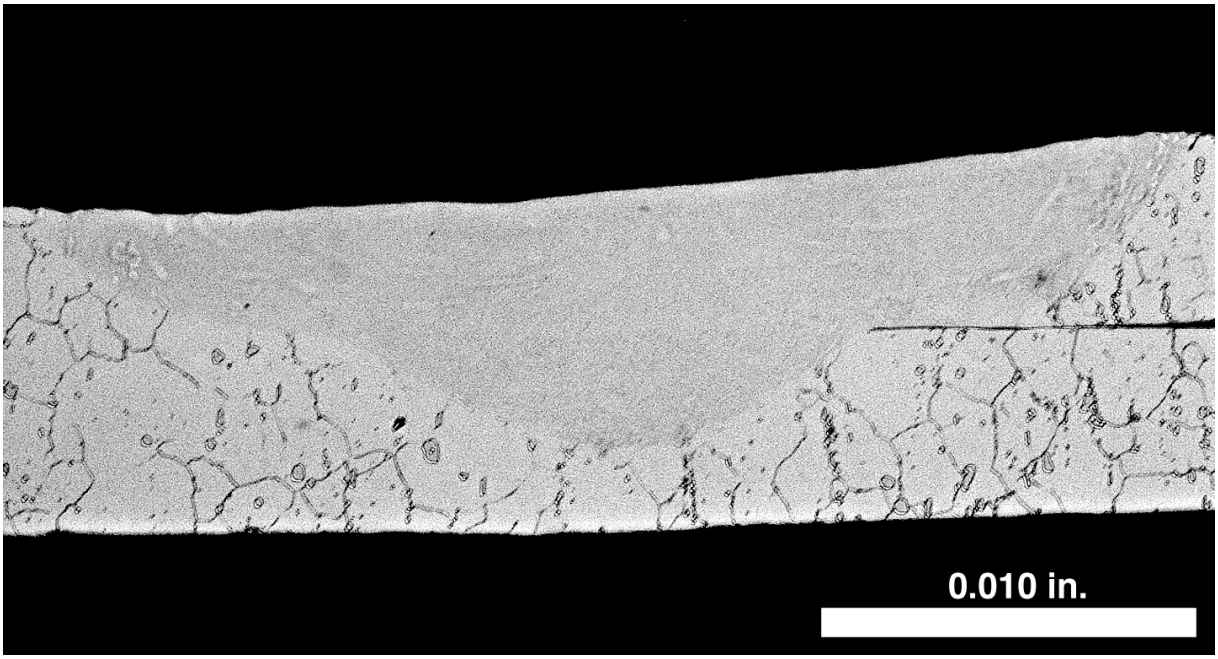


Figure 8. Test laser weld using a Haynes 230 0.010-in. thick coupon with a lap joint.

Each of the five heat shield pieces has a constant outer diameter. Three of the five have tapered inner diameters that form tubes of varying thickness. The thickness starts at 0.010 in. on one side and increases to 0.025 in. The middle piece has a wall thickness of 0.005 in. in the middle and increases to 0.010 in. at both ends. The two end pieces have constant outer diameters and inner diameters with a thickness of 0.025 in.

A sole-source contract was placed with Axsys Technologies in Cullman, Alabama. Axsys is a NQA-1 qualified machine shop and is on the INL suppliers list. Axsys obtained bar stock from Haynes International for the five pieces. Bar stock was necessary because of the minimal residual stresses in the material. Tube stock would have stress relief, which causes distortion in the pieces during machining. Axsys has the high-accuracy lathes necessary to complete the work. Other critical machining Axsys performs for INL is the machining of beryllium blocks that go into the ATR core. Figure 9 shows pictures of the delivered pieces.

An alignment fixture is required to support the graphite and heat shield in concentric alignment. This fixture is attached to a small rotary table, which rotates the heat shield on its axis and allows an automated weld process to be in place (see Figure 10). The laser welder is permanently attached to the wall. The rotary table, end fixtures, graphite, and heat shield are attached to a vertical rail by means of cantilever arms. The rotary table height on the vertical rail is adjusted manually by sliding the cantilever arms up and down on the vertical rail using clamps to secure the arms to the vertical rail. Also, the fixture, rotary table, graphite, and heat shield can pivot into the horizontal position for welding.

Figure 9. Delivered Haynes 230 heat shield parts.

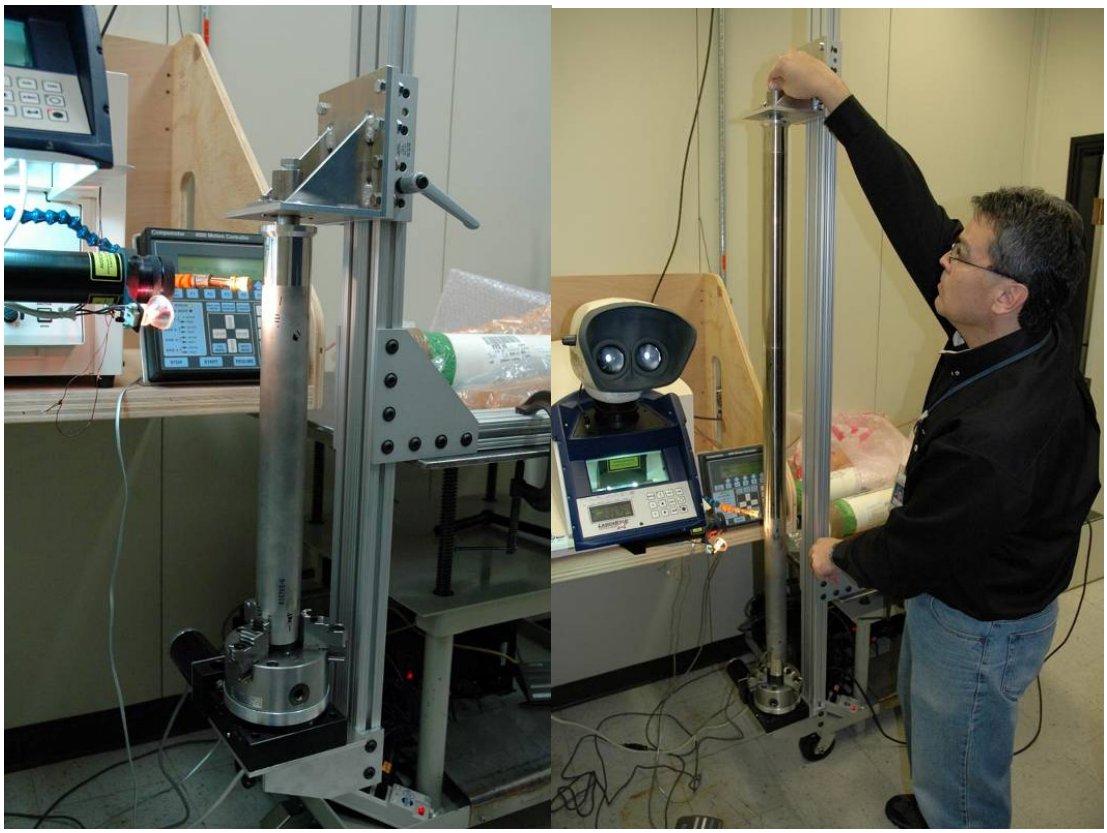


Figure 10. Set up for laser welding on the heat shield.

4.2.1 Laser Weld Procedure Development

An INL weld procedure will be written specifically for the laser welding depicted in Figure 10. This will require additional flat weld coupons fabricated from flat sheets of Haynes 230 that are obtained from the West Coast supplier of Haynes 230 seam welded tubing used in the assembly mockup. The lap joint will be machined on the ends of the coupons. After laser welding, some of the coupons will be destructively tested and others will be metallographically inspected for penetration of the heat affected zone and to ensure the power settings do not burn through the back of the coupon. This work will not be performed in this mockup; it will be performed next fiscal year. It is mentioned here for completeness. Parameters used in the fabrication and assembly mockups will be recorded in a laboratory notebook; therefore, values can be compared to ones used in the future weld procedure development.

4.2.2 Laser Welder Equipment Modification

Figure 11 shows configuration of the laser used to weld the heat shield tubes. Normally, the laser projects the beam directly down to weld in the horizontal configuration. In order to weld in the vertical configuration shown, a special right angle lens was procured from the laser manufacturer. Figure 12 shows the right angle lens installed on the laser.

Figure 11. LaserStar laser welder and vertical lens configuration.

Figure 12. Right angle lens installed on the laser welder.

4.2.3 Nondestructive Examination Determination of Tube Wall Thickness on Tapered Wall Haynes 230 Tubing

A critical aspect of the heat shield is the variable gas gap formed between the graphite and heat shield constructed from the tapered tube wall thickness. Verification of the tapered tube thickness is crucial to the experiment's temperature distribution and satisfying programmatic goals.

Two methods using nondestructive techniques have been proposed to determine the tapered wall thickness without using physical measurements. The first method uses a special transducer to determine thickness of the tapered wall heat shield tubing. This method can scan the entire tube and provide thicknesses. This method has previously demonstrated accuracies down to ± 0.001 in. and currently is used to inspect cladding thicknesses on ATR fuel plates. The other method uses a standard eddy current pencil probe. The accuracy of the eddy current method is not known and, if used would only determine the tube's wall thicknesses at point.

Work has progressed on the development of NDE inspection techniques on the Haynes 230 heat shield. A section of the seam welded Haynes 230 tubing is being used to develop the parameters to measure thickness. The tube is placed vertically in a water tank. The tube is rotated and the transducer moves vertically. This is a temporary set up, the actual inspection will be done with the tube laying horizontally. The signal strength is strong with very little noise. This sensitivity of the transducer and electronics will be able to detect thickness variations down to 0.0001", which is more than adequate for the requirements on the heat shield. Figure 13 is a photo of the temporary set up in the tank. The dark stripe down the tube is the welded seam. Next fiscal year a formal calibration of the system will be completed.

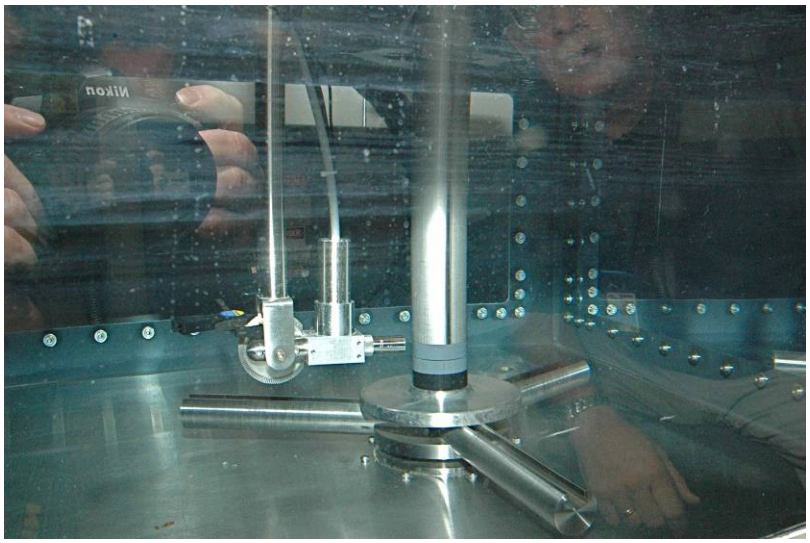


Figure 13. Photo of Haynes 230 seam welded tube in tank with ultrasonic transducer

Figure 14 is the scan produced by the system for two inches of the tube. The dark line on the left is the welded seam. The colors represent the different thicknesses. The dark line on the right is a ridge on the surface due to the manufacturing process.

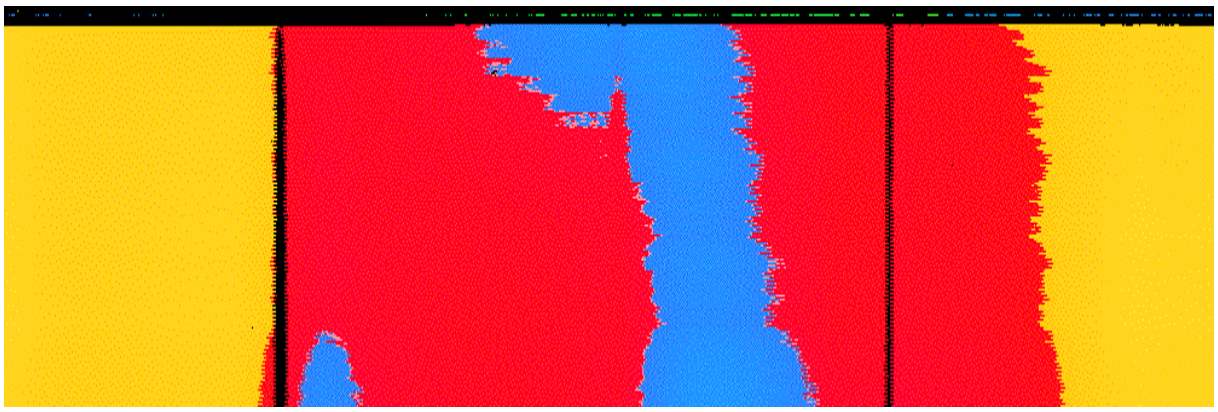


Figure 14. Scanned output of the Haynes 230 tube thickness

The eddy current method is faster, but would provide less data than the scanning method. The scanning method is only limited by the required size of the immersion tank; however, the eddy current

method has no such limitations. Preliminary NDE development on the heat shield using eddy current techniques has been successful with thicknesses of stock less than 0.025". Additional coupons of known thickness will be needed to develop the non-linear curve calibration curve for the eddy current probe. Additional blind tests must be carried out to fully qualify the measurement technique. After qualification this technique will be invaluable for source inspections at the contracted machining facility.

4.3 Scoping Studies on the Outer Pressure Boundary

The outer pressure boundary isolates the internal atmosphere of the helium pressure inside the capsule and resists the external pressure from ATR's primary reactor coolant. Maximum pressure in the primary reactor coolant for worst-case accident condition is 429 psi; therefore, the thickness of the outer pressure boundary has been sized using American Society of Mechanical Engineers (ASME) Section III, Class 3 design rules. The thickness of the tube has been increased over the ASME design to allow broached U-shape grooves in the wall of the outer pressure boundary. The depth of the groove meets the minimum ASME wall thickness for Section III, Class 3 rules. The grooves provide a path for the gas lines to the lower pneumatic rams and neutron flux wires away from the hot core section while maintaining the gap between the heat shield and the inner diameter of the outer pressure boundary.

In addition, the straightness of the outer pressure boundary is critical in order to maintain the necessary gap between the outer pressure boundary and the inside diameter of the south chopped dummy in-pile tube. The gap is sized to meet critical heat flux restrictions and core pressure drop requirements. The chopped dummy is made from Schedule 160 wall American Society for Testing and Materials (ASTM) aluminum tubing and has been in the ATR for at least two core internal changeouts (approximately over 14 years). ASTM standards allow a 12% variation on the inner diameter and currently, there is no true way of measuring the effects long-term irradiation exposure has on the configuration of the chopped dummy in-pile tube. Because it is easier to fabricate a new chopped dummy in-pile tube than to ascertain its current condition, the project has decided to fabricate the tube using techniques that will have less variation in the inner diameter than ASTM standards for thick-wall aluminum tubing. Fabrication techniques will be discussed later in this section.

Broaching operations on the outer pressure boundary are performed with a tool that cuts a deeper grove with each stroke. This process can be done by cutting one grove at a time, by all groves being cut at the same time, or a combination between if a press with sufficient forced is used. When commercial broachers were contacted about how they would broach the tube, all replied they would broach all groves at the same time. This operation requires very large presses, up to 60-tons, that would cut all the groves at one time, but has the potential to stretch and enlarge the tube beyond specifications.

Further issue with broaching is the length of the tube, because as the length of the tube increases, the force required pushing the tool the entire length increases.

The ATR machine shops were contacted because of prior broaching operations they had performed. After initial consultation, the 6-ft length (based on preliminary design) of the tube would not be broachable due to inadequate lathe capability. This left dividing the tube into two 3-ft pieces that would be broached separately and welded at the center. As a scoping demonstration, two 1-ft tubes would be bored from solid bar and broached. The two pieces were welded using an automatic welding machine.

After welding, the measured runout was 0.005 in. over the length of the 2-ft piece. A copper heat sink was fabricated to prevent the weld metal from filling in the grooves. The tube could not be broached after welding due to the increased hardness of the weld metal around the joint. The scraping tool would

jump or skip, which resulted in a nonuniform grove or a groove that was out of specification. Figure 15. Completed 2-ft outer pressure boundary scoping test. provides pictures of the completed 2-ft scoping test.

Figure 15. Completed 2-ft outer pressure boundary scoping test.

Scoping test results showed that the outer pressure boundary could be fabricated from two pieces and welded together. Upon further critical evaluation between the project and ATR machine shop, it was agreed upon that the tube would be broached over the entire length and not be fabricated from a welded tube.

The ATR machine shop reviewed the broaching tool design limitations and proposed changes in design that would enable it to broach the entire 5-ft tube. The new length has decreased from 6 to 5 ft due to changes from the preliminary design. The new broaching tool was fabricated and tested on a 1-ft piece of spare tube because no outer pressure boundary tubing existed.

With the decision to broach the entire 5-foot tube the next step is to procure gun barrel drilled outer pressure boundary tubing. A search was made for gun barrel drillers with the capability to accurately machine the tube from a solid bar. Two firms responded and confirmed they could fabricate the outer pressure boundary to the specifications. The two firms responded and confirmed they could fabricate two tubes as test articles. Once the test articles are received from the two firms, the tubes will be measured against the specifications. The firm with the best performance will be chosen to machine the outer pressure boundary tube for the AGC-1 experiment. Both firms supplied the requisite test articles. Figure 16 is one set of tubes received from one of the drillers. All four tubes have been inspected on the outside, but Quality Control inspectors did not have the appropriate tools to measure the runout on the inside diameter. The runout is the difference between the actual axis of the inner diameter to a reference axis. The QC inspectors are evaluating a special commercial built tool or rely on a tool developed at the lab to inspect the runout on the inner diameter. The decision will be made next fiscal year and the inspection completed.

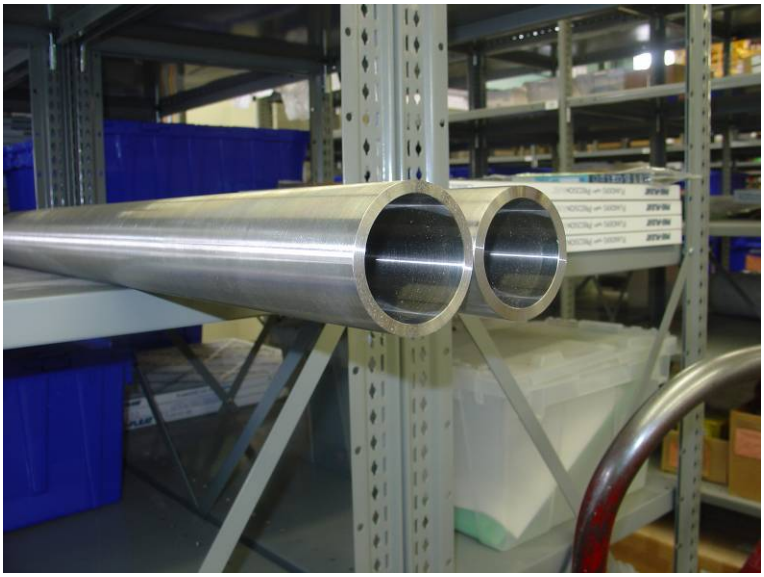


Figure 16. Received gun barrel drilled tube.

One tube was selected for the assembly mockup and broaching performed on the tube. This work was performed at the ATR machine shops because of the larger size lathe required. Figure 17 shows photos of the set up on the large lathe at the ATR machine shop. The broaching tool is on the tip of the long bar. The lathe pushes the broaching tool through the tube. The cutting teeth only work on the downstroke. Two tools were developed to broach the 13 groves: one tool originally had 6 teeth and the second tool had 7 teeth. The broaching tools had to be modified in order to complete the broaching. It was determined the number of teeth had to be reduced to 3 per tool to ensure the lathe would not stall out pushing the broaching tool through the tube. The teeth are custom ground carbon steel that were heat treated at the ATR machine shop. The teeth proved unreliable because of frequent breakage and would dull quickly. In fact the grooves are at the proper depth at one end of the tube and become shallower as the groove reaches the other end of the tube. Using custom ground ceramic or specially alloy teeth could alleviate this situation. Figure 18 shows the completed outer broach boundary tube.

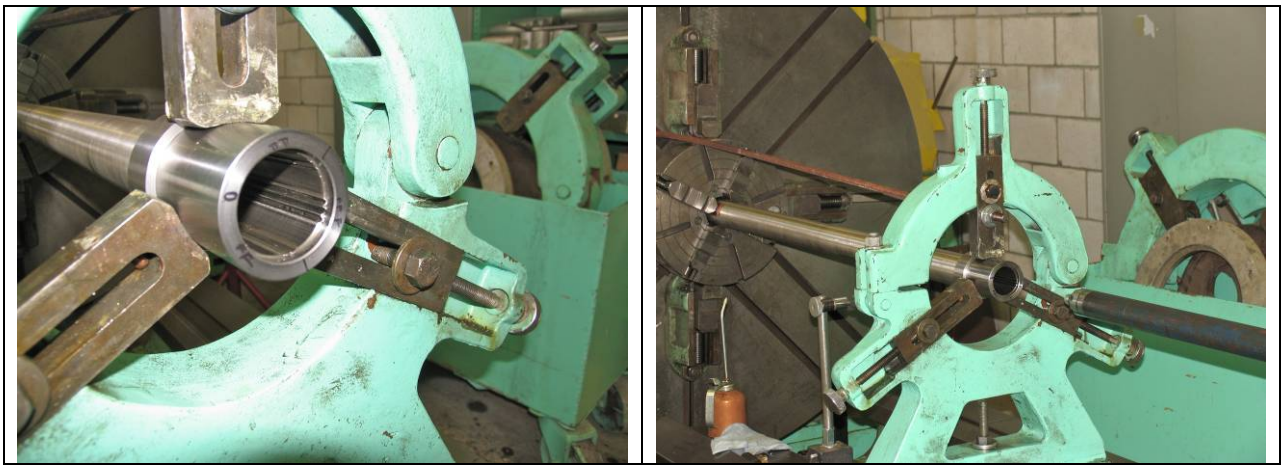


Figure 17. Broaching setup at the ATR machine shop.

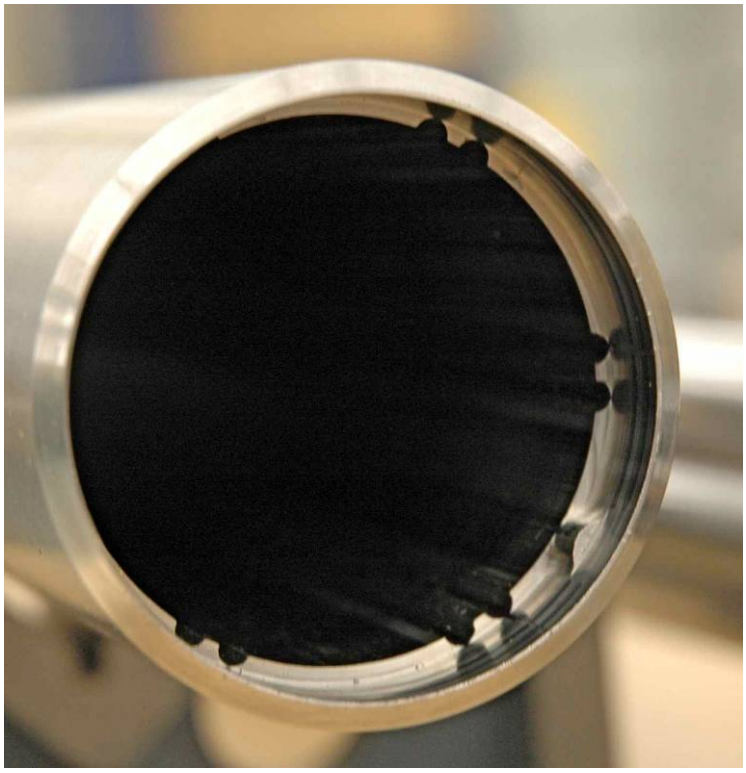


Figure 18. Completed broached outer pressure boundary tube.

In reviewing the capabilities of the two firms responding to the outer pressure boundary tubes, both firms should be capable of boring the inner diameter on long aluminum bars more accurately than the ASTM standard allows. Therefore, the firm chosen to fabricate the outer pressure boundary tubes will bore the inner diameter for the south chopped dummy in-pile tube. Final fabrication for the in-pile tube will be completed in the ATR machine shops. Fabrication of the south chopped dummy in-pile tube will be part of final preparations for the AGC-1 experiment for the next fiscal year.

5. ASSEMBLY MOCKUP ACTIVITIES

5.1 Full-Size Mockup of AGC-1 Capsule

In order to assess completeness of capsule design and integration of the different active systems within the real estate inside the capsule, the project decided to fabricate a full-scale mockup of the AGC-1 capsule. The limited timeframe of the work does not allow all components to be machined from the materials that will be used in the actual capsule. The graphite body, graphite specimens, and heat shield use materials that are long lead items and require machining outside of INL. Therefore, these parts will be machined from readily available materials with similar characteristics. All machining for the capsule will be performed at the North Holmes Laboratory except for the outer pressure boundary.

During assembly of the full-scale capsule, the engineer will take notes and photos so that assembly procedures can be developed for the actual capsule assembly. In addition, any fixtures needed for assembly also will be developed.

Figure 19 shows the 30-ft capsule divided into sections to fit on the page. The top section is the top head closure that mates with the ATR reactor vessel head and supports the entire capsule. The next section down is the upper half of the capsule where the pneumatic rams and load cells are located. This section is above the reactor, but inside the ATR reactor vessel. The next section is the in-core section that contains the graphite body and specimens. The last section is the portion of the experiment that hangs below the core and contains the pneumatic rams used to momentarily upset the graphite specimens when the reactor is not operating.

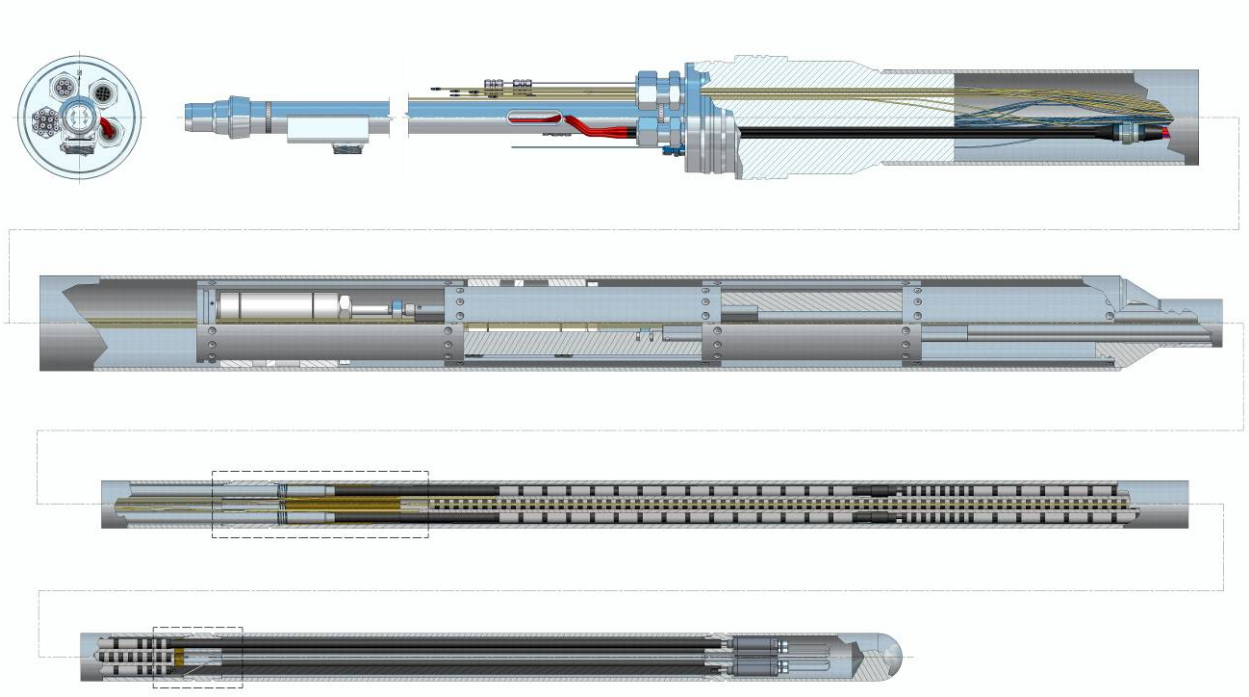


Figure 19. Divided view of the AGC 1 capsule.

5.2 Assembly Bench and Welding Development

The AGC-1 capsule is 30 ft in length and requires an assembly bench to concentrically align the tubular sections of the capsule and weld the joints. The difference between the idealized axis of the cylinder and the actual cylinder axis is the runout. The runout will occur in discrete steps at each of the tubular sections and can be additive or compensating. The runout is most crucial in the in-core section of the capsule where it navigates the chopped dummy in-pile tube.

Figure 20 shows a sketch of the 30-ft assembly bench and weld head design to assemble and weld the AGC-1 full-scale mockup capsule. The assembly bench uses aluminum-extruded rails that have been selected to have minimal deflection when loaded with the capsule. The table is manufactured in three 10-ft sections that are mechanically fastened together. The table will be assembled in the North Holmes Laboratory, but can be disassembled to move to the Reactor Technology Complex when a building becomes available.

Figure 21 shows an isometric view of the weld head on the assembly bench. The capsule is supported on the bench by an indexer. The indexer controls the height of the capsule on the assembly bench and alignment of the cylindrical axes. The indexer was design and fabricated at the INL due to commercial industry be able to fabricate similar designs in the time frame the project needed. There are 10 indexers installed on the assembly bench.

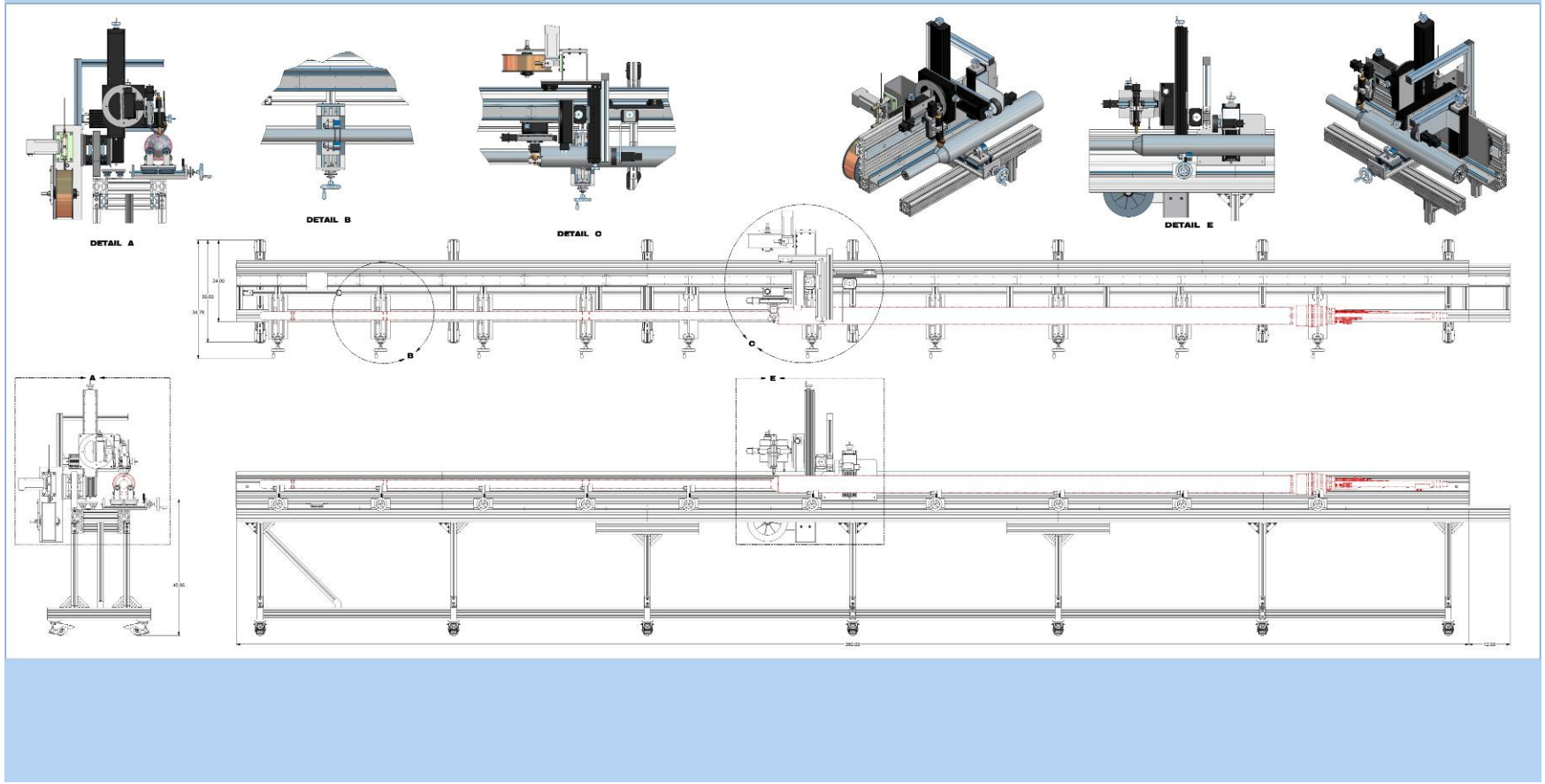


Figure 20. Sketch of the assembly table with weld head to assembly and weld the full size AGC 1 mockup capsule.

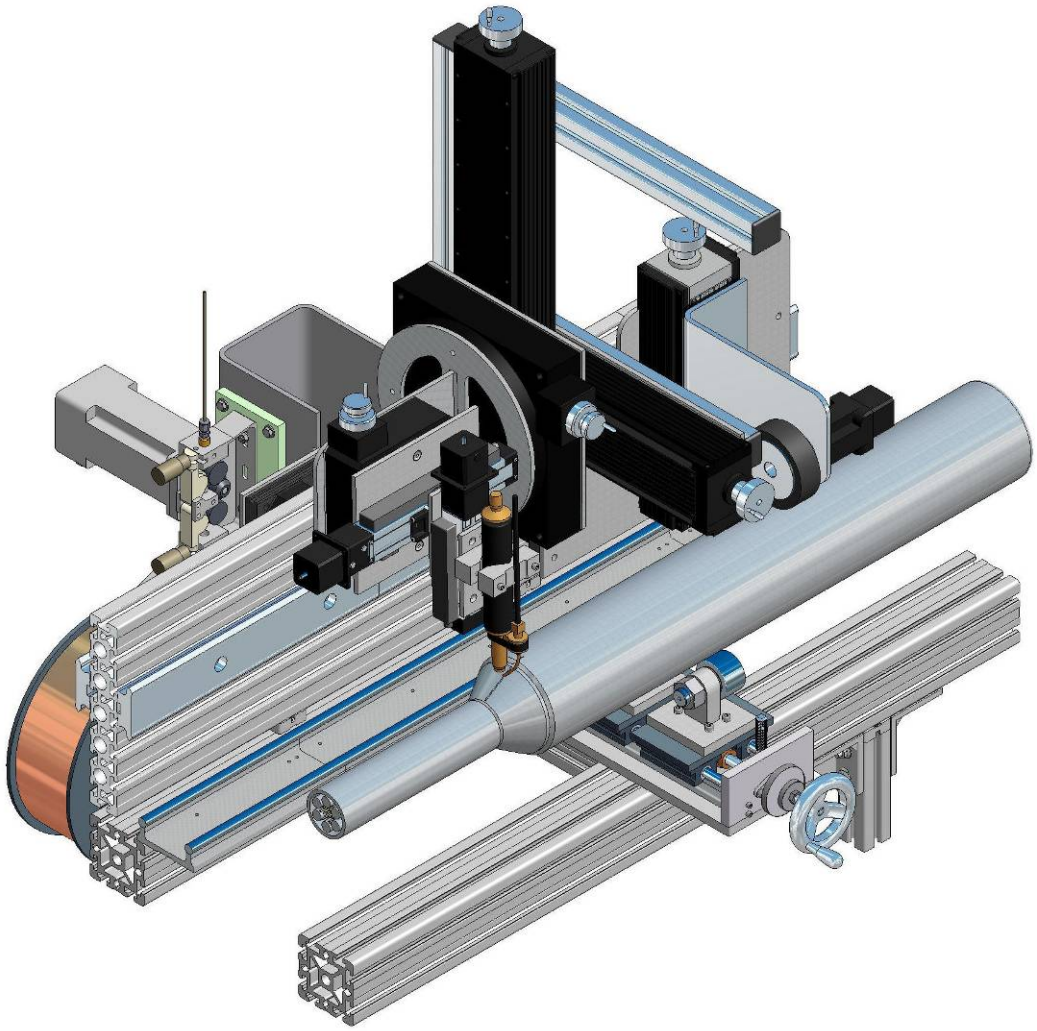


Figure 21. Isometric view of the weld head on the assembly bench.

The vertical section of the assembly bench has two rails that support the weld head and driver wheel. The weld head was design by INL weld engineers with experience in designing programmable welding systems using commercial off the shelf items. The software to control the weld head was developed at the INL. The weld head has four axes of controllable motion. A master computer controls two of the four axes along with the welder power, the wire feed, and rotational velocity of the capsule. The driver wheel is connected to a motor that drives the rotational velocity of the tube. The computer will be programmed to make automatic welds by first laying down skip welds, a roots pass, and finally filling in the remaining joint.

The dual linear rail located between the indexer and vertical portion of the bench is where the measuring arm will be located on a carriage that transverses the assembly bench. The arm has two dial indicators mounted perpendicular to each other to measure the misalignment in the tube (see Figure 22). A laser alignment system will be used to align the three 10-ft sections of dual rail on the bench.

This type of computer control over the welding process has been shown to minimize heat input to the base metal, avoiding excessive flexure by the capsule during welding.

A weld procedure for stainless steel using a tungsten inert gas welder is already in INL weld procedures. A development effort is needed to determine and qualify the parameters of the weld system that must be controlled by the computer. In addition, the operators also must be qualified on the computer and equipment.

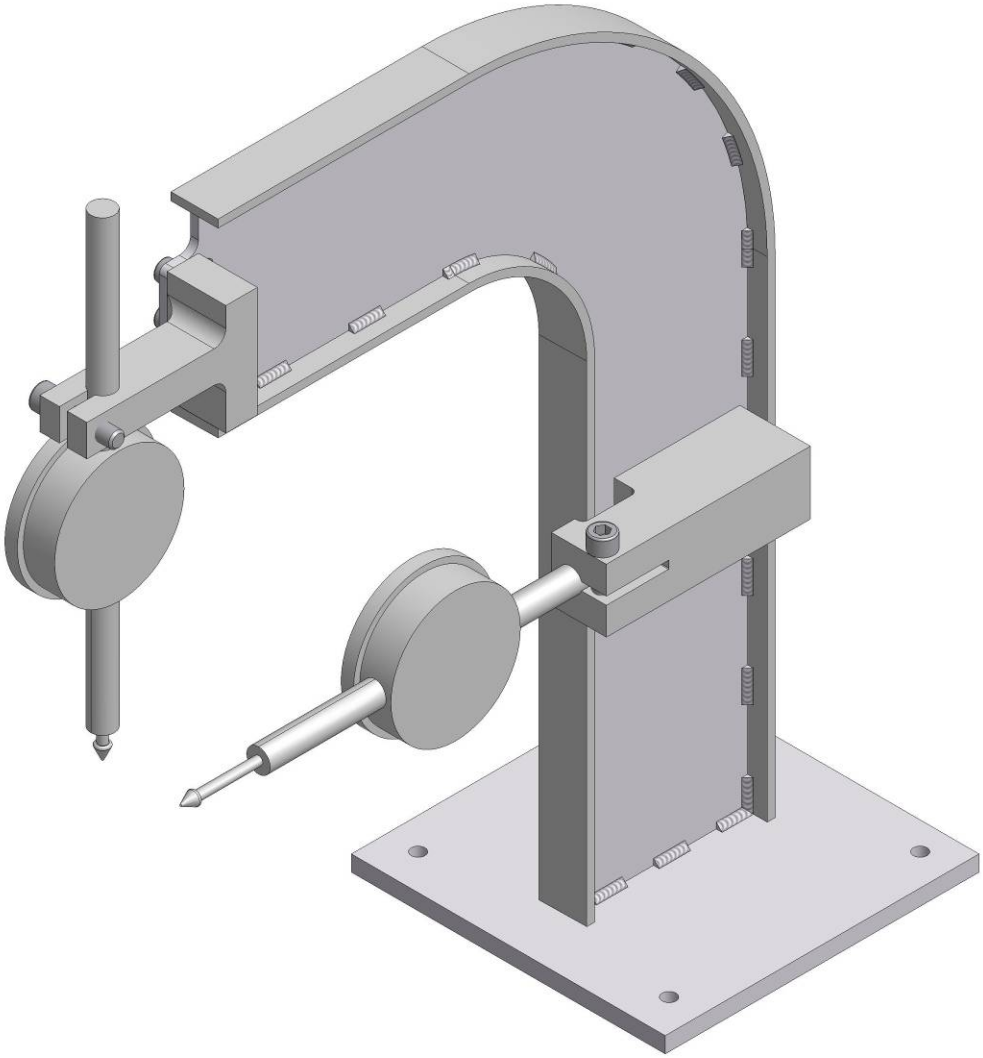


Figure 22. The measuring arm that will be mounted on the linear rail next to the capsule.

The length of the assembly required the removal of a laboratory wall to accommodate the length of the bench. Facility modifications were completed, which included the installation of a 480-volt service for the power supply for the weld head. Figure 23 shows the assembled bench (without weld head) in the modified laboratory.

Figure 23. Assembly bench in modified laboratory

5.3 Capsule Fabrication and Assembly

The capsule was fabricated from materials readily available and easily machined due to time period of performance. For that reason the graphite core section is machined from aluminum and Delrin™ (machinable plastic). The heat shield was fabricated from seam welded Haynes 230 tubing. Due to the limitation of the suppliers equipment the tubing was ordered with a 2-in. diameter instead of the actual 2.11-in. diameter. This required reducing the outer diameter of the simulated graphite body, which was fabricated from aluminum.

The actual heat shield has sections that have a tapered inner diameter. Because the tube supplier could not taper the thickness of the Haynes 230 plate stock to mimic the taper of the actual heat shield, the heat shield will be fabricated from three tubes having the same outer diameter, but different inner diameters and thicknesses. After placing the order, the tube supplier informed the INL there would be a delay in fabricating the thinnest wall tube due to securing a supplier for rolled Haynes 230 plate. Nevertheless, the tube will be useful for the calibration of the NDE systems being developed.

The tubes were cut to the required dimensions and lap joints machined on the ends. The Delrin graphite specimens were loaded into the aluminum graphite body. The heat shield was laser welded into two pieces and slipped over the aluminum “graphite” body. The final laser weld was made completing the heat shield. Figure 24 shows the heat shield being loaded into the broached outer pressure boundary. The gray rings are on the heat shield are plastic rings machined to the 2.11-in. outer diameter the actual heat shield. These rings centered the heat shield in the broached outer pressure boundary.

Figure 24. Loading the heat shield into the broached outer pressure boundary.

The upper section of the experiment was assembled in the back up configuration. This configuration is in case the pneumatic rams with the internal position sensors fail to satisfy pressure testing. The manufacture of the rams informed the project before the mockup began that new internal sensors would be used, which would seal better than the prior sensors. Because of the switch the rams would not be available until after assembly would be finished. The backup configuration uses the same bore diameter rams and similar linear resistor position sensor attached to the push rods to measure movement. Figure 25 shows the partially assembled upper section of the capsule. The next step was to pull the thermocouples and gas through the upper section of the capsule. The thermocouples were received as tights coils and required straightening using a tool provided by the thermocouple manufacture. The thermocouples are 3 mm in diameter for the in-core section and 2 mm in diameter for the out-of-core sections of the experiment. The reduction of the diameter for the out-of-core section was chosen to increase flexibility of the thermocouple. The 2 mm diameters turn out to be too flexible. For the actual experiment the thermocouples will be ordered with straight 3 mm diameter for the entire thermocouple. Figure 26 shows the installation of the thermocouples in the upper section of the capsule. Gas lines were routed through the lower section and connected to the lower cylinders. All the weld joints were tack welded to ensure a conductive path is present during welding and maintain assembled geometry.

One observation was the off the shelf stainless steel tubing used for the outer pressure boundary excluding the in-core section was out of round, especially the 5-in. tube used in the upper section. Some of concentricity issues come from allowables in the ASTM standard, but most comes in errant material handling between the mill and delivery to the Lab. The project proposes to ensure alignment by procuring all stainless steel tubing by boring our solid bar. The cost of gun barrel drilling for the in-core outer pressure boundary was not prohibitive. The concentricity of the current stainless steel tube will limit the degree of straightness obtained in this mockup.

The capsule was transferred to the assembly bench. Figure 27 shows the capsule on the assembly bench with the five-inch tube over the upper section. Figure 28 shows the complete upper head closure with the Conax™ seals installed. The weld head was positioned over the capsule's joints for welding the capsules joints. The head closure and bottom end of the capsule was left off to perform some functional testing after welding of the other joints. Electrical connections must be made, tested, and routed through the Conax™ seals before the upper head closure is mated to the capsule for welding. Prior weld coupon testing showed that each joint would shrink 0.040" per joint. Prior to transfer to the assembly bench, each joint was fitted with a 0.040" wire spacer at each joint to account for the shrinkage. This lengthened the experiment reducing the functional capability of the lower rams. After welding all the joints, the shrinkage reduced the required quarter inch movement of the lower cylinders to eighth of an inch. Thus not all the extended length due to the spacers was recovered from weld shrinkage. Thus new rams will be ordered with a longer stroke to compensate for joint spacing.

Figure 29 shows the weld head positioned over the capsule for the first weld. Figure 30 is an array of photos for each of the weld joints. The weld head performed all the stainless to stainless welds, while a qualified welder performed the Nitronic to stainless welds since the weld head was not qualified to perform Nitronic to stainless steel welds.

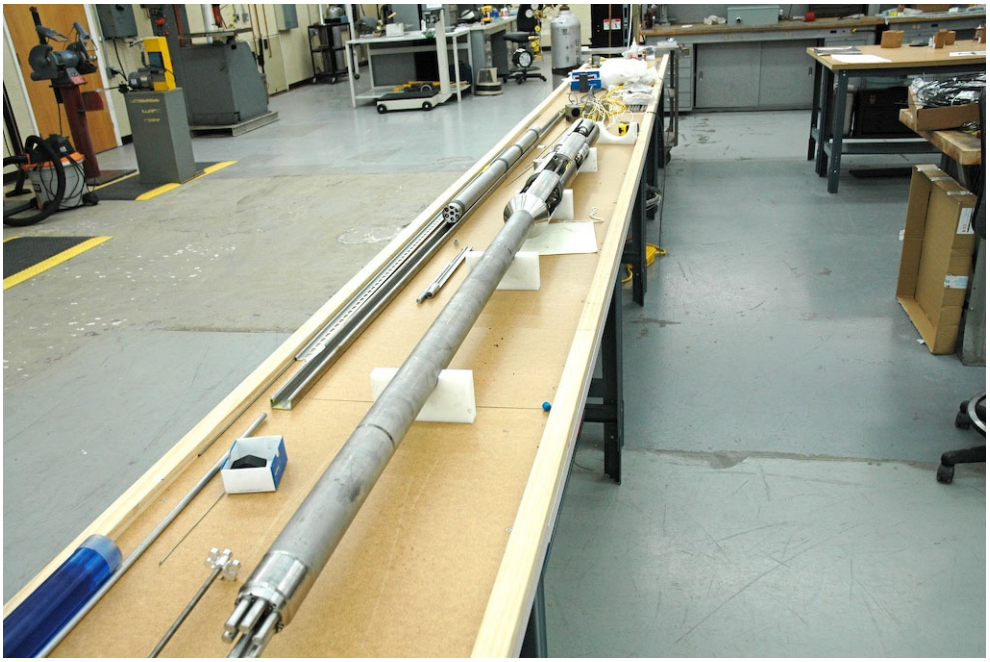


Figure 25. Assembled upper section of the mockup.

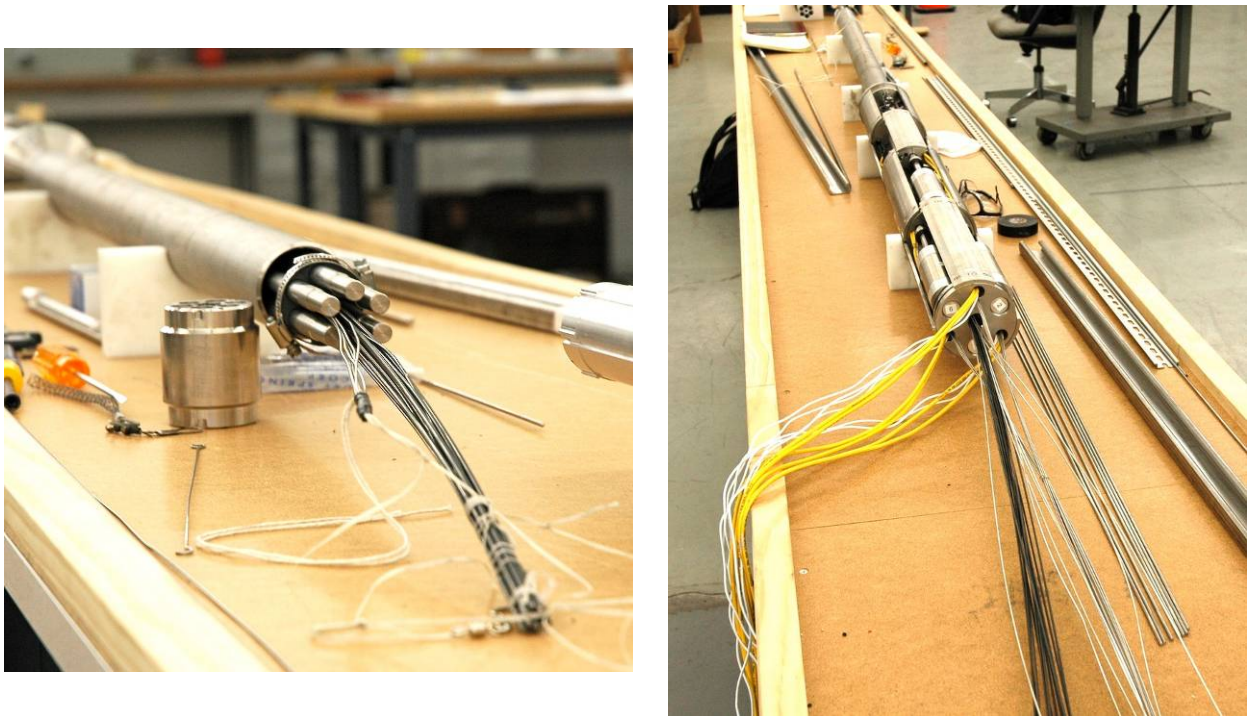


Figure 26. Installation of thermocouples and gas lines in the upper section of the mockup.

Figure 27. Assembled AGC-1 mockup on the assembly bench.

Figure 28. Completed upper head closure with Conax seals installed.

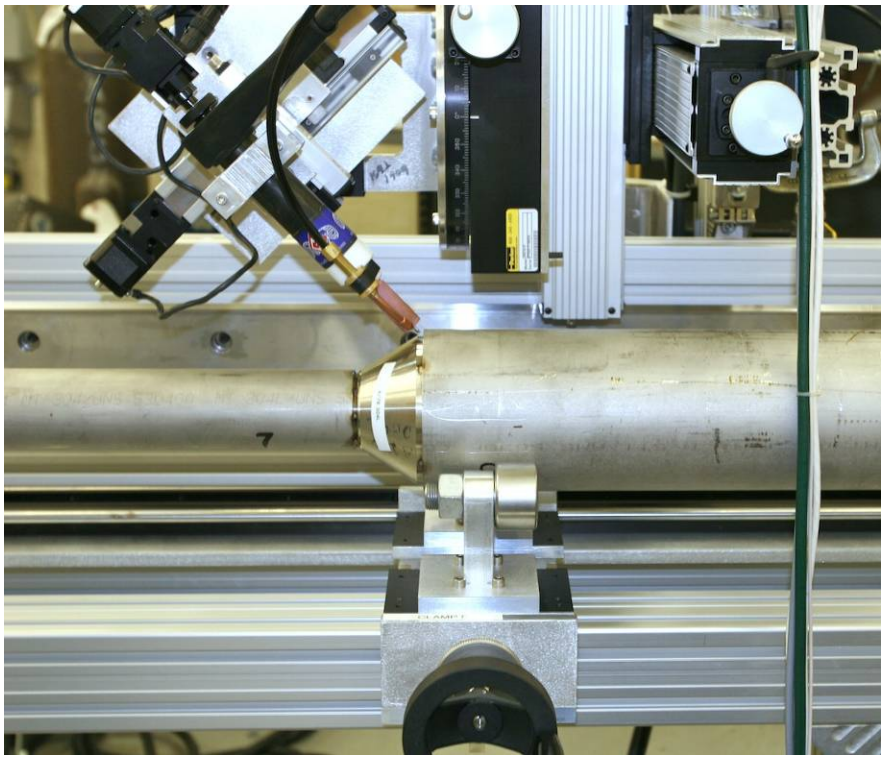


Figure 29. Weld head position over the capsule for the first weld.

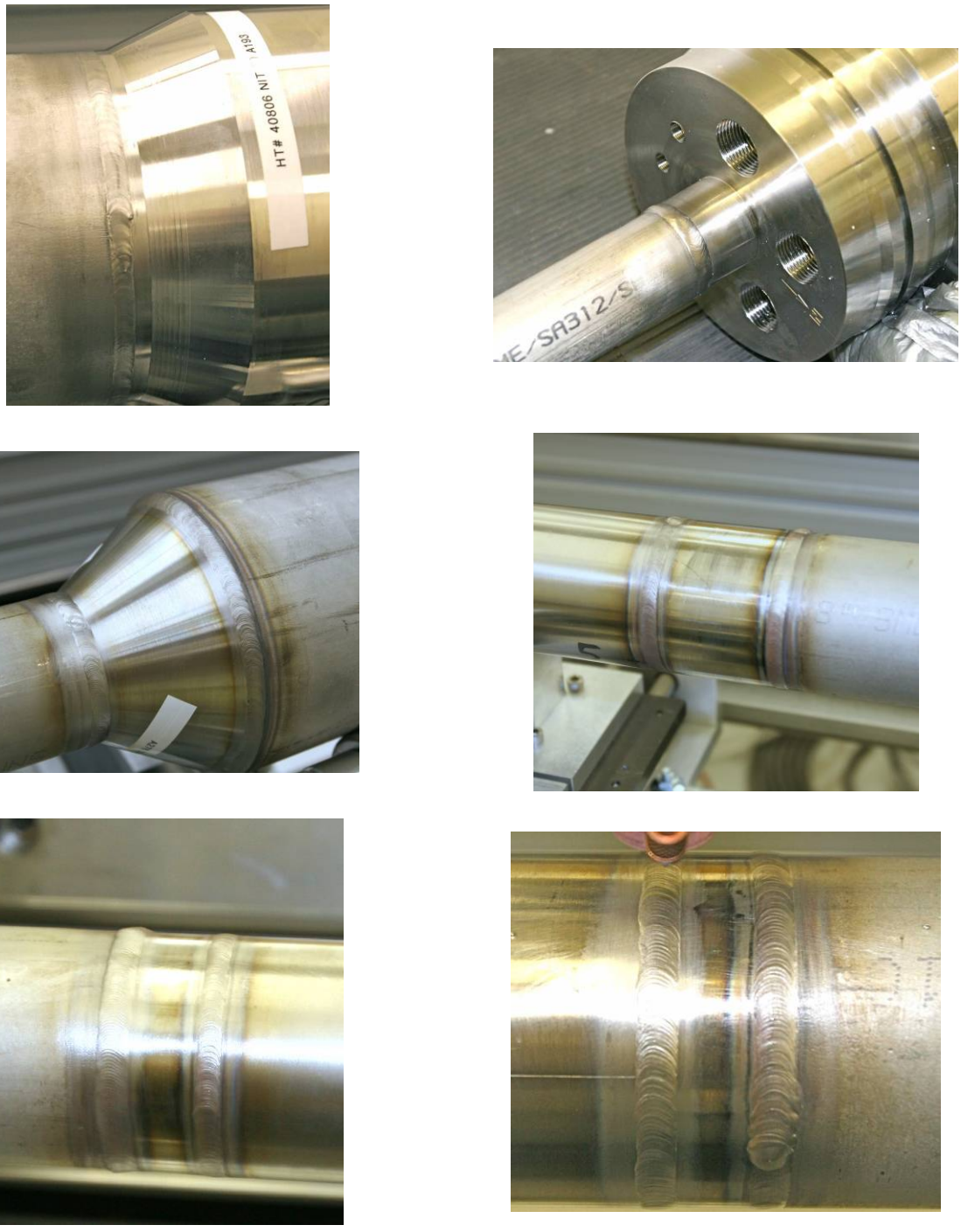


Figure 30. Photos of the AGC-1 capsule welds

6. CONCLUSION

This report describes the work performed on the AGC-1 fabrication and assembly mockups. As a result of internal programmatic reviews, NGNP is pursuing additional mockups to reduce the risk to the program and increase confidence in achieving programmatic goals. Three mockups are being pursued: (1) Operational Mockup Testing, (2) Fabrication Mockup, and (3) Assembly/Welding Mockup. Each of the mockups addresses different technical issues of the design. The mockups were performed to demonstrate the capsule could be fabricated and assembled to the design required to determine the irradiated graphite qualification data for the NGNP. The mockup has shown the in-core graphite experiment body, the heat shield and the broached outer boundary can be fabricated. Although inspection techniques still need to be qualified, fabrication of the components was successful.

The mockup has shown the capsule can be assembled to the design needed for the experiment. Detailed notes and photos were taken during assembly and will be use to develop detailed assembly procedures next fiscal year. Tooling was developed to assemble the graphite body, heat shield, and outer pressure boundary. Tooling that will come in contact with the graphite body or specimens will be replicated in non-metallic material for the actual capsule assembly. Experience was gained with external suppliers to determine limitations and lead times for future material purchases for the actual capsule.

A custom designed assembly bench was fabricated. Some errors in machining on the assembly bench limited availability of some features; nevertheless, the assembly bench performed as needed. Modifications to the assembly bench design will be pursued next fiscal year to mitigate the limited availability of features. The INL-designed weld head performed as required, but further optimization of the software controls would be beneficial to the actual capsule welding. The equipment was qualified and demonstrated the capability to meet the requirements in assembling and welding the capsule.

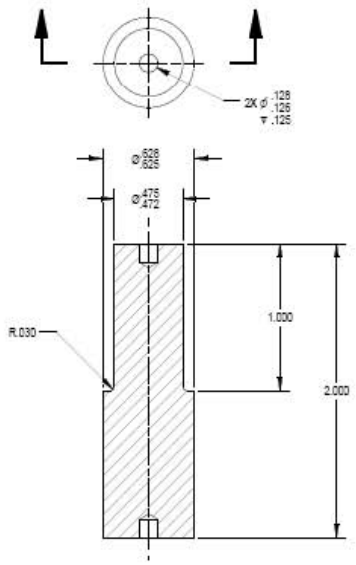
Numerous improvements were identified in the design, assembly, and welding of the mockup. The improvements will be implemented before the final design review of the capsule.

Appendix A

Inspection Records from SGL

SGL CARBON INSPECTION REPORT

Work Order No :	5086395	Quanity :	7
Sales Order No :	316739	Sample Size :	5
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Specimen Divider	Grade :	NBG25
Blue Print No :	635763 Revision 1 - Item 13	Date :	9/15/2006

Comments:	None
Schematic for Item - 16	

772209 Rev. 9/15/2006

SGL CARBON INSPECTION REPORT

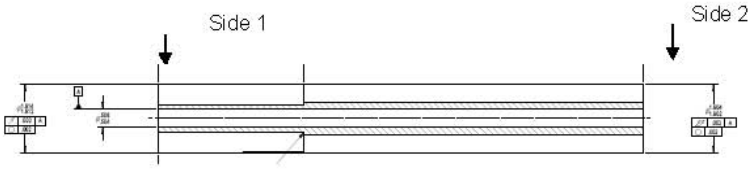
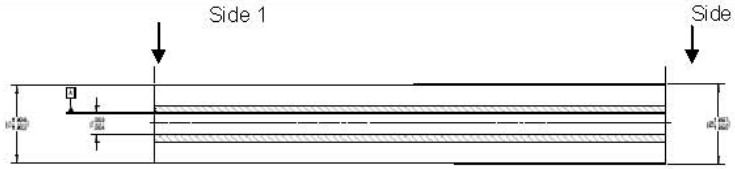
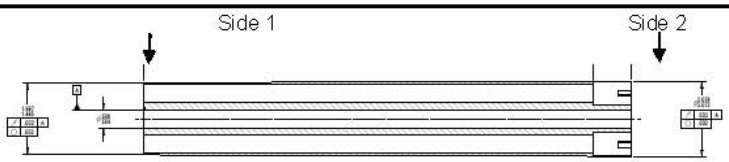
Work Order No :	5086395	**Quanity :**	7
Sales Order No :	316739	**Sample Size :**	5
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Specimen Divider	**Grade :**	NBG25
Blue Print No :	635763 Revision 1 - Item 13	**Date :**	9/15/2006

	SERIAL NUMBER						
Specifications	1	2	3	4	5		
Overall Length 2.000 +/- .010	1.9930	2.0000	2.0000	2.0000	2.0000		
Length 1.000 +/- .010	1.0020	1.0010	1.0000	1.0010	1.0000		
Outside Diameter .6265 +/- .0015	0.6265	0.6260	0.6265	0.6260	0.6260		
Outside Diameter .4735 +/- .0015	0.4738	0.4735	0.4730	0.4734	0.4730		
C-Bore Diameter .127 +/- .001	0.1280	0.1280	0.1280	0.1280	0.1280		
C-Bore Depth .125 +/- .010	0.1270	0.1260	0.1260	0.1260	0.1270		

772029 Rev. 9/15/2006

SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-6, 630427-7 and 630427-8
Comments:	**Parts were identified with identification numbers 630427-6, 630427-7 and 630427-8. .499 plug gage slid freely thru .504 diameter hole. Slight mis-match at glue joint of item 6 and 7, and items 7 and 8. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 9 and 10 after assembly. Holes broke thru the outside diameter due to thin wall thickness on item 630427-6.**
Schematic for Item - 6	
Schematic for Item - 7	
Schematic for Item - 8	

772167 Rev. 9/15/2006

SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-6						
Specifications							
Assembly Overall Length 39.000 +/- .030	39.0020						
Overall Length (Item 6) 13.250 +/- .005	13.2494						
Outside Diameter (Item 6) 1.913 +/- .001 - Side 1	1.9140						
Circulairty (Item 6) .002 Max. - Side 1	0.0008						
Outside Diameter (Item 6) 1.903 +/- .001 - Side 2	1.9037						
Circulairty (Item 6) .002 Max. - Side 2	0.0007						
.750 B.C. Diameter (Item 6) .750 +/- .010 - Side 1	0.7534						
1.39 B.C. Diameter (Item 6) 1.390 +/- .010 - Side 1	1.3913						
1.64 B.C. Diameter (Item 6) 1.640 +/- .010 - Side 1	1.6400						
.132 Diameter (Item 6) .132 +/- .004	0.1311						
.505 Diameter (Item 6) .505 +/- .001	0.5030						
.635 Diameter (Item 6) .635 +/- .010	0.6426						

772167 Rev. 9/15/2006

SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-6						
Specifications							
.750 B.C. Diameter (Item 6) .750 +/- .010 - Side 2	0.7500						
1.39 B.C. Diameter (Item 6) 1.390 +/- .010 - Side 2	1.3901						
.505 Position (Item 6) .005 Max. - Side 1	0.0037	0.0046	0.0050	0.0049	0.0047	0.0046	
.505 Position (Item 6) .005 Max. - Side 2	0.0064	0.0059	0.0114	0.0104	0.0141	0.0100	
.132 Position (Item 6) - Outer .005 Max. - Side 1	0.0088	0.0164	0.0087	0.0124	0.0084	0.0071	
.132 Position (Item 6) - Inner .005 Max. - Side 1	0.0076	0.0083	0.0111	0.0068	0.0086	0.0112	
.132 Position (Item 6) - Outer .005 Max. - Side 2	0.0093	0.0095	0.0095	0.0092	0.0096	0.0098	
.132 Position (Item 6) - Inner .005 Max. - Side 2	0.0094	0.0097	0.0101	0.0095	0.0094	0.0095	
Perp. of -B- to -A- (Item 6) .002 Max.	0.0006						
Para. to -B- (Item 6) .002 Max.	0.0009						

772167 Rev. 9/15/2006

SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-7						
Specifications							
Overall Length (Item 7) 12.500 +/- .010	12.4990						
Outside Diameter (Item 7) 1.903 +/- .001 - Side 1	1.9040						
Circulairty (Item 7) .002 Max. - Side 1	0.0009						
Outside Diameter (Item 7) 1.996 +/- .001 - Side 2	1.9950						
Circulairty (Item 7) .002 Max. - Side 2	0.0007						
.750 B.C. Diameter (Item 7) .750 +/- .010 - Side 1	0.7500						
1.39 B.C. Diameter (Item 7) 1.390 +/- .010 - Side 1	1.3900						
1.64 B.C. Diameter (Item 7) 1.640 +/- .010 - Side 1	1.6399						
.505 Diameter (Item 7) .505 +/- .001	0.5030						
.265 Diameter (Item 7) .265 +/- .005	0.2657						
.132 Diameter (Item 7) .132 +/- .004	0.1306						
.750 B.C. Diameter (Item 7) .750 +/- .010 - Side 2	0.7453						

772167 Rev. 9/15/2006

SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427- 7						
Specifications							
1.64 B.C. Diameter (Item 7) 1.640 +/- .010 - Side 2	1.6442						
.505 Position (Item 7) .005 Max. - Side 1	0.0042	0.0040	0.0042	0.0038	0.0042	0.0042	
.505 Position (Item 7) .005 Max. - Side 2	0.0027	0.0073	0.0039	0.0036	0.0069	0.0064	
.132 Position (Item 6) - Outer .005 Max. - Side 1	0.0042	0.0041	0.0040	0.0034	0.0050	0.0053	
.132 Position (Item 6) - Inner .005 Max. - Side 1	0.0048	0.0048	0.0048	0.0043	0.0046	0.0055	
.132 Position (Item 6) - Outer .005 Max. - Side 2	0.0197	0.0159	0.0192	0.0146	0.0045	0.0068	
.132 Position (Item 6) - Inner .005 Max. - Side 2	0.0214	0.0153	0.0100	0.0166			
Perp. of -B- (Item 7) .002 Max.	0.0003						
Para. to -B- (Item 7) .002 Max.	0.0005						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-8						
Specifications							
Overall Length (Item 8) 13.250 +/- .010	13.2470						
Outside Diameter (Item 8) 1.996 +/- .001 - Side 1	1.9968						
Circulairty (Item 8) .002 Max. - Side 1	0.0006						
Outside Diameter (Item 8) 2.073 +/- .001 - Side 2	2.0740						
Circulairty (Item 8) .002 Max. - Side 2	0.0009						
.750 B.C. Diameter (Item 8) .750 +/- .010 - Side 1	0.7499						
1.39 B.C. Diameter (Item 8) 1.390 +/- .010 - Side 1	1.3901						
1.64 B.C. Diameter (Item 8) 1.640 +/- .010 - Side 1	1.6399						
.505 Diameter (Item 8) .505 +/- .001	0.5030						
.265 Diameter (Item 8) .265 +/- .005	0.2661						
.132 Diameter (Item 8) .132 +/- .004	0.1318						
.750 B.C. Diameter (Item 8) .750 +/- .010 - Side 2	0.7446						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086394	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 1	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427- 8						
Specifications							
1.64 B.C. Diameter (Item 8) 1.640 +/- .010 - Side 2	1.6414						
.635 Diameter (Item 8) .635 +/- .005	0.6428						
.505 Position (Item 8) .005 Max. - Side 1	0.0055	0.0053	0.0052	0.0054	0.0056	0.0054	
.505 Position (Item 8) .005 Max. - Side 2	0.0064	0.0070	0.0094	0.0079	0.0046	0.0034	
.132 Position (Item 8) - Outer .005 Max. - Side 1	0.0063	0.0064	0.0066	0.0068	0.0068	0.0070	
.132 Position (Item 8) - Inner .005 Max. - Side 1	0.0069	0.0071	0.0065	0.0069			
.132 Position (Item 8) - Outer .005 Max. - Side 2	0.0046	0.0097	0.0041	0.0058	0.0085	0.0129	
.132 Position (Item 8) - Inner .005 Max. - Side 2	0.0086	0.0157					
Perp. of -B- (Item 7) .002 Max.	0.0006						
Para. to -B- (Item 7) .002 Max.	0.0006						

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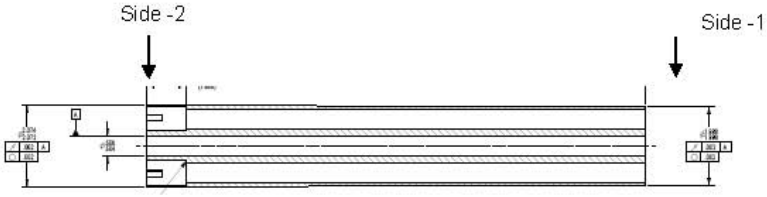
SGL CARBON INSPECTION REPORT

Work Order No :	5086388	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 2	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER
Comments:	Parts were identified with identification numbers 630427-9 and 630427-10. .479 plug gage slid freely thru .479 thru diameter. .501 plug gage slid freely thru .504 diameter hole. Slight mis-match at glue joint of item 9 and item 10. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 9 and 10 after assembly.
Schematic for Item - 9	
Schematic for Item - 10	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086388	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 2	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER 630427-9						
Specifications							
Assembly Overall Length 25.500 +/- .020	25.5010						
Overall Length (Item 9) 12.750 +/- .005	12.7503						
Outside Diameter (Item 9) 2.073 +/- .001 - Side 2	2.0752						
Circulairty (Item 9) .002 Max. - Side 2	0.0003						
Outside Diameter (Item 9) 1.997 +/- .001 - Side 1	1.9945						
Circulairty (Item 9) .002 Max. - Side 1	0.0003						
1.39 B.C. Diameter (Item 9) 1.390 +/- .010	1.3929						
1.64 B.C. Diameter (Item 9) 1.640 +/- .010 - Side 2	1.6400						
.505 Diameter (Item 9) .505 +/- .001	0.5040						
.635 Diameter (Item 9) .635 +/- .010	0.6421						
.265 Diameter (Item 9) .265 +/- .005	0.2662						
.132 Diameter (Item 9) .132 +/- .004	0.1308						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086388	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 2	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER 630427-9						
Specifications							
1.64 B.C. Diameter (Item 9) 1.640 +/- .010 - Side 1	1.6400						
.265 Diameter (Item 9) .265 +/- .005 - Side 1	0.2656						
.505 Position (Item 9) .005 Max. - Side 1	0.0036	0.0079	0.0031	0.0027	0.0067	0.0053	
.505 Position (Item 9) .005 Max. - Side 2	0.0016	0.0019	0.0017	0.0011	0.0005	0.0009	
.265 Position (Item 9) .005 Max. - Side 1	0.0010	0.0012	0.0020	0.0021	0.0018	0.0007	
.265 Position (Item 9) .005 Max. - Side 2	0.0029	0.0032	0.0021	0.0015	0.0017	0.0028	
.132 Position (Item 9) .005 Max. - Side 2	0.0011	0.0005	0.0011	0.0018	0.0021	0.0012	
Perp. of -B- to -A- (Item 9) .002 Max.	0.0012						
Para. to -B- (Item 9) .002 Max.	0.0010						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086388	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 2	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER 630427-10						
Specifications							
Overall Length (Item 10) 12.750 +/- .005	12.7486						
Outside Diameter (Item 10) 1.997 +/- .001 - Side 2	1.9972						
Circulairty (Item 10) .002 Max. - Side 2	0.0003						
Outside Diameter (Item 10) 1.939 +/- .001 - Side 1	1.9371						
Circulairty (Item 10) .002 Max. - Side 1	0.0003						
1.39 B.C. Diameter (Item 10) 1.390 +/- .010 - Side 2	1.3901						
1.64 B.C. Diameter (Item 10) 1.640 +/- .010 - Side 2	1.6400						
.505 Diameter (Item 10) .505 +/- .001	0.5045						
.479 Diameter (Item 10) .479 +/- .001	0.4793						
.265 Diameter (Item 10) .265 +/- .005	0.2658						
.132 Diameter (Item 10) .132 +/- .004	0.1320						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086388	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 2	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER 630427-10						
Specifications							
1.64 B.C. Diameter (Item 10) 1.640 +/- .010 - Side 1	**1.6400**						
.265 Diameter (Item 10) .265 +/- .005 - Side 1	**0.2662**						
.479 Position (Item 10) .005 Max. - Side 1	**0.0009**	**0.0003**	**0.0003**	**0.0003**	**0.0002**	**0.0002**	
.505 Position (Item 10) .005 Max. - Side 2	**0.0005**	**0.0004**	**0.0007**	**0.0003**	**0.0009**	**0.0013**	
.265 Position (Item 10) .005 Max. - Side 1	**0.0012**	**0.0014**	**0.0011**	**0.0008**	**0.0008**	**0.0006**	
.265 Position (Item 10) .005 Max. - Side 2	**0.0023**	**0.0027**	**0.0025**	**0.0025**	**0.0026**	**0.0025**	
.132 Position (Item 10) .005 Max. - Side 2	**0.0018**	**0.0008**	**0.0029**	**0.0015**	**0.0013**	**0.0009**	
Perp. of -B- (Item 10) .002 Max.	**0.0012**						
Para. to -B- (Item 10) .002 Max.	**0.0005**						

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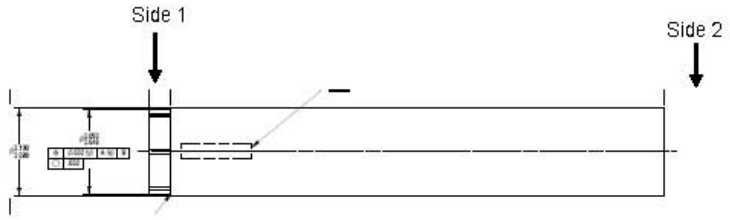
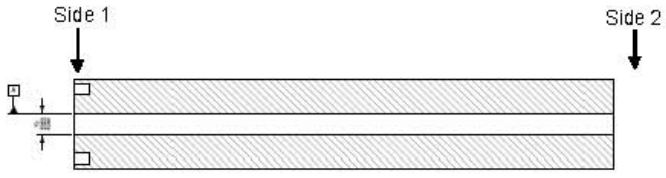
SGL CARBON INSPECTION REPORT

Work Order No :	5086385	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 3	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER - 630427-11 A
Comments:	Part was identified with identification numbers 630427-11-A. Identifiers "A"thru "F" were added to identification to keep individual dimensional traceability. No identification number required for Item 12. .501 plug gage slid freely thru .504 thru diameter. Slight mis-match in .504 holes at glue joint of item 11 and item 12. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 11 and 12 after assembly. Small glue spots on surface of outside diameter after assembly.
Schematic for Item - 11	
Schematic for Item - 12	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 A						
Specifications							
Assembly Overall Length 24.750 +/- .020	24.7520						
Overall Length (Item 11) 12.125 +/- .010	12.1247						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 1	2.0991						
Circulairty (Item 11) .002 Max. - Side 1	0.0002						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 2	2.0990						
Circulairty (Item 11) .002 Max. - Side 2	0.0009						
Shoulder Diameter (Item 11) 2.049 +/- .001 - Side 1	2.0492						
Circulairty (Item 11) .002 Max. - Side 1	0.0006						
1.39 B.C. Diameter (Item 11) 1.390 +/- .010	1.3901						
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 11) .505 +/- .001	0.5035						
.265 Diameter (Item 11) .265 +/- .010	0.2661						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 A						
Specifications							
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 2	1.6401						
.265 Diameter (Item 11) .265 +/- .005 - Side 2	0.2662						
.505 Position (Item 11) .005 Max. - Side 1	0.0023	0.0035	0.0033	0.0036	0.0021	0.0037	
.505 Position (Item 11) .005 Max. - Side 2	0.0056	0.0057	0.0061	0.0053	0.0054	0.0060	
.265 Position (Item 11) .005 Max. - Side 1	0.0041	0.0045	0.0043	0.0042	0.0040	0.0038	
.265 Position (Item 11) .005 Max. - Side 2	0.0066	0.0061	0.0060	0.0065	0.0076	0.0069	
Perp. of -B- to -A- (Item 11) .002 Max.	0.0005						
Para. to -B- (Item 11) .002 Max.	0.0009						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 A						
Specifications							
Overall Length (Item 12) 12.625 +/- .010	12.6247						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 1	2.0995						
Circulairty (Item 12) .002 Max. - Side 1	0.0006						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 2	2.0991						
Circulairty (Item 12) .002 Max. - Side 2	0.0005						
1.39 B.C. Diameter (Item 12) 1.390 +/- .010	1.3900						
1.64 B.C. Diameter (Item 12) 1.640 +/- .010 - Side 1	1.6399						
.505 Diameter (Item 12) .505 +/- .001	0.5035						
.265 Diameter (Item 12) .265 +/- .005	0.2663						
1.39 B.C. Diameter (Item 12) 1.3900 +/- .010 - Side 2	1.3921						
.505 Position (Item 12) .005 Max. - Side 1	0.0023	0.0031	0.0037	0.0027	0.0029	0.0034	
.505 Position (Item 12) .005 Max. - Side 2	0.0049	0.0053	0.0057	0.0051	0.0048	0.0050	

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SGL CARBON INSPECTION REPORT

Work Order No :	**5086385**	**Quanity :**	**1**
Sales Order No :	**316739**	**Sample Size :**	**1**
Customer :	**Batelle Energy Alliance**	**Inspector :**	**SB**
Description :	**Advanced Graphite Capsule Assembly - 3**	**Grade :**	**NBG25**
Blue Print No :	**635763 Revision 1**	**Date :**	**9/15/2006**

	SERIAL NUMBER - 630427-11 A						
Specifications							
.265 Position (Item 12) .005 Max. - Side 1	**0.0041**	**0.0045**	**0.0043**	**0.0042**	**0.0040**	**0.0038**	
Perp. of -B- (Item 12) .002 Max.	**0.0008**						
Para. to -B- (Item 12) .002 Max.	**0.0007**						

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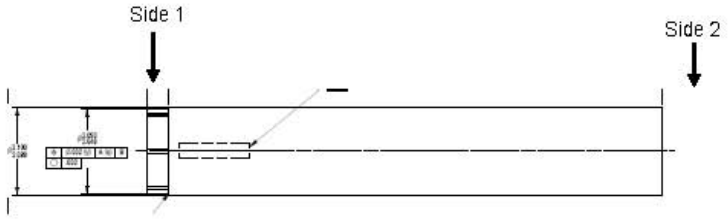
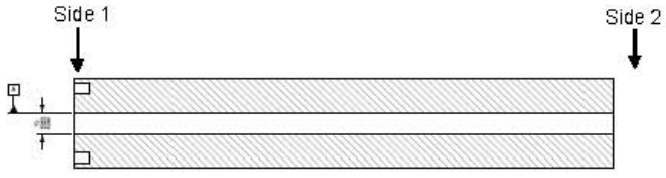
SGL CARBON INSPECTION REPORT

Work Order No :	5086385	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 3	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER - 630427-11 B
Comments:	Part was identified with identification numbers 630427-11-B. Identifiers "A"thru "F" were added to identification to keep individual dimensional traceability. No identification number required for Item 12. .500 plug gage slid freely thru .504 thru diameter. Slight mis-match in .504 holes at glue joint of item 11 and item 12. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 11 and 12 after assembly. Small glue spots on surface of outside diameter after assembly.
Schematic for Item - 11	
Schematic for Item - 12	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 B						
Specifications							
Assembly Overall Length 24.750 +/- .020	24.7510						
Overall Length (Item 11) 12.125 +/- .010	12.1244						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 1	2.0989						
Circulairty (Item 11) .002 Max. - Side 1	0.0002						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 2	2.0982						
Circulairty (Item 11) .002 Max. - Side 2	0.0002						
Shoulder Diameter (Item 11) 2.049 +/- .001 - Side 1	2.0490						
Circulairty (Item 11) .002 Max. - Side 1	0.0007						
1.39 B.C. Diameter (Item 11) 1.390 +/- .010	1.3902						
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 11) .505 +/- .001	0.5035						
.265 Diameter (Item 11) .265 +/- .010	0.2660						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 B						
Specifications							
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 2	1.6400						
.265 Diameter (Item 11) .265 +/- .005 - Side 2	0.2661						
.505 Position (Item 11) .005 Max. - Side 1	0.0042	0.0041	0.0043	0.0051	0.0053	0.0041	
.505 Position (Item 11) .005 Max. - Side 2	0.0062	0.0065	0.0060	0.0061	0.0058	0.0067	
.265 Position (Item 11) .005 Max. - Side 1	0.0069	0.0071	0.0064	0.0060	0.0057	0.0058	
.265 Position (Item 11) .005 Max. - Side 2	0.0096	0.0080	0.0062	0.0062	0.0081	0.0102	
Perp. of -B- to -A- (Item 11) .002 Max.	0.0006						
Para. to -B- (Item 11) .002 Max.	0.0010						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 B						
Specifications							
Overall Length (Item 12) 12.625 +/- .010	12.6263						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 1	2.0990						
Circulairty (Item 12) .002 Max. - Side 1	0.0003						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 2	2.0985						
Circulairty (Item 12) .002 Max. - Side 2	0.0001						
1.39 B.C. Diameter (Item 12) 1.390 +/- .010	1.3901						
1.64 B.C. Diameter (Item 12) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 12) .505 +/- .001	0.5035						
.265 Diameter (Item 12) .265 +/- .005	0.2655						
1.39 B.C. Diameter (Item 12) 1.3900 +/- .010 - Side 2	1.3905						
.505 Position (Item 12) .005 Max. - Side 1	0.0027	0.0025	0.0021	0.0036	0.0039	0.0041	
.505 Position (Item 12) .005 Max. - Side 2	0.0049	0.0047	0.0052	0.0053	0.0050	0.0051	

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SGL CARBON INSPECTION REPORT

Work Order No :	**5086385**	**Quanity :**	**1**
Sales Order No :	**316739**	**Sample Size :**	**1**
Customer :	**Batelle Energy Alliance**	**Inspector :**	**SB**
Description :	**Advanced Graphite Capsule Assembly - 3**	**Grade :**	**NBG25**
Blue Print No :	**635763 Revision 1**	**Date :**	**9/15/2006**

	SERIAL NUMBER - 630427-11 B						
Specifications							
.265 Position (Item 12) .005 Max. - Side 1	**0.0033**	**0.0031**	**0.0029**	**0.0033**	**0.0035**	**0.0032**	
Perp. of -B- (Item 12) .002 Max.	**0.0009**						
Para. to -B- (Item 12) .002 Max.	**0.0007**						

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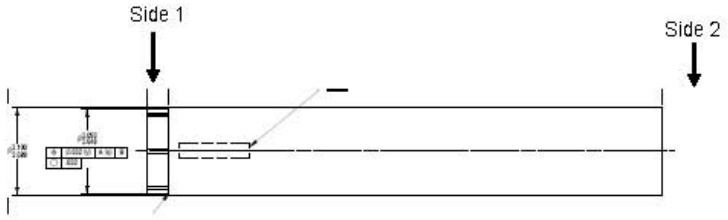
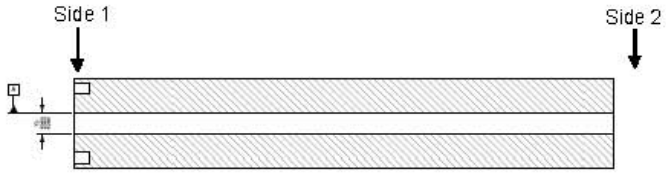
SGL CARBON INSPECTION REPORT

Work Order No :	5086385	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 3	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER - 630427-11 C
Comments:	Part was identified with identification numbers 630427-11-C. Identifiers "A"thru "F" were added to identification to keep individual dimensional traceability. No identification number required for Item 12. .501 plug gage slid freely thru .504 thru diameter. Slight mis-match in .504 holes at glue joint of item 11 and item 12. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 11 and 12 after assembly.
Schematic for Item - 11	
Schematic for Item - 12	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 C						
Specifications							
Assembly Overall Length 24.750 +/- .020	24.7500						
Overall Length (Item 11) 12.125 +/- .010	12.1246						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 1	2.0991						
Circulairty (Item 11) .002 Max. - Side 1	0.0001						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 2	2.0986						
Circulairty (Item 11) .002 Max. - Side 2	0.0002						
Shoulder Diameter (Item 11) 2.049 +/- .001 - Side 1	2.0509						
Circulairty (Item 11) .002 Max. - Side 1	0.0007						
1.39 B.C. Diameter (Item 11) 1.390 +/- .010	1.3902						
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 11) .505 +/- .001	0.5030						
.265 Diameter (Item 11) .265 +/- .010	0.2263						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 C						
Specifications							
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 2	1.6403						
.265 Diameter (Item 11) .265 +/- .005 - Side 2	0.2662						
.505 Position (Item 11) .005 Max. - Side 1	0.0031	0.0037	0.0038	0.0042	0.0047	0.0041	
.505 Position (Item 11) .005 Max. - Side 2	0.0049	0.0056	0.0053	0.0051	0.0053	0.0048	
.265 Position (Item 11) .005 Max. - Side 1	0.0022	0.0021	0.0017	0.0021	0.0023	0.0023	
.265 Position (Item 11) .005 Max. - Side 2	0.0046	0.0032	0.0036	0.0037	0.0047	0.0053	
Perp. of -B- to -A- (Item 11) .002 Max.	0.0003						
Para. to -B- (Item 11) .002 Max.	0.0007						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 C						
Specifications							
Overall Length (Item 12) 12.625 +/- .010	12.6255						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 1	2.0990						
Circulairty (Item 12) .002 Max. - Side 1	0.0001						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 2	2.0985						
Circulairty (Item 12) .002 Max. - Side 2	0.0001						
1.39 B.C. Diameter (Item 12) 1.390 +/- .010	1.3900						
1.64 B.C. Diameter (Item 12) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 12) .505 +/- .001	0.5030						
.265 Diameter (Item 12) .265 +/- .005	0.2662						
1.39 B.C. Diameter (Item 12) 1.3900 +/- .010 - Side 2	1.3912						
.505 Position (Item 12) .005 Max. - Side 1	0.0040	0.0046	0.0043	0.0052	0.0041	0.0048	
.505 Position (Item 12) .005 Max. - Side 2	0.0059	0.0049	0.0057	0.0061	0.0053	0.0057	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 C						
Specifications							
.265 Position (Item 12) .005 Max. - Side 1	0.0049	0.0057	0.0057	0.0051	0.0049	0.0049	
Perp. of -B- (Item 12) .002 Max.	0.0010						
Para. to -B- (Item 12) .002 Max.	0.0010						

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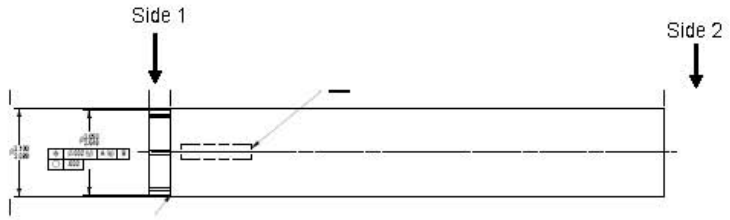
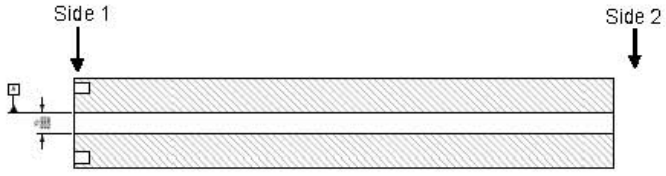
SGL CARBON INSPECTION REPORT

Work Order No :	5086385	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 3	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER - 630427-11 D
Comments:	Part was identified with identification numbers 630427-11-D. Identifiers "A"thru "F" were added to identification to keep individual dimensional traceability. No identification number required for Item 12. .501 plug gage slid freely thru .504 thru diameter. Slight mis-match in .504 holes at glue joint of item 11 and item 12. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 11 and 12 after assembly.
Schematic for Item - 11	
Schematic for Item - 12	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 D						
Specifications							
Assembly Overall Length 24.750 +/- .020	24.7490						
Overall Length (Item 11) 12.125 +/- .010	12.1233						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 1	2.0989						
Circulairty (Item 11) .002 Max. - Side 1	0.0001						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 2	2.0990						
Circulairty (Item 11) .002 Max. - Side 2	0.0002						
Shoulder Diameter (Item 11) 2.049 +/- .001 - Side 1	2.0485						
Circulairty (Item 11) .002 Max. - Side 1	0.0009						
1.39 B.C. Diameter (Item 11) 1.390 +/- .010	1.3902						
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 1	1.6401						
.505 Diameter (Item 11) .505 +/- .001	0.5030						
.265 Diameter (Item 11) .265 +/- .010	0.2662						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 D						
Specifications							
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 2	1.6404						
.265 Diameter (Item 11) .265 +/- .005 - Side 2	0.2661						
.505 Position (Item 11) .005 Max. - Side 1	0.0040	0.0042	0.0047	0.0051	0.0042	0.0043	
.505 Position (Item 11) .005 Max. - Side 2	0.0049	0.0053	0.0051	0.0056	0.0049	0.0050	
.265 Position (Item 11) .005 Max. - Side 1	0.0039	0.0035	0.0036	0.0041	0.0044	0.0048	
.265 Position (Item 11) .005 Max. - Side 2	0.0040	0.0061	0.0060	0.0047	0.0031	0.0024	
Perp. of -B- to -A- (Item 11) .002 Max.	0.0004						
Para. to -B- (Item 11) .002 Max.	0.0005						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 D						
Specifications							
Overall Length (Item 12) 12.625 +/- .010	12.6255						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 1	2.0990						
Circulairty (Item 12) .002 Max. - Side 1	0.0004						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 2	2.0994						
Circulairty (Item 12) .002 Max. - Side 2	0.0002						
1.39 B.C. Diameter (Item 12) 1.390 +/- .010	1.3900						
1.64 B.C. Diameter (Item 12) 1.640 +/- .010 - Side 1	1.6399						
.505 Diameter (Item 12) .505 +/- .001	0.5030						
.265 Diameter (Item 12) .265 +/- .005	0.2661						
1.39 B.C. Diameter (Item 12) 1.3900 +/- .010 - Side 2	1.3905						
.505 Position (Item 12) .005 Max. - Side 1	0.0039	0.0037	0.0035	0.0038	0.0042	0.0046	
.505 Position (Item 12) .005 Max. - Side 2	0.0053	0.0056	0.0057	0.0051	0.0049	0.0054	

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SGL CARBON INSPECTION REPORT

Work Order No :	**5086385**	**Quanity :**	**1**
Sales Order No :	**316739**	**Sample Size :**	**1**
Customer :	**Batelle Energy Alliance**	**Inspector :**	**SB**
Description :	**Advanced Graphite Capsule Assembly - 3**	**Grade :**	**NBG25**
Blue Print No :	**635763 Revision 1**	**Date :**	**9/15/2006**

	SERIAL NUMBER - 630427-11 D						
Specifications							
.265 Position (Item 12) .005 Max. - Side 1	**0.0039**	**0.0041**	**0.0039**	**0.0041**	**0.0041**	**0.0039**	
Perp. of -B- (Item 12) .002 Max.	**0.0009**						
Para. to -B- (Item 12) .002 Max.	**0.0008**						

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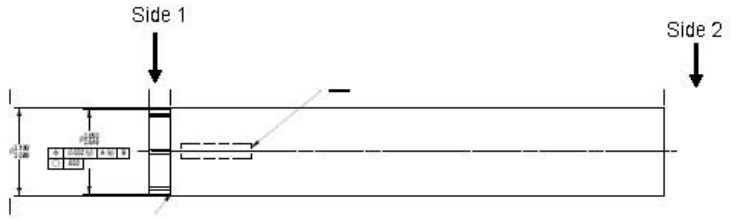
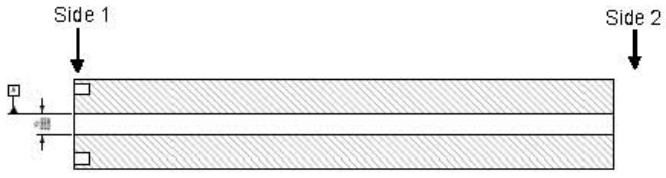
SGL CARBON INSPECTION REPORT

Work Order No :	5086385	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 3	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER - 630427-11 E
Comments:	Part was identified with identification numbers 630427-11-D. Identifiers "A"thru "F" were added to identification to keep individual dimensional traceability. No identification number required for Item 12. .501 plug gage slid freely thru .504 thru diameter. Slight mis-match in .504 holes at glue joint of item 11 and item 12. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 11 and 12 after assembly.
Schematic for Item - 11	
Schematic for Item - 12	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 E						
Specifications							
Assembly Overall Length 24.750 +/- .020	24.7530						
Overall Length (Item 11) 12.125 +/- .010	12.1239						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 1	2.0993						
Circulairty (Item 11) .002 Max. - Side 1	0.0003						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 2	2.0990						
Circulairty (Item 11) .002 Max. - Side 2	0.0001						
Shoulder Diameter (Item 11) 2.049 +/- .001 - Side 1	2.0487						
Circulairty (Item 11) .002 Max. - Side 1	0.0008						
1.39 B.C. Diameter (Item 11) 1.390 +/- .010	1.3901						
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 11) .505 +/- .001	0.5035						
.265 Diameter (Item 11) .265 +/- .010	0.2657						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 E						
Specifications							
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 2	1.6403						
.265 Diameter (Item 11) .265 +/- .005 - Side 2	0.2661						
.505 Position (Item 11) .005 Max. - Side 1	0.0036	0.0041	0.0031	0.0032	0.0033	0.0036	
.505 Position (Item 11) .005 Max. - Side 2	0.0051	0.0047	0.0053	0.0056	0.0052	0.0055	
.265 Position (Item 11) .005 Max. - Side 1	0.0032	0.0036	0.0034	0.0031	0.0030	0.0027	
.265 Position (Item 11) .005 Max. - Side 2	0.0066	0.0047	0.0031	0.0041	0.0061	0.0074	
Perp. of -B- to -A- (Item 11) .002 Max.	0.0004						
Para. to -B- (Item 11) .002 Max.	0.0006						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 E						
Specifications							
Overall Length (Item 12) 12.625 +/- .010	12.6263						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 1	2.0985						
Circulairty (Item 12) .002 Max. - Side 1	0.0007						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 2	2.0991						
Circulairty (Item 12) .002 Max. - Side 2	0.0006						
1.39 B.C. Diameter (Item 12) 1.390 +/- .010	1.3902						
1.64 B.C. Diameter (Item 12) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 12) .505 +/- .001	0.5035						
.265 Diameter (Item 12) .265 +/- .005	0.2653						
1.39 B.C. Diameter (Item 12) 1.3900 +/- .010 - Side 2	1.3906						
.505 Position (Item 12) .005 Max. - Side 1	0.0039	0.0041	0.0042	0.0037	0.0036	0.0043	
.505 Position (Item 12) .005 Max. - Side 2	0.0057	0.0056	0.0053	0.0056	0.0059	0.0061	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 E						
Specifications							
.265 Position (Item 12) .005 Max. - Side 1	**0.0021**	**0.0028**	**0.0018**	**0.0025**	**0.0026**	**0.0027**	
Perp. of -B- (Item 12) .002 Max.	**0.0008**						
Para. to -B- (Item 12) .002 Max.	**0.0007**						

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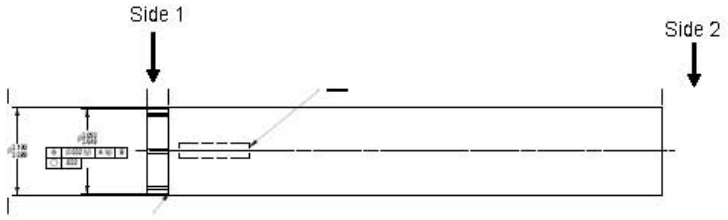
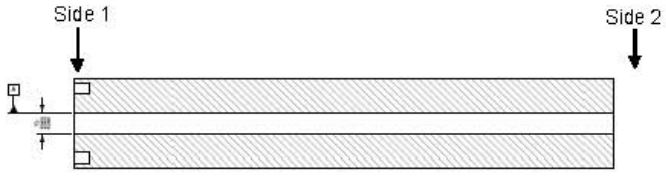
SGL CARBON INSPECTION REPORT

Work Order No :	5086385	Quanity :	1
Sales Order No :	316739	Sample Size :	1
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Advanced Graphite Capsule Assembly - 3	Grade :	NBG25
Blue Print No :	635763 Revision 1	Date :	9/15/2006

	SERIAL NUMBER - 630427-11 F
Comments:	Part was identified with identification numbers 630427-11-F. Identifiers "A"thru "F" were added to identification to keep individual dimensional traceability. No identification number required for Item 12. .500 plug gage slid freely thru .504 thru diameter. Slight mis-match in .504 holes at glue joint of item 11 and item 12. Slight mis-match on the outside diameter of part due to assembly. No post machining done on items 11 and 12 after assembly. Glue spots on outside diameter. 1 tab machined too deep, cut into 2.049 diameter.
Schematic for Item - 11	
Schematic for Item - 12	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 F						
Specifications							
Assembly Overall Length 24.750 +/- .020	24.7520						
Overall Length (Item 11) 12.125 +/- .005	12.1247						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 1	2.0992						
Circulairty (Item 11) .002 Max. - Side 1	0.0004						
Outside Diameter (Item 11) 2.099 +/- .001 - Side 2	2.0989						
Circulairty (Item 11) .002 Max. - Side 2	0.0002						
Shoulder Diameter (Item 11) 2.049 +/- .001 - Side 1	2.0499						
Circulairty (Item 11) .002 Max. - Side 1	0.0006						
1.39 B.C. Diameter (Item 11) 1.390 +/- .010	1.3902						
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 1	1.6400						
.505 Diameter (Item 11) .505 +/- .001	0.5035						
.265 Diameter (Item 11) .265 +/- .010	0.2663						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 F						
Specifications							
1.64 B.C. Diameter (Item 11) 1.640 +/- .010 - Side 2	1.6401						
.265 Diameter (Item 11) .265 +/- .005 - Side 2	0.2661						
.505 Position (Item 11) .005 Max. - Side 1	0.0047	0.0051	0.0053	0.0048	0.0049	0.0048	
.505 Position (Item 11) .005 Max. - Side 2	0.0056	0.0058	0.0051	0.0053	0.0054	0.0056	
.265 Position (Item 11) .005 Max. - Side 1	0.0044	0.0049	0.0048	0.0045	0.0043	0.0043	
.265 Position (Item 11) .005 Max. - Side 2	0.0064	0.0054	0.0067	0.0091	0.0094	0.0080	
Perp. of -B- to -A- (Item 11) .002 Max.	0.0005						
Para. to -B- (Item 11) .002 Max.	0.0008						

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SGL CARBON INSPECTION REPORT

Work Order No :	5086385	**Quanity :**	1
Sales Order No :	316739	**Sample Size :**	1
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Advanced Graphite Capsule Assembly - 3	**Grade :**	NBG25
Blue Print No :	635763 Revision 1	**Date :**	9/15/2006

	SERIAL NUMBER - 630427-11 F						
Specifications							
Overall Length (Item 12) 12.625 +/- .005	12.6258						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 1	2.0993						
Circulairty (Item 12) .002 Max. - Side 1	0.0002						
Outside Diameter (Item 12) 2.099 +/- .001 - Side 2	2.0990						
Circulairty (Item 12) .002 Max. - Side 2	0.0001						
1.39 B.C. Diameter (Item 12) 1.390 +/- .010	1.3901						
1.64 B.C. Diameter (Item 12) 1.640 +/- .010 - Side 1	1.6398						
.505 Diameter (Item 12) .505 +/- .001	0.5035						
.265 Diameter (Item 12) .265 +/- .005	0.2659						
1.39 B.C. Diameter (Item 12) 1.3900 +/- .010 - Side 2	1.3907						
.505 Position (Item 12) .005 Max. - Side 1	0.0037	0.0032	0.0031	0.0027	0.0028	0.0031	
.505 Position (Item 12) .005 Max. - Side 2	0.0049	0.0053	0.0056	0.0051	0.0054	0.0052	

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SGL CARBON INSPECTION REPORT

Work Order No :	**5086385**	**Quanity :**	**1**
Sales Order No :	**316739**	**Sample Size :**	**1**
Customer :	**Batelle Energy Alliance**	**Inspector :**	**SB**
Description :	**Advanced Graphite Capsule Assembly - 3**	**Grade :**	**NBG25**
Blue Print No :	**635763 Revision 1**	**Date :**	**9/15/2006**

	SERIAL NUMBER - 630427-11 F						
Specifications							
.265 Position (Item 12) .005 Max. - Side 1	**0.0019**	**0.0024**	**0.0026**	**0.0024**	**0.0020**	**0.0020**	
Perp. of -B- (Item 12) .002 Max.	**0.0009**						
Para. to -B- (Item 12) .002 Max.	**0.0010**						

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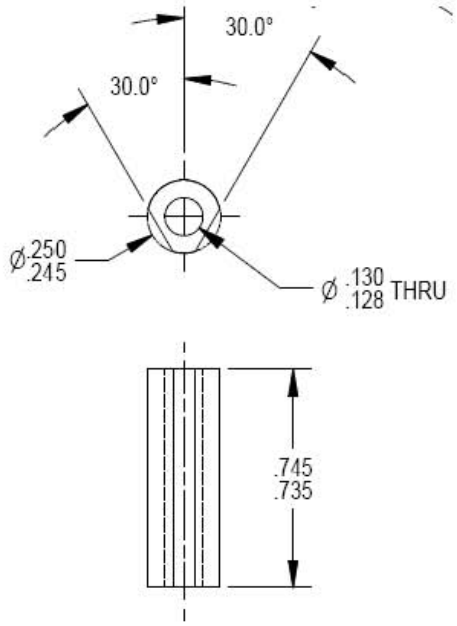
SGL CARBON INSPECTION REPORT

Work Order No :	5086396	Quanity :	24
Sales Order No :	316739	Sample Size :	6
Customer :	Batelle Energy Alliance	Inspector :	SB
Description :	Shaved Centering Pin	Grade :	NBG25
Blue Print No :	635763 Revision 1 - Item 16	Date :	9/15/2006

Comments:	None.
Schematic for Item - 16	

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SGL CARBON INSPECTION REPORT

Work Order No :	5086396	**Quanity :**	24
Sales Order No :	316739	**Sample Size :**	6
Customer :	Batelle Energy Alliance	**Inspector :**	SB
Description :	Shaved Centering Pin	**Grade :**	NBG25
Blue Print No :	635763 Revision 1 - Item 16	**Date :**	9/15/2006

	SERIAL NUMBER						
Specifications	1	2	3	4	5	6	
Overall Length .740 +/- .005	0.7420	0.7420	0.7440	0.7430	0.7430	0.7420	
Outside Diameter .2475 +/- .0025	0.2490	0.2490	0.2490	0.2490	0.2490	0.2490	
Inside Diameter .129 +/- .001	0.1290	0.1290	0.1290	0.1290	0.1290	0.1290	
Angle #1 30 Degrees +/- 2 Degrees	30	30	30	30	30	30	
Angle #2 30 Degrees +/- 2 Degrees	30	30	30	30	30	30	

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Appendix B

Inspection Records from Axsys Technologies

S/N 001

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 8-15-06

Part #: 635765-7 Production Order: 112526 Project: 228448
Desc: HEAT SHIELD BOTTOM END SECTION PO #: 00055169 Customer: BATTELLE ENERGY ALLIANCE

Item	Zone	Characteristic	Gauging Method	Accept	Remarks
		REV. 2	STANDARD EQUIPMENT		
		SHEET 4 OF 4		—	
		VIEW K		—	
1	B7	PAR. .002 B		SR 3	.0002
2	B7	.035		SR 3	.0362
3	A7	R. .005		SR 3	.006
		DETAIL		—	
4	A4	DIA. 2.109 / 2.111 - A -		SR 3	2.1104 - 2.1106
5	A4	DIA. 2.058 / 2.060		SR 3	2.0584
6	A4	TP. DIA. .002(M) A(M) B		SR 3	.0003
7	A4	TOTAL RUNOUT .002 A		SR 3	.0005
8	A3	2.000		SR 3	2.0005
9	A2	MARK PER NOTE # 4 FS.		SR 3	OK
10	A2	DIA. 2.098 / 2.100		SR 3	2.0982

GQ-2011-2 PAGE: 1 OF 2

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 9-15-06

11	A2	TP. DIA. .002(M) A(M) B		SBS	.0005
12	B3	STRAIGHTNESS .002		SBS	.0005
		VERIFY DRAWING NOTES:		SBS	

GQ-2011-2 PAGE: 2 OF 2

CAUTION: COMPLETE TRACEABILITY MUST BE MAINTAINED

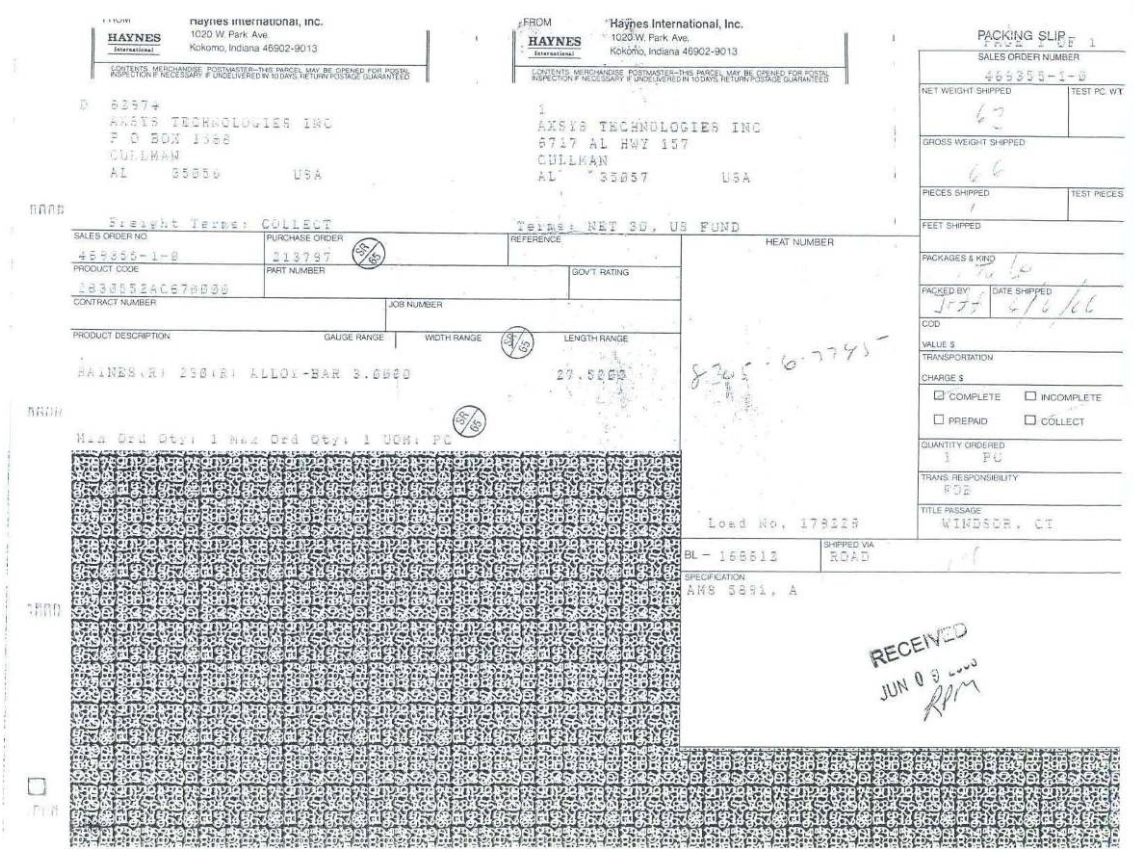
Item:	635765-7	Project:	228448	Prod Order:	112526
Customer:	BATTELLE ENERGY ALLIANCE			Desc:	HEAT SHIELD BOTTOM END
Date Received:	06-09-06	Date Released:	7/28/2006	PO #:	213797
Supplier:	HAYNES INTERNATIONAL			Shipper:	469355-1-0
Type Material:	HAYNES			Spec:	230
Size:	3.00 DIA X 2.120 LONG				
Qty Released:	1	Rel. By:	MGIBBS	Prev. Job:	NONE
Cert. Received:	Yes	X-Ray Received:	No	Corrected Release Sheet:	No
Note:					

Qty	Heat Lot	X-Ray	Serial # From	Serial # To		
1	8305 6 7795		001			

SR
MATERIAL
CONTROL
9

CAUTION: COMPLETE TRACEABILITY MUST BE MAINTAINED

PAGE: 1 OF 1 Date Printed: 7/28/2006



HAYNES International, Inc.
1020 W. Park Ave.
Kokomo, Indiana 46902-9013

CONTENTS: MERCHANDISE. POSTMASTER—THIS PARCEL MAY BE OPENED FOR POSTAL INSPECTION IF NECESSARY. IF UNDELIVERED IN 10 DAYS, RETURN POSTAGE GUARANTEED

AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

PACKING SLIP

SALES ORDER NUMBER: 469355-1-0
NET WEIGHT SHIPPED: 62
GROSS WEIGHT SHIPPED: 66
PIECES SHIPPED: 1
FEET SHIPPED:
PACKAGES & KIND:
PACKED BY: JFF
DATE SHIPPED: 6/6/06
COD:
VALUE $:
TRANSPORTATION:
CHARGE $:
☑ COMPLETE ☐ INCOMPLETE
☐ PREPAID ☐ COLLECT
QUANTITY ORDERED: 1 PC
TRANS. RESPONSIBILITY: ROE
TITLE PASSAGE: WINDSOR, CT

Freight Terms: COLLECT
Terms: NET 30, US FUND

SALES ORDER NO: 469355-1-0
PURCHASE ORDER: 213797
REFERENCE:
HEAT NUMBER: 8305-6-7795
PRODUCT CODE:
PART NUMBER:
GOVT RATING:
CONTRACT NUMBER:
JOB NUMBER:
PRODUCT DESCRIPTION: HAYNES(R) 230(R) ALLOY-BAR 3.0000
GAUGE RANGE:
WIDTH RANGE: 27.5000
LENGTH RANGE:
Max Ord Qty: 1 Max Ord Qty: 1 UOM: PC

Load No. 178128
BL - 168612
SHIPPED VIA: ROAD
SPECIFICATION: AMS 5891, A

RECEIVED
JUN 08 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355001-0	06/02/06	213797	20060606049	1 Of 4

CUSTOMER COPY

HAYNES International
Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sold To • Client • Bestelleranschrift:
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellemenge:
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung:
3 x 0/0 x 27.500
.
HAYNES(R) 230(R) ALLOY BAR -
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Chemical Analysis • Analyse Chimique • Chemische Analyse

Heat Number / Numero De Coulee / Charge Nr	Al	B	C	Co+Ta (Nb+Ta)	Co	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	V	W	
8305 6 7795	0.3477	0.002	0.1		0.3376	21.85	0.0879	0.9403	0.5088	1.3367	BAL	0.009	0.002	0.3333	<0.01		14.18	BUTT END *02

Heat Number	(Co+Ni)	Ta	Zr	Bi	Se	La	(Ce+Co)	Pb	Mg	Y	Ag	N	Ca	Al+Ti	Ni+Co	Ni+Mo	
8305 6 7795						0.011											BUTT END *02

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

JUN - 9 2006

Appendix B

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

CUSTOMER COPY

HAYNES International

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355001-0	06/02/06	213797	20060606049	2 Of 4

Sold To • Client • Bestellanschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 27.500
.
HAYNES(R) 230(R) ALLOY BAR -
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Tensile Test at Room Temperature • Essai De Traction A Temp. Ambiante • Zugversuch Bei Raum Temp.

Ultimate / Zugfestigkeit	1% Yield Lim. Elast. A 1% / 1% Streckgrenze	0.2% Yield Lim. Elast. A 0.2% / 0.2% Streckgrenze	% Elong In % Allong EN % Dehnung	%RA	
122000 PSI		54000 PSI	54 %	53 %	(1)(A)

Tensile Test at Elevated Temperature • Essai De Traction A Hte.Temp. Warm Zugversuch

Test Essai Versuch Temp:	Ultimate / Zugfestigkeit	1% Yield Lim. Elast. A 1% / 1% Streckgrenze	0.2% Yield Lim. Elast. A 0.2% / 0.2% Streckgrenze	% Elong In % Allong EN % Dehnung	%RA

Stress Rupture Temperature • Essai A Charge De Rupture Zeitstandversuch

Test Essai Versuch Temp:	Stress Constrainte Spannung	Hours Heures Stunden	% Elong In % Allong EN % Dehnung	% RA % RA	
1700 °F	10000 PSI	141 HRS	54 %	60 %	(1)(A)

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744766401

JUN - 9 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

CUSTOMER COPY

HAYNES International

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355001-0	06/02/06	213797	20060606049	3 Of 4

Sold To • Client • Bestellanschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 27.500
.
HAYNES(R) 230(R) ALLOY BAR -
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Annealed Hardness / Durette Recuit / Geglueht Haerte	Aged Hardness / Durette Vieilli / Gealtert Haerte	Grain Size / Grosseur De Grain / Korngroesse						IGA	Uniformity	Corrosion Rate		Oxidation Rate	Charpy Impact Test				Creep Rupture					
		Grain Size	Predominant Grain Size	Recrys. Grain	Unrecrys. Grain %	ALA	P&W Figure Number	Attack Depth		Corrosion MPY	Test Method		Toughness Avg Ft. Lbs.	Toughness 1 Ft. Lbs.	Toughness 2 Ft. Lbs.	Toughness 3 Ft. Lbs.	Test Essai Versuch Temp:	Stress Constrainte Spannung PSI	Hours Heures Stunden	% Elong In % Allong EN % Dehnung	% Elong @ 15 Hrs
90 HRB	(1)(A)	3.5																				

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744766401

JUN - 9 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

CUSTOMER COPY

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355001-0	06/02/06	213797 SR 65	20060606049	4 Of 4

HAYNES International

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sold To • Client • Bestelladresschrift	Ship To • Destinataire • Bestellmenge	Product Description • Description Produit • Material Beshreibung
AXSYS TECHNOLOGIES INC P O BOX 1588 CULLMAN AL 35056 USA	AXSYS TECHNOLOGIES INC 6717 AL HWY 157 CULLMAN AL 35057 USA	3 x 0/0 x 27.500 . HAYNES(R) 230(R) ALLOY BAR - Nadcap CERTIFICATE NUMBER 0089 S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100 SR 65

Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

All tests and inspections have been performed and results meet specification requirements.
THIS MATERIAL IS FREE FROM MERCURY, CADMIUM, RADIUM, AND ALPHA SOURCE CONTAMINATION.
THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE UNITED STATES.
Mill Orders Used: 3744766401 (1 PC)
(A) 2150 °F to 2275 °F

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes — 6/6/2006
Certification Technician

Robert Janes

JUN - 9 2006

CUSTOMER: **BATTELLE ENERGY ALI.**		PART NAME: **HEAT SHIELD BOTTOM SEC.**				DATE: **9-18-6**			
PROJECT NUMBER: **112526**		PRODUCTION ORDER #: **228448**				PART NUMBER: **635765-7**			
PARTICLE COUNT (ROOM)		TEMP AND HUMIDITY				**P.C. ONLY = TO VC-1**			
AM	PM	AM	PM	AM	PM				
3			64//52						
CLEANING LEVEL REQUIRED		**STD-7022 LEVEL C**							
PARTICLE COUNT (PART)		QTY OF PARTICLES PER SIZE (FIRST COUNT)				QTY OF PARTICLES PER SIZE (SECOND COUNT)			
AUTO	MANUAL **NA**	15-24	25-50	51-100	>100	15-24	25-50	51-100	>100
NVR **NA**	Per Sq.In. ☐ Ft Sq ☐	NVR	Per	Sq.In. ☐	Ft Sq ☐	NVR	Per	Sq.In. ☐	M^{Ft} Sq ☐
PASS ☒ FAIL ☐	INSPECTOR Randall Henderson					DATE **9-18-6**			Time Bagged **1:30 PM**
NOTES: **LIQ- DET, DI WATER , ACETONE, #2 PROPANOL**									

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 9-26-06

Part #: 635765-8 Production Order: 112527 Project: 228448
Desc: HEAT SHIELD TOP END SECTION PO #: Customer: BATTELLE ENERGY ALLIANCE

Item	Zone	Characteristic	Gauging Method	Accept	Remarks
		REV. 2			
1	B4/2	6 X 60.0 DEG BASIC		SA 23	BSC
2	B4/2	DIA 1.916 - 1.920		SA 23	1.9185
3	B4/2	TP DIA .004 (M) A (M) B		SA 23	W/M. 004
4	B4/2	TOTAL RUNOUT .002 A		SA 23	W/M. 002
5	B3/2	DIA 2.058 - 2.060		SA 23	2.059
6	B3/2	TP DIA .002 (M) A (M) B		SA 23	W/M. 002
7	B3/2	TOTAL RUNOUT .002 A		SA 23	W/M. 002
				—	
8	B2/2	2.000		SA 23	2.000
9	B3/2	6 X 45.0 DEG		SA 23	45°
10	B2/2	6 X .060		SA 23	.060
11	B2/2	STRAIGHT .002		SA 23	W/M. 002
12	A3/2	DIA 2.109 - 2.111		SA 23	2.110

GQ-2011-2 PAGE: 1 OF 2

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 9-26-06

13	A1/2	DIA 2.098 - 2.100		SA 23	2.0985
13	A1/2	TP DIA .002 (M) A (M) B		SA 23	W/M. 002
		VIEW C		—	
14	B6/2	.125		SA 23	.124
15	B6.2	.063		SA 23	.063
16	B6/2	2 X R MIN		SA 23	ok
17	B6/2	R .063		SA 23	.063
18	B6/2	1.023 BASIC		SA 23	BSC
		VIEW D		—	
19	C1/2	.035		SA 23	.035
20	C1/2	R .005		SA 23	ok
				—	
		VERIFY REQUIRED DRAWING NOTES		SA 23	

GQ-2011-2 PAGE: 2 OF 2

CUSTOMER: **BATTELLE ENERGY ALLIANCE**		PART NAME: **HEAT SHIELD TOP SEC.**				DATE: **10-2-6**			
PROJECT NUMBER: **112527**		PRODUCTION ORDER #: **228448**				PART NUMBER: **635765-8**			
PARTICLE COUNT (ROOM)		TEMP AND HUMIDITY				**1-PC**			
AM	PM	AM	PM	AM	PM				
3		64\\36							
CLEANING LEVEL REQUIRED		**PER STD 7022 LEVEL C | = TO VC-2 |**							
PARTICLE COUNT (PART)		QTY OF PARTICLES PER SIZE (FIRST COUNT)				QTY OF PARTICLES PER SIZE (SECOND COUNT)			
AUTO	MANUAL **NA**	15-24	25-50	51-100	>100	15-24	25-50	51-100	>100
NVR **NA**	Per Sq.In. ☐ Ft Sq ☐	NVR	Per	Sq.In. ☐	Ft Sq ☐	NVR	Per	Sq.In. ☐	M^{Ft} Sq ☐
PASS ☒ FAIL ☐	INSPECTOR Randall Henderson					DATE **10-2-6**			Time Bagged 9:00AM
NOTES: = **TO VC-2**									

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 10/16/06

Part #: 635765-6 Production Order: 112525 Project: 228448
Desc: LOWER HEAT SHIELD SECTION PO #: Customer: BATTELLE ENERGY ALLIANCE

Item	Zone	Characteristic	Gauging Method	Accept	Remarks
		REV. 2	"BEST EFFORT"		
01	D7	2.111/2.109 DIA. (O.D.)			2.109/2.111 AVG. (OUT-OF-ROUND)
02	D7	2.100/2.098 DIA. (I.D.)			2.098/2.100 AVG. (OUT-OF-ROUND)
03	D7	2.090/2.088 DIA. (I.D.)			2.089/2.090 " (" " ")
04	D7	POS.DIA..002 M -A- M -B-			W/N.002
05	D7	.002 -A- TOTAL RUNOUT			W/N.002
06	D1	2.098/2.096 DIA. (O.D.)			2.096/2.098 AVG. (OUT-OF-ROUND)
07	D1	2.060/2.058 DIA. (I.D.)			2.058/2.060 AVE (" " ")
08	D1	POS.DIA..002 M -A- M -B-			W/N.002
09	D1	.002 -A- TOTAL RUNOUT			W/N.002
10	D4	16.050 LENGTH			16.0575
		VIEW -H-			—
11	B8	.035			.035
12	D8	PERP..002 -A-			W/N.0015
13	B7	RAD..005			OK

GQ-2011-2 PAGE: 1 OF 2

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 10/16/06

		VIEW -J-			
14	C2	SHARP CORNER			OK
15	B1	.025			.025
16		VERIFY ALL NOTES			OK

GQ-2011-2 PAGE: 2 OF 2

CAUTION: COMPLETE TRACEABILITY MUST BE MAINTAINED

Item:	635765-6	Project:	228448	Prod Order:	112525
Customer:	BATTELLE ENERGY ALLIANCE			Desc:	LOWER HEAT SHIELD SECTION
Date Received:	06-09-06	Date Released:	7/28/2006	PO #:	213797
Supplier:	HAYNES INTERNATIONAL			Shipper:	469355-2-0
Type Material:	HAYNES			Spec:	230
Size:	3.00 DIA X 16.6 LONG				
Qty Released:	1	Rel. By:	MGIBBS	Prev. Job:	NONE
Cert. Received:	Yes	X-Ray Received:	No	Corrected Release Sheet:	No
Note:					

Qty	Heat Lot	X-Ray	Serial # From	Serial # To		
1	8305 5 7766		001			

SR MATERIAL CONTROL 9

CAUTION: COMPLETE TRACEABILITY MUST BE MAINTAINED

PAGE: 1 OF 1 Date Printed: *7/28/2006*

RECEIVING AND INSPECTION REPORT — REPORT NUMBER: 30883

Date Received: 6 / 9 / 06 Received From: HAYNE INTERNATIONAL Purchased Item ☑

Speedring P.O. Number: 213797 Shop Order Number: 228448 Cust Furn Matl ☐

Customer P.O. Number: _____ Shipper/Other Number: 469355-2-0 Customer Return ☐

	YES	NO	COMMENTS / OBSERVATIONS
Correct quantity of packages per delivery documents?	☑	☐	HC# 830557760
Are all packages free of visible external damage?	☑	☐	10513 24 25
Have all required documents been received?	☑	☐	

RECEIVED JUN – 9 2006

Item #	Qty Order	Qty Rcv'd	Part Number / Description / Identification	Subcontracted Service? YES	NO
10	1	1	HAYNES-1-DIA-300 3.00 x 52.12	☐	☒

Receiving Clerk Signature: R M Bragg

IMPORTANT – FOR BERYLLIUM MATERIAL (Purchased or Customer Furnished)

	YES	NO
Does any data indicate "High Density Inclusions" or "Deviation Approval Request (DAR)"?	☐	☐
If the answer above is "YES", has Quality Engineering been contacted?	☐	☐

PURCHASED MATERIALS, PARTS or SERVICES

	YES	NO	N/A
Is supplier/subcontractor approved?	☒	☐	
Verify against Speedring PO requirements:			
- All supplied documents refer to correct Speedring PO number?	☒	☐	
- Certification(s) received?	☒	☐	☐
- Chemical/physical analysis rcvd?	☒	☐	☐
- Do certifications, chem/phys analysis, etc. reference correct specifications?	☒	☐	☐
Are all items free of cosmetic damage?	☒	☐	
Do shelf-life / age controls apply?	☐	☒	
Vendor History Record updated?	☒	☐	☐

Review Speedring PO to determine specified requirements.
Sample items per MIL-STD-105, Tbl 1, Lvl II, 4.0 AQL.
Verify that sampled items meet specified requirements.
Enter inspection results on reverse side of this document.

CUSTOMER FURNISHED MATERIALS or RETURNS

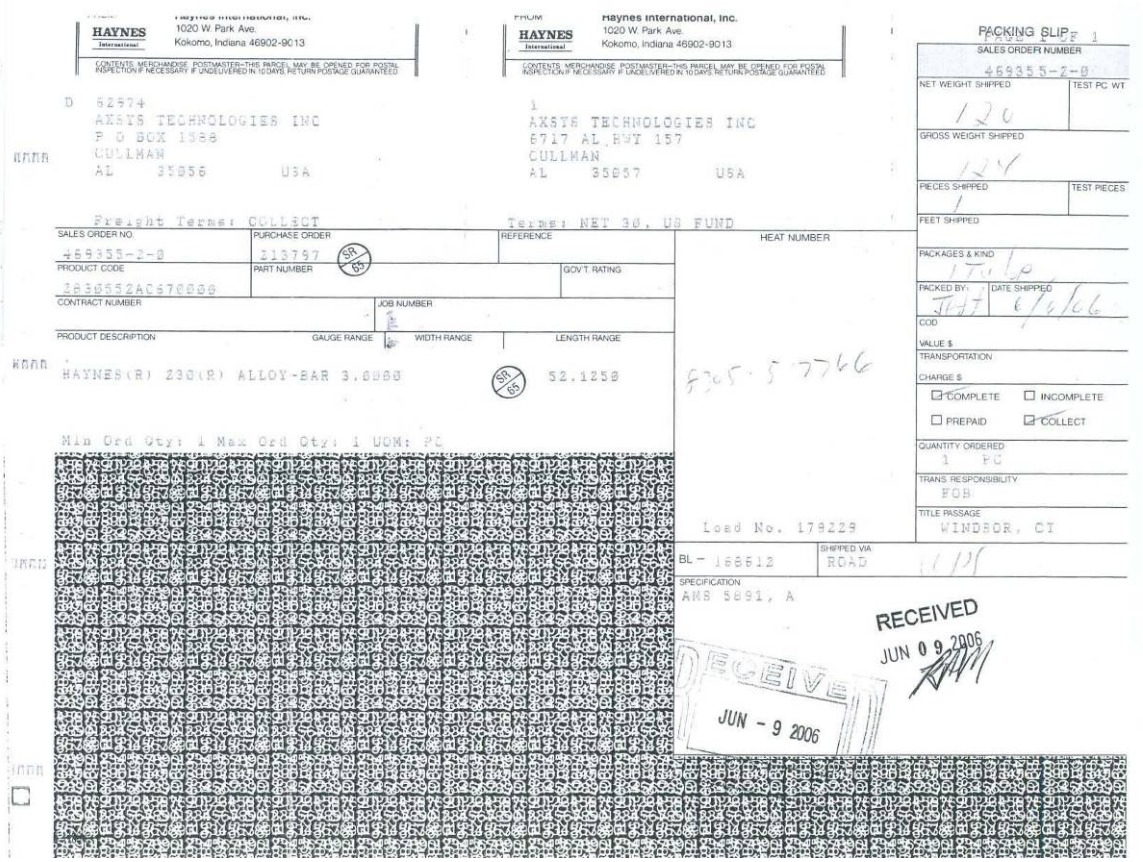
	YES	NO
Are all items free of cosmetic damage?	☐	☐
Verify against incoming shipper:		
- Items correctly identified?	☐	☐
- All required documents received?	☐	☐
For customer returned items only:		
- Was item produced by Speedring?	☐	☐
- Nonconformance(s) verified?	☐	☐
- History file pulled & reviewed?	☐	☐
- Chief inspector notified?	☐	☐
- Is a Quantity Change required?	☐	☐

From: _____ To: _____

Review incoming shipper to determine requirements.
Verify that all items meet specified requirements.
Sampling inspection is not authorized.
Enter inspection results on reverse side of this document.

Inspector: SR 65 Date: 6 / 9 / 06

QA-F 013 08/99 Side 1 of 2



HAYNES International
1020 W. Park Ave.
Kokomo, Indiana 46902-9013

CONTENTS: MERCHANDISE. POSTMASTER—THIS PARCEL MAY BE OPENED FOR POSTAL INSPECTION IF NECESSARY IF UNDELIVERED IN 10 DAYS. RETURN POSTAGE GUARANTEED.

D 52574
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

FROM Haynes International, Inc.
1020 W. Park Ave.
Kokomo, Indiana 46902-9013

1
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Freight Terms: COLLECT
Terms: NET 30, US FUND

PACKING SLIP

SALES ORDER NUMBER	469355-2-0
NET WEIGHT SHIPPED	120
TEST PC WT	
GROSS WEIGHT SHIPPED	124
PIECES SHIPPED	1
TEST PIECES	
FEET SHIPPED	
PACKAGES & KIND	1 Tulip
PACKED BY	JEFF
DATE SHIPPED	6/6/06
COD	
VALUE $	
TRANSPORTATION	
CHARGE $	
COMPLETE / INCOMPLETE	COMPLETE
PREPAID / COLLECT	COLLECT
QUANTITY ORDERED	1 PC
TRANS. RESPONSIBILITY	FOB
TITLE PASSAGE	WINDSOR, CT

SALES ORDER NO.	469355-2-0
PURCHASE ORDER	213797 (SR 65)
REFERENCE	
HEAT NUMBER	8305 5 7766
PRODUCT CODE	2830552AC670000
PART NUMBER	
GOV'T. RATING	
CONTRACT NUMBER	
JOB NUMBER	
PRODUCT DESCRIPTION	HAYNES(R) 230(R) ALLOY-BAR 3.0000
GAUGE RANGE	
WIDTH RANGE	
LENGTH RANGE	52.1250 (SR 65)

Min Ord Qty: 1 Max Ord Qty: 1 UOM: PC

Load No. 178229
BL - 168512
SHIPPED VIA ROAD
SPECIFICATION AMS 5891, A

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CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	1 Of 4

HAYNES International

CUSTOMER COPY
Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sold To • Client • Bestellanschrift	Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC P O BOX 1588 CULLMAN AL 35056 USA	AXSYS TECHNOLOGIES INC 6717 AL HWY 157 CULLMAN AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 52.125
.
HAYNES(R) 230(R) ALLOY BAR - (SR 65)
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Chemical Analysis • Analyse Chimique • Chemische Analyse

Heat Number / Numero De Coulee / Charge Nr	Al	B	C	Cb+Ta (Nb+Ta)	Co	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	V	W	
8305 5 7766	0.2301	<0.002	0.1		0.1541	21.76	0.044	2.5092	0.5721	1.3677	BAL	0.005	<0.002	0.41	<0.01		14.32	BUTT END *05

Heat Number	(Nb+Ta)	Ta	Zr	Bi	Se	La	Co+Ni+W	Pb	Mg	Y	Ag	N	Ca	Al+Ti	Ni+Co	Ni+Mo	
8305 5 7766						0.011											BUTT END *05

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

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Appendix B

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

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Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	2 Of 4

Sold To • Client • Bestellaranschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 52.125
.
HAYNES(R) 230(R) ALLOY BAR - (SR 65)
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Tensile Test at Room Temperature • Essai De Traction A Temp. Ambiante • Zugversuch Bei Raum Temp.

Ultimate / Zugfestigkeit	1% Yield Lim. Elast. A 1% 1% Streckgrenze	0.2% Yield Lim. Elast. A 0.2% 0.2% Streckgrenze	% Elong In % Allong EN % Dehnung	%RA %RA	
122000 PSI		58500 PSI	51.5 %	52 %	(1)(A)

Tensile Test at Elevated Temperature • Essai De Traction A Hte.Temp. Warm Zugversuch

Test Essai Versuch Temp:	Ultimate / Zugfestigkeit	1% Yield Lim. Elast. A 1% 1% Streckgrenze	0.2% Yield Lim. Elast. A 0.2% 0.2% Streckgrenze	% Elong In % Allong EN % Dehnung	%RA %RA	

Stress Rupture Temperature • Essai A Charge De Rupture Zeitstandversuch

Test Essai Versuch Temp:	Stress Constrainte Spannung	Hours Heures Stunden	% Elong In % Allong EN % Dehnung	% RA % RA	
1700 °F	10000 PSI	185 HRS	50 %	61 %	(1)(A)

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744080001

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CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

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HAYNES International

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	3 Of 4

Sold To • Client • Bestellaranschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 52.125
.
HAYNES(R) 230(R) ALLOY BAR - (SR 65)
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Annealed Hardness / Durette Recuit / Geglueht Haerte	Aged Hardness / Durette Vieilli / Gealtert Haerte		Grain Size / Grosseur De Grain / Korngroesse						IGA	Uniformity	Corrosion Rate		Oxidation Rate	Charpy Impact Test				Creep Rupture					
			Grain Size	Predominant Grain Size	Recry. Grain	Unrecry. Grain %	ALA	P&W Figure Number	Attack Depth		Corrosion MPY	Test Method		Toughness Avg Ft. Lbs.	Toughness 1 Ft. Lbs.	Toughness 2 Ft. Lbs.	Toughness 3 Ft. Lbs.	Test Essai Versuch Temp:	Stress Constrainte Spannung PSI	Hours Heures Stunden	% Elong In % Allong EN % Dehnung	% Elong @ 15 Hrs	
92 HRB		(1)(A)	3																				

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744080001

RECEIVED JUN - 9 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No Reference Commande Bestellungs Nr	Date Entered Date De Commande Bestelldatum	Customer Reference Reference Client Kundenbestdlldaten	Report No. Rapport No Zeugnis Nr	Pages of Pages Page de Pages Anzahl der Seiten
469355002-0	06/02/06	213797	20060606048	4 Of 4

HAYNES International

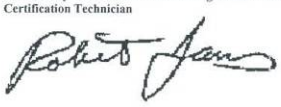
CUSTOMER COPY
Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

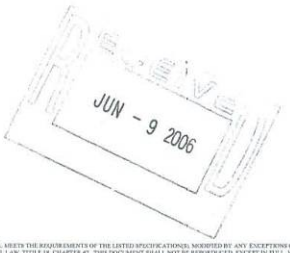
Sold To • Client • Bestellranschrift	Ship To • Destinataire • Bestellmenge	Product Description • Description Produit • Material Beshreibung
AXSYS TECHNOLOGIES INC P O BOX 1588 CULLMAN AL 35056 USA	AXSYS TECHNOLOGIES INC 6717 AL HWY 157 CULLMAN AL 35057 USA	3 x 0/0 x 52.125 . HAYNES(R) 230(R) ALLOY BAR - Nadcap CERTIFICATE NUMBER 0089 S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered Quantie Commandee Bestellemenge	Quantity Shipped Quantitie Expediee Liefermenge
AMS 5891, A	1 PC	1 PC

All tests and inspections have been performed and results meet specification requirements.
THIS MATERIAL IS FREE FROM MERCURY, CADMIUM, RADIUM, AND ALPHA SOURCE CONTAMINATION.
THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE UNITED STATES.
Mill Orders Used: 3744080001 (1 PC)
(A) 2150 °F to 2275 °F

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes — 6/6/2006
Certification Technician





RECEIVING AND INSPECTION REPORT REPORT NUMBER: 30883

Date Received: 6/9/06 Received From: HAYNE INTERNATIONAL Purchased Item ☑

Speedring P.O. Number: 213797 Shop Order Number: 228448 Cust Furn Matl ☐

Customer P.O. Number: _____ Shipper/Other Number: 469355-2-0 Customer Return ☐

	YES	NO	COMMENTS / OBSERVATIONS
Correct quantity of packages per delivery documents?	☑	☐	HC# 830557766
Are all packages free of visible external damage?	☑	☐	
Have all required documents been received?	☑	☐	

RECEIVED JUN – 9 2006

Item #	Qty Order	Qty Rcv'd	Part Number / Description / Identification	Subcontracted Service? YES	NO
10	1	1	HAYNES-1-DIA-300 3.06 x 52.12	☐	☒

Receiving Clerk Signature: K M Bragg

IMPORTANT – FOR BERYLLIUM MATERIAL (Purchased or Customer Furnished)

	YES	NO
Does any data indicate "High Density Inclusions" or "Deviation Approval Request (DAR)"?	☐	☐
If the answer above is "YES", has Quality Engineering been contacted?	☐	☐

PURCHASED MATERIALS, PARTS or SERVICES

	YES	NO	N/A
Is supplier/subcontractor approved?	☒	☐	
Verify against Speedring PO requirements:			
- All supplied documents refer to correct Speedring PO number?	☒	☐	
- Certification(s) received?	☒	☐	☐
- Chemical/physical analysis rcvd?	☒	☐	☐
- Do certifications, chem/phys analysis, etc. reference correct specifications?	☒	☐	☐
Are all items free of cosmetic damage?	☒	☐	
Do shelf-life / age controls apply?	☐	☒	
Vendor History Record updated?	☒	☐	☐

Review Speedring PO to determine specified requirements.
Sample items per MIL-STD-105, Tbl 1, Lvl II, 4.0 AQL.
Verify that sampled items meet specified requirements.
Enter inspection results on reverse side of this document.

CUSTOMER FURNISHED MATERIALS or RETURNS

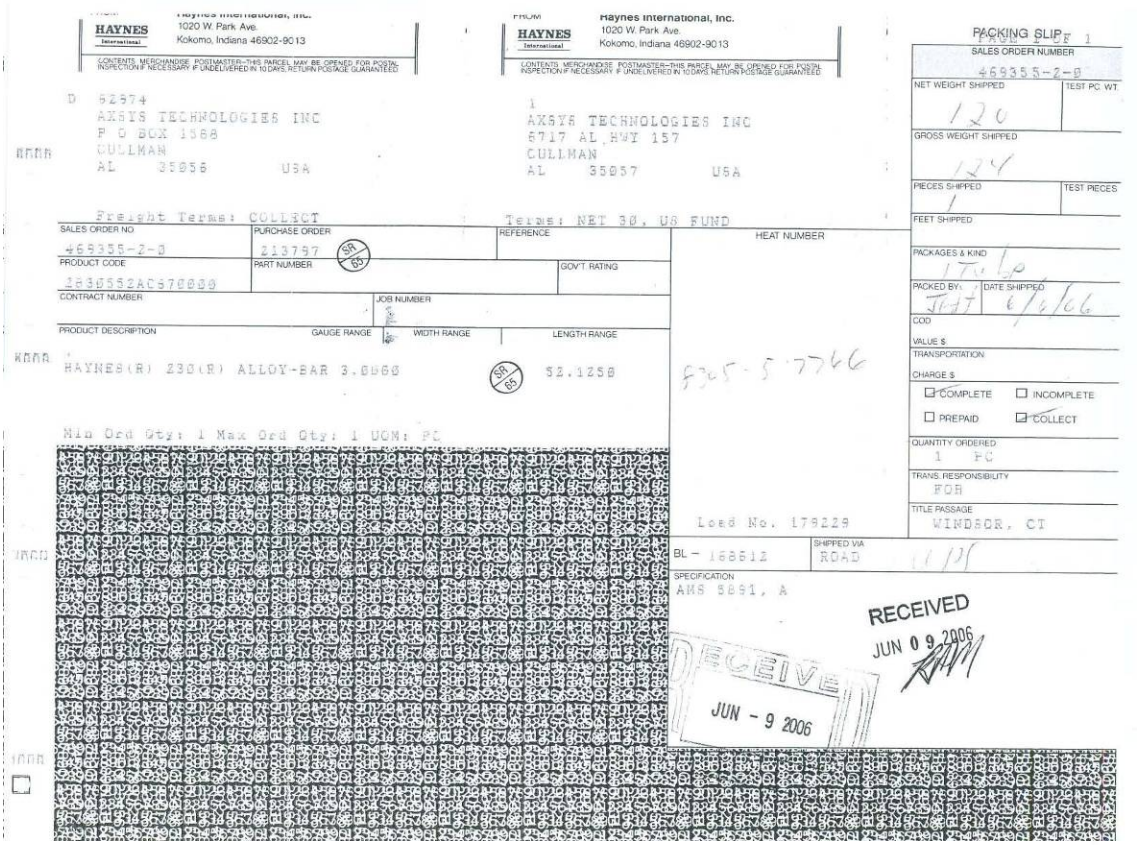
	YES	NO
Are all items free of cosmetic damage?	☐	☐
Verify against incoming shipper:		
- Items correctly identified?	☐	☐
- All required documents received?	☐	☐
For customer returned items only:		
- Was item produced by Speedring?	☐	☐
- Nonconformance(s) verified?	☐	☐
- History file pulled & reviewed?	☐	☐
- Chief inspector notified?	☐	☐
- Is a Quantity Change required?	☐	☐

From: _____ To: _____

Review incoming shipper to determine requirements.
Verify that all items meet specified requirements.
Sampling inspection is not authorized.
Enter inspection results on reverse side of this document.

Inspector: SR 65 Date: 6/7/06

QA-F 013 08/99 Side 1 of 2



HAYNES International
1020 W. Park Ave.
Kokomo, Indiana 46902-9013

CONTENTS MERCHANDISE POSTMASTER—THIS PARCEL MAY BE OPENED FOR POSTAL INSPECTION IF NECESSARY IF UNDELIVERED IN 10 DAYS RETURN POSTAGE GUARANTEED

D 62874
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

1
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Freight Terms: COLLECT

Terms: NET 30, US FUND

PACKING SLIP

SALES ORDER NO	PURCHASE ORDER	REFERENCE
469355-2-0	213797 (SR 65)	

PRODUCT CODE	PART NUMBER	GOV'T RATING
1B30552AC970000		

CONTRACT NUMBER	JOB NUMBER

PRODUCT DESCRIPTION	GAUGE RANGE	WIDTH RANGE	LENGTH RANGE
HAYNES(R) 230(R) ALLOY-BAR 3.0000			52.1250

HEAT NUMBER
8305-5-7766

Min Ord Qty: 1 Max Ord Qty: 1 UOM: PC

Load No. 179229

BL - 168612 SHIPPED VIA ROAD

SPECIFICATION
AMS 5891, A

SALES ORDER NUMBER	469355-2-0
NET WEIGHT SHIPPED	120
TEST PC. WT.	
GROSS WEIGHT SHIPPED	124
PIECES SHIPPED	1
TEST PIECES	
FEET SHIPPED	
PACKAGES & KIND	1 Tube
PACKED BY	JHT
DATE SHIPPED	6/7/06
COD	
VALUE $	
TRANSPORTATION	
CHARGE $	☐ COMPLETE ☐ INCOMPLETE ☐ PREPAID ☑ COLLECT
QUANTITY ORDERED	1 PC
TRANS. RESPONSIBILITY	FOB
TITLE PASSAGE	WINDSOR, CT

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CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	1 Of 4

HAYNES International

CUSTOMER COPY
Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sold To • Client • Bestellanschrift	Ship To • Destinataire • Bestellmenge	Product Description • Description Produit • Material Beshreibung
AXSYS TECHNOLOGIES INC P O BOX 1588 CULLMAN AL 35056 USA	AXSYS TECHNOLOGIES INC 6717 AL HWY 157 CULLMAN AL 35057 USA	3 x 0/0 x 52.125 . HAYNES(R) 230(R) ALLOY BAR - (SR 65) Nadcap CERTIFICATE NUMBER 0089 S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Chemical Analysis • Analyse Chimique • Chemische Analyse

Heat Number / Numero De Coulee / Charge Nr	Al	B	C	Cb+Ta (Nb+Ta)	Co	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	V	W	
8305 5 7766	0.2301	<0.002	0.1		0.1541	21.76	0.044	2.5092	0.5721	1.3677	BAL	0.005	<0.002	0.41	<0.01		14.32	BUTT END *05
	Ce(Nb)	Ta	Zr	Bi	Se	La	Ce+La+Nd	Pb	Mg	Y	Ag	N	Ca	Al+Ti	Ni+Co	Ni+Mo		
8305 5 7766						0.011											BUTT END *05	

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

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Appendix B

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

CUSTOMER COPY

HAYNES International

Haynes International
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PO Box 9013
Kokomo, Indiana, 46902

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	2 Of 4

Sold To • Client • Bestellaranschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 52.125
.
HAYNES(R) 230(R) ALLOY BAR - (SR 65)
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Tensile Test at Room Temperature • Essai De Traction A Temp. Ambiante • Zugversuch Bei Raum Temp.

Ultimate / Zugfestigkeit	1% Yield / Lim. Elast. A 1% / 1% Streckgrenze	0.2% Yield / Lim. Elast. A 0.2% / 0.2% Streckgrenze	% Elong In / % Allong EN / % Dehnung	%RA / %RA	
122000 PSI		58500 PSI	51.5 %	52 %	(1)(A)

Tensile Test at Elevated Temperature • Essai De Traction A Hte.Temp. Warm Zugversuch

Test Essai Versuch Temp:	Ultimate / Zugfestigkeit	1% Yield / Lim. Elast. A 1% / 1% Streckgrenze	0.2% Yield / Lim. Elast. A 0.2% / 0.2% Streckgrenze	% Elong In / % Allong EN / % Dehnung	%RA / %RA

Stress Rupture Temperature • Essai A Charge De Rupture Zeitstandversuch

Test Essai Versuch Temp:	Stress Constrainte / Spannung	Hours / Heures / Stunden	% Elong In / % Allong EN / % Dehnung	% RA / % RA	
1700 °F	10000 PSI	185 HRS	50 %	61 %	(1)(A)

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744080001

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CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

CUSTOMER COPY

HAYNES International

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	3 Of 4

Sold To • Client • Bestellaranschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 52.125
.
HAYNES(R) 230(R) ALLOY BAR - (SR 65)
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Annealed Hardness / Durette Recuit / Geglueht Haerte	Aged Hardness / Durette Vieilli / Gealtert Haerte		Grain Size / Grosseur De Grain / Korngroesse						IGA	Uniformity	Corrosion Rate		Oxidation Rate	Charpy Impact Test				Creep Rupture					
			Grain Size	Predominant Grain Size	Recry. Grain	Unrecry. Grain %	ALA	P&W Figure Number	Attack Depth		Corrosion MPY	Test Method		Toughness Avg Ft. Lbs.	Toughness 1 Ft. Lbs.	Toughness 2 Ft. Lbs.	Toughness 3 Ft. Lbs.	Test Essai Versuch Temp:	Stress Constrainte Spannung PSI	Hours Heures Stunden	% Elong In % Allong EN % Dehnung	% Elong @ 15 Hrs
92 HRB		(1)(A)	3																				

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744080001

RECEIVED JUN - 9 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 54)	20060606048	4 Of 4

HAYNES International

CUSTOMER COPY

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sold To • Client • Bestellaranschrift	Ship To • Destinataire • Bestellmenge	Product Description • Description Produit • Material Beshreibung
AXSYS TECHNOLOGIES INC P O BOX 1588 CULLMAN AL 35056 USA	AXSYS TECHNOLOGIES INC 6717 AL HWY 157 CULLMAN AL 35057 USA	3 x 0/0 x 52.125 . HAYNES(R) 230(R) ALLOY BAR - (SR 65) Nadcap CERTIFICATE NUMBER 0089 S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

All tests and inspections have been performed and results meet specification requirements.
THIS MATERIAL IS FREE FROM MERCURY, CADMIUM, RADIUM, AND ALPHA SOURCE CONTAMINATION.
THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE UNITED STATES.
Mill Orders Used: 3744080001 (1 PC)
(A) 2150 °F to 2275 °F

Certified By • Certific Par • Bescheinigt Durch: Bob Janes 6/6/2006
Certification Technician

Robert Janes

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JUN - 9 2006

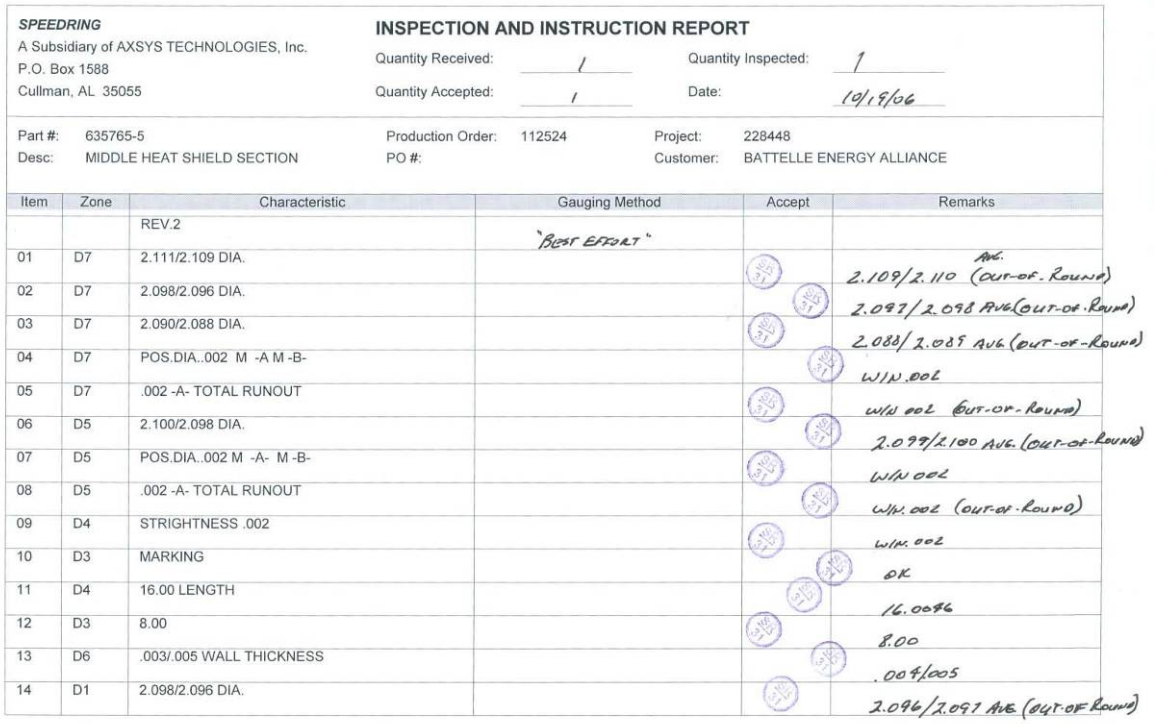
CUSTOMER: BATTELL ENERGY ALI.		PART NAME: LOWER HEAT SHIELD SECTION				DATE: 10-23-6
PROJECT NUMBER: 228448		PRODUCTION ORDER #: 112525				PART NUMBER: 635765-6
PARTICLE COUNT (ROOM)		TEMP AND HUMIDITY				1PC
AM	PM	AM	PM	AM	PM	
6		70//25				

CLEANING LEVEL REQUIRED STD 7022 LEVEL C [= T0 VC-1]

PARTICLE COUNT (PART)				QTY OF PARTICLES PER SIZE (FIRST COUNT)				QTY OF PARTICLES PER SIZE (SECOND COUNT)			
AUTO	MANUAL NA			15-24	25-50	51-100	>100	15-24	25-50	51-100	>100
NVR NA	Per	Sq.In. ☐	Ft Sq ☐	NVR	Per	Sq.In. ☐	Ft Sq ☐	NVR	Per	Sq.In. ☐	M^{Ft} Sq ☐

PASS ☒ FAIL ☐	INSPECTORRandall Henderson	DATE 10-23-6	Time Bagged 10:45 AM

NOTES: 1PC OD NOT A MACHINED SURFACE [LAPPED ??]



SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 10/19/06

Part #: 635765-5 Production Order: 112524 Project: 228448
Desc: MIDDLE HEAT SHIELD SECTION PO #: Customer: BATTELLE ENERGY ALLIANCE

Item	Zone	Characteristic	Gauging Method	Accept	Remarks
		REV.2	"BEST EFFORT"		
01	D7	2.111/2.109 DIA.			AVG. 2.109/2.110 (OUT-OF-ROUND)
02	D7	2.098/2.096 DIA.			2.097/2.098 AVG (OUT-OF-ROUND)
03	D7	2.090/2.088 DIA.			2.088/2.089 AVG (OUT-OF-ROUND)
04	D7	POS.DIA..002 M -A M -B-			WIN .002
05	D7	.002 -A- TOTAL RUNOUT			WIN .002 (OUT-OF-ROUND)
06	D5	2.100/2.098 DIA.			2.099/2.100 AVG. (OUT-OF-ROUND)
07	D5	POS.DIA..002 M -A- M -B-			WIN .002
08	D5	.002 -A- TOTAL RUNOUT			WIN. .002 (OUT-OF-ROUND)
09	D4	STRIGHTNESS .002			WIN. .002
10	D3	MARKING			OK
11	D4	16.00 LENGTH			16.0086
12	D3	8.00			8.00
13	D6	.003/.005 WALL THICKNESS			.004/.005
14	D1	2.098/2.096 DIA.			2.096/2.097 AVG. (OUT-OF-ROUND)

GQ-2011-2 PAGE: 1 OF 2

SPEEDRING
A Subsidiary of AXSYS TECHNOLOGIES, Inc.
P.O. Box 1588
Cullman, AL 35055

INSPECTION AND INSTRUCTION REPORT

Quantity Received: 1 Quantity Inspected: 1
Quantity Accepted: 1 Date: 10/19/06

15	D1	POS.DIA..002 M -A- M -B-	"BEST EFFORT"		WIN .002
16	D1	.002 TOTAL RUNOUT			WIN. .002
17	A8	.025			.025
18	A8	PERP..002 -A-			WIN .021
19	B7	SHARP CORNER			OK
20	B6	SHARP CORNER			OK
21	A5	.025			.025
22	A5	PERP. .002 -A-			WIN .005
23	A3	BLEND THE TAPER IN THIS AREA SO			OK
		THAT A SHARP CORNER DOES NOT REMAIN			
		AFTER MACHING.			

GQ-2011-2 PAGE: 2 OF 2

CAUTION: COMPLETE TRACEABILITY MUST BE MAINTAINED

Item: 635765-5 Project: 228448 Prod Order: 112524
Customer: BATTELLE ENERGY ALLIANCE Desc: MIDDLE HEAT SHIELD SECTION
Date Received: 06-09-06 Date Released: 7/28/2006 PO #: 213797
Supplier: HAYNES INTERNATIONAL Shipper: 469355-2-0
Type Material: HAYNES Spec: 230
Size: 3.00 DIA X 16.6 LONG
Qty Released: 1 Rel. By: MGIBBS Prev. Job: NONE
Cert. Received: Yes X-Ray Received: No Corrected Release Sheet: No
Note:

Qty	Heat Lot	X-Ray	Serial # From	Serial # To		
1	8305 5 7766		001			

CAUTION: COMPLETE TRACEABILITY MUST BE MAINTAINED

PAGE: 1 OF 1 Date Printed: 7/28/2006

RECEIVING AND INSPECTION REPORT REPORT NUMBER: 30883

Date Received: 6/9/06 Received From: HAYNE INTERNATIONAL Purchased Item ☑

Speedring P.O. Number: 213797 Shop Order Number: 228448 Cust Furn Matl ☐

Customer P.O. Number: _____ Shipper/Other Number: 469355-2-0 Customer Return ☐

	YES	NO	COMMENTS / OBSERVATIONS
Correct quantity of packages per delivery documents?	☑	☐	HLH 830557766 1 of 8
Are all packages free of visible external damage?	☑	☐	10513 24 25
Have all required documents been received?	☑	☐	

RECEIVED JUN – 9 2006

Item #	Qty Order	Qty Rcv'd	Part Number / Description / Identification	Subcontracted Service? YES	NO
10	1	1	HAYNES-1-DIA-300 3.00 x 52.12	☐	☒

Receiving Clerk Signature: L M Bragg

IMPORTANT – FOR BERYLLIUM MATERIAL (Purchased or Customer Furnished)

	YES	NO
Does any data indicate "High Density Inclusions" or "Deviation Approval Request (DAR)"?	☐	☐
If the answer above is "YES", has Quality Engineering been contacted?	☐	☐

PURCHASED MATERIALS, PARTS or SERVICES

	YES	NO	N/A
Is supplier/subcontractor approved?	☒	☐	
Verify against Speedring PO requirements:			
- All supplied documents refer to correct Speedring PO number?	☒	☐	
- Certification(s) received?	☒	☐	☐
- Chemical/physical analysis rcvd?	☒	☐	☐
- Do certifications, chem/phys analysis, etc. reference correct specifications?	☒	☐	☐
Are all items free of cosmetic damage?	☒	☐	
Do shelf-life / age controls apply?	☐	☒	
Vendor History Record updated?	☒	☐	☐

Review Speedring PO to determine specified requirements.
Sample items per MIL-STD-105, Tbl 1, Lvl II, 4.0 AQL.
Verify that sampled items meet specified requirements.
Enter inspection results on reverse side of this document.

CUSTOMER FURNISHED MATERIALS or RETURNS

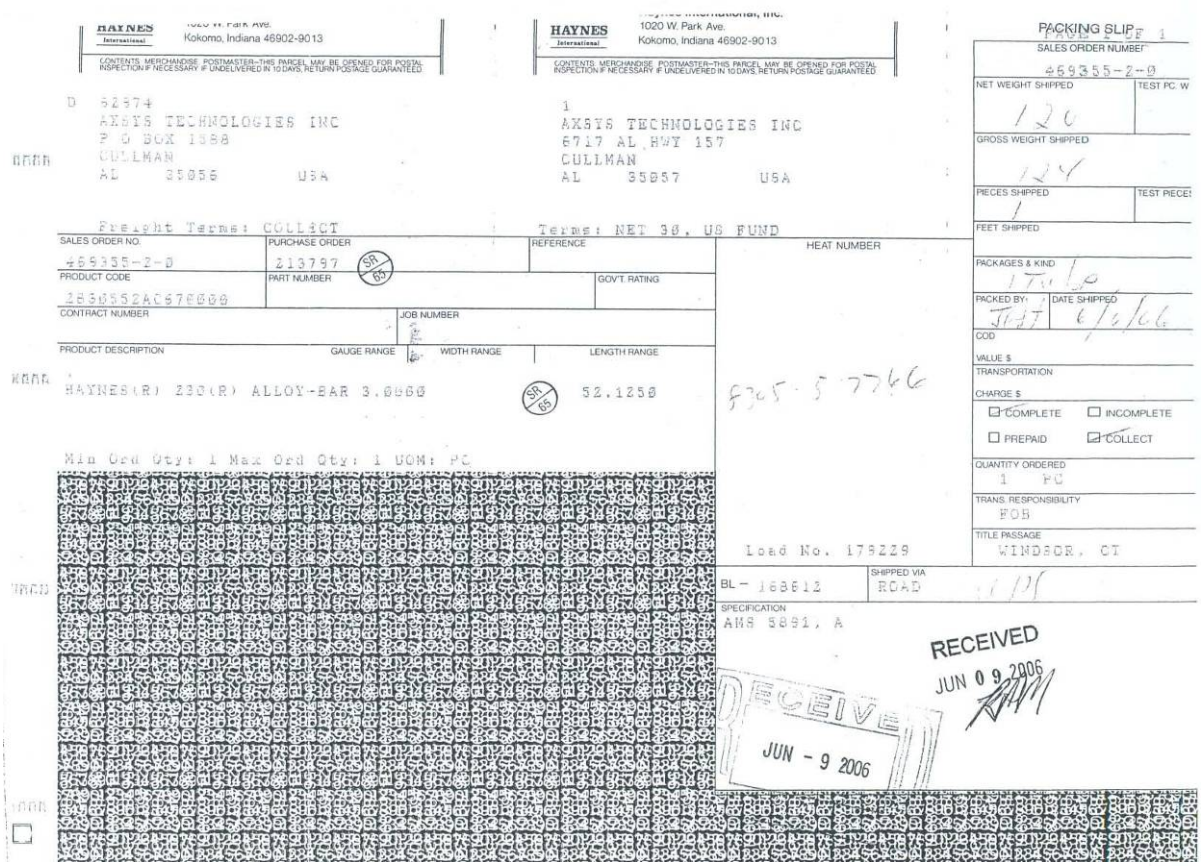
	YES	NO
Are all items free of cosmetic damage?	☐	☐
Verify against incoming shipper:		
- Items correctly identified?	☐	☐
- All required documents received?	☐	☐
For customer returned items only:		
- Was item produced by Speedring?	☐	☐
- Nonconformance(s) verified?	☐	☐
- History file pulled & reviewed?	☐	☐
- Chief inspector notified?	☐	☐
- Is a Quantity Change required?	☐	☐

From: _____ To: _____

Review incoming shipper to determine requirements.
Verify that all items meet specified requirements.
Sampling inspection is not authorized.
Enter inspection results on reverse side of this document.

Inspector: SR 65 Date: 6/9/06

QA-F 013 08/99 Side 1 of 2



HAYNES International
Kokomo, Indiana 46902-9013
CONTENTS: MERCHANDISE POSTMASTER–THIS PARCEL MAY BE OPENED FOR POSTAL INSPECTION IF NECESSARY IF UNDELIVERED IN 10 DAYS, RETURN POSTAGE GUARANTEED

D 62874
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

1
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Freight Terms: COLLECT
Terms: NET 30, US FUND

PACKING SLIP
SALES ORDER NUMBER: 469355-2-0
NET WEIGHT SHIPPED: 120
GROSS WEIGHT SHIPPED: 124
PIECES SHIPPED: 1
FEET SHIPPED:
PACKAGES & KIND: 1 Tube
PACKED BY: JJT
DATE SHIPPED: 6/6/06
COD:
VALUE $:
TRANSPORTATION:
CHARGE $:
☐ COMPLETE ☐ INCOMPLETE
☐ PREPAID ☑ COLLECT
QUANTITY ORDERED: 1 PC
TRANS. RESPONSIBILITY: FOB
TITLE PASSAGE: WINDSOR, CT

SALES ORDER NO.	PURCHASE ORDER	REFERENCE	HEAT NUMBER
469355-2-0	213797 (SR 65)		8305 5 7766

PRODUCT CODE	PART NUMBER	GOV'T. RATING
2B60552AC670000		

CONTRACT NUMBER: JOB NUMBER:

PRODUCT DESCRIPTION	GAUGE RANGE	WIDTH RANGE	LENGTH RANGE
HAYNES(R) 230(R) ALLOY-BAR 3.0000 (SR 65)			52.1250

Min Ord Qty: 1 Max Ord Qty: 1 UOM: PC

Load No. 179229
BL – 168812
SHIPPED VIA: ROAD
SPECIFICATION: AMS 5891, A

RECEIVED JUN 09 2006
RECEIVED JUN - 9 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	1 Of 4

CUSTOMER COPY

HAYNES International
Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sold To • Client • Bestellarasschrift
AXSYS TECHNOLOGIES INC
P O BOX 1588
CULLMAN
AL 35056 USA

Ship To • Destinataire • Bestellmenge
AXSYS TECHNOLOGIES INC
6717 AL HWY 157
CULLMAN
AL 35057 USA

Product Description • Description Produit • Material Beshreibung
3 x 0/0 x 52.125
.
HAYNES(R) 230(R) ALLOY BAR - (SR 65)
Nadcap CERTIFICATE NUMBER 0089
S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Chemical Analysis • Analyse Chimique • Chemische Analyse

Heat Number / Numero De Coulee / Charge Nr	Al	B	C	Cb+Ta (Nb+Ta)	Co	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	V	W	
8305 5 7766	0.2301	<0.002	0.1		0.1541	21.76	0.044	2.5092	0.5721	1.3677	BAL	0.005	<0.002	0.41	<0.01		14.32	BUTT END *05

	O(ppm)	Ta	Zr	Bi	Se	La	C+S+O+N	Pb	Mg	Y	Ag	N	Ca	Al+Ti	Ni+Co	Ni+Mo		
8305 5 7766						0.011											BUTT END *05	

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician
6/6/2006

RECEIVED JUN - 9 2006

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKZEUGNIS

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HAYNES International

Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
469355002-0	06/02/06	213797 (SR 65)	20060606048	2 Of 4

Sold To • Client • Bestellaranschrift	Ship To • Destinataire • Bestellmenge	Product Description • Description Produit • Material Beshreibung
AXSYS TECHNOLOGIES INC P O BOX 1588 CULLMAN AL 35056 USA	AXSYS TECHNOLOGIES INC 6717 AL HWY 157 CULLMAN AL 35057 USA	3 x 0/0 x 52.125 . HAYNES(R) 230(R) ALLOY BAR - (SR 65) Nadcap CERTIFICATE NUMBER 0089 S400 4/29/2004, S1000 1/3/2005, EN 10204 3.1, AS9100

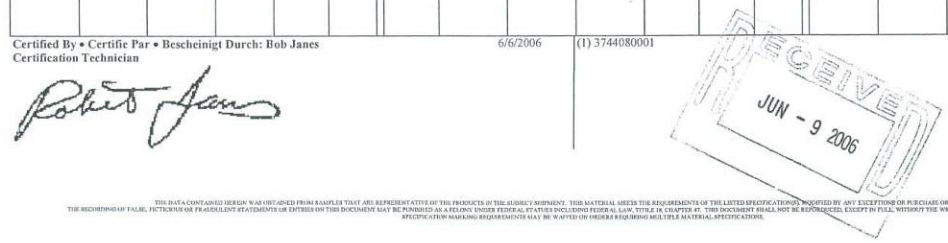
Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Tensile Test at Room Temperature • Essai De Traction A Temp. Ambiante • Zugversuch Bei Raum Temp.						Tensile Test at Elevated Temperature • Essai De Traction A Hte.Temp. Warm Zugversuch						Stress Rupture Temperature • Essai A Charge De Rupture Zeitstandversuch					
Ultimate / Zugfestigkeit	1% Yield / Lim. Elast. A 1% / 1% Streckgrenze	0.2% Yield / Lim. Elast. A 0.2% / 0.2% Streckgrenze	% Elong in / % Allong EN / % Dehnung	%RA		Test / Essai / Versuch / Temp:	Ultimate / Zugfestigkeit	1% Yield / Lim. Elast. A 1% / 1% Streckgrenze	0.2% Yield / Lim. Elast. A 0.2% / 0.2% Streckgrenze	% Elong In / % Allong EN / % Dehnung	%RA	Test / Essai / Versuch / Temp:	Stress / Contrainte / Spannung	Hours / Heures / Stunden	% Elong In / % Allong EN / % Dehnung	% RA	
122000 PSI		58500 PSI	51.5 %	52 %	(1)(A)							1700 °F	10000 PSI	185 HRS	50 %	61 %	(1)(A)

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744080001



CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKZEUGNIS

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Haynes International
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Kokomo, Indiana, 46902

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469355002-0	06/02/06	213797 (SR 65)	20060606048	3 Of 4

Sold To • Client • Bestellaranschrift	Ship To • Destinataire • Bestellmenge	Product Description • Description Produit • Material Beshreibung
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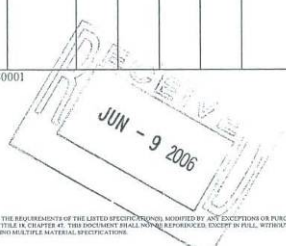
Specification • Specification • Spezifikation	Quantity Ordered / Quantie Commandee / Bestellemenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

Annealed Hardness / Durette Recuit / Geglueht Haerte	Aged Hardness / Durette Vieilli / Gealtert Haerte		Grain Size / Grosseur De Grain / Korngroesse						IGA	Uniformity	Corrosion Rate		Oxidation Rate	Charpy Impact Test				Creep Rupture					
			Grain Size	Predominant Grain Size	Recry. Grain	Unrecry. Grain %	ALA	Pd/W Figure Number	Attack Depth		Corrosion / MPY	Test Method		Toughness Avg / Ft. Lbs.	Toughness 1 / Ft. Lbs.	Toughness 2 / Ft. Lbs.	Toughness 3 / Ft. Lbs.	Test / Essai / Versuch / Temp:	Stress / Contrainte / Spannung / PSI	Hours / Heures / Stunden	% Elong In / % Allong EN / % Dehnung	% Elong @ 15 Hrs	
92 HRB		(1)(A)	3																				

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes
Certification Technician

6/6/2006

(1) 3744080001



CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

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469355002-0	06/02/06	213797 (SR. 65)	20060606048	4 Of 4

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PO Box 9013
Kokomo, Indiana, 46902

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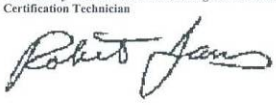
Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellmenge	Quantity Shipped / Quantitie Expediee / Liefermenge
AMS 5891, A	1 PC	1 PC

All tests and inspections have been performed and results meet specification requirements.
THIS MATERIAL IS FREE FROM MERCURY, CADMIUM, RADIUM, AND ALPHA SOURCE CONTAMINATION.
THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE UNITED STATES.
Mill Orders Used: 3744080001 (1 PC)
(A) 2150 °F to 2275 °F

Certified By • Certifie Par • Bescheinigt Durch: Bob Janes 6/6/2006
Certification Technician



THE DATA CONTAINED HEREIN WAS OBTAINED FROM SAMPLES THAT ARE REPRESENTATIVE OF THE PRODUCTS IN THE SUBJECT SHIPMENT. THIS MATERIAL MEETS THE REQUIREMENTS OF THE LISTED SPECIFICATIONS, MODIFIED BY ANY EXCEPTIONS OR PURCHASE ORDER REQUIREMENTS.
THE RECORDING OF FALSE, FICTICIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED AS A FELONY UNDER FEDERAL STATUES INCLUDING FEDERAL LAW, TITLE 18, CHAPTER 47. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN CONSENT OF HAYNES INTERNATIONAL, INC.
SPECIFICATION MARKING REQUIREMENTS MAY BE WAIVED ON ORDERS REQUIRING MULTIPLE MATERIAL SPECIFICATIONS.

CUSTOMER: BATTELLE ENERGY ALI.	PART NAME: MIDDLE HEAT SHIEL SEC.	DATE: 10-23-6
PROJECT NUMBER: 228448	PRODUCTION ORDER #: 112524	PART NUMBER: 635765-5

PARTICLE COUNT (ROOM)		TEMP AND HUMIDITY				1PC.
AM	PM	AM	PM	AM	PM	
	4	68//24				

CLEANING LEVEL REQUIRED STD 7022 LEVEL C [= TO C-1]

PARTICLE COUNT (PART)				QTY OF PARTICLES PER SIZE (FIRST COUNT)				QTY OF PARTICLES PER SIZE (SECOND COUNT)			
AUTO	MANUAL NA			15-24	25-50	51-100	>100	15-24	25-50	51-100	>100
NVR NA	Per	Sq.In. ☐	Ft Sq ☐	NVR	Per	Sq.In. ☐	Ft Sq ☐	NVR	Per	Sq.In. ☐	M^{Ft} Sq ☐

PASS ☒ FAIL ☐	INSPECTORRandall Henderson	DATE 10-23-6	Time Bagged 4:20 PM

NOTES: PART HAD SPOTS AND STAINS ON OD THAT REQ. EXTRA CLANING