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Engineering Calculations and Analysis

ECAR Title: AGC-2 Specimen Position Adjustment

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2. Concurrence of method or approach. See definition in LWP-10106.
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ECAR No.: 2549 Rev. No.: 0 Project No.: 23747 Date: 06/01/2016

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	06/01/2016	All	New document.

Title: AGC-2 Specimen Position Adjustment

ECAR No.: 2549 Rev. No.: 0 Project No.: 23747 Date: 06/01/2016

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7. Objective/Purpose: This engineering calculations and analysis report documents the Advanced Graphite Creep-2 specimen position/elevation adjustments that are necessary from as-built dimension corrections, component thermal growth, and variable specimen elevation due to irradiation induced shrinkage and load-induced creep. These effects are calculated and integrated into a table that lists the specimen IDs, their stack number, their nominal elevation, and the average specimen elevation for each reactor cycle.

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9. Conclusions/Recommendations:

   Specimen position adjustments vary as a function of their initial position in the experiment. The lower uncompressed specimen adjustments are approximately 0.25 in. higher than their nominal elevations. At the end of the test, the upper compressed specimens are up to 1.15 in. lower than their nominal elevation. These upper compressed specimens are located at the steepest slope of the reactor dose curve; therefore, when the specimen moves downward up to 1.4 in., the specimen is positioned in an approximate 18% higher flux region than its starting position. A 0.10 in. adjustment of the uppermost specimen results in a 1.3% change in the received dose. The lower specimens experience a 2.5% change in dose for a 0.10 in. position adjustment.

CONTENTS

APPENDIXES

Title: AGC-2 Specimen Position Adjustment

ECAR No.: 2549 Rev. No.: 0 Project No.: 23747 Date: 06/01/2016

PROJECT ROLES AND RESPONSIBILITIES

Project Role	Name (Typed)	Organization	Pages covered (if applicable)
Performer	Ted R. Reed	D510	All
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Responsibilities:

a. Confirmation of completeness, mathematical accuracy, and correctness of data and appropriateness of assumptions.

b. Concurrence of method or approach. See definition in LWP-10106.

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e. Concurrence with the document's assumptions and input information. See definition of acceptance in LWP-10200.

SCOPE AND BRIEF DESCRIPTION

This engineering calculations and analysis report (ECAR) calculates the Advanced Graphite Creep (AGC)-2 specimen position adjustments that result from (1) as-built dimension corrections of the Advanced Test Reactor (ATR) reactor, experiment, and specimens, (2) thermal growth of the capsule wall and graphite components, and (3) variable specimen elevations as the specimen stacks shrink due to radiation-induced shrinkage and axial load-induced creep.

The specimen elevations listed in the experiment assembly documents do not accurately represent the actual specimen positions in relation to the reactor core mid-plane. Prior experiment insertion difficulties have shown that the distance from the reactor top head closure plate to the core is greater than the nominal elevations shown on the ATR facility drawings. Drawing 600001 [1] lists the measured difference between the closure plate and the gearbox support beam as 0.313 in. greater than the facility drawings. Thus, the height of the specimens in relation to the core mid-plane is 0.313 in. higher than the nominal dimensions. In addition, the overall dimension of the experiment is 0.084 in. shorter than the nominal drawing dimension on Drawing 601266 [2]. As a further adjustment, the average weld shrinkage of the three capsule welds is 0.035 each, which affects the as-built position of the lower isolation weld plate (i.e., Part #601266-9) onto which all graphite components are stacked.

In addition to the as-built adjustments mentioned above, the specimens also are subject to a stack up error, which is due to the thickness difference from nominal. This effect is most apparent in the center S-7 stack that has a large number of specimens (i.e., 170 specimens). Per post-irradiation examination (PIE) measurements, the average S-7 specimen is about 0.0008 in. smaller than nominal. Even though this difference is small, when multiplied by the number specimens, the top specimen experiences an elevation reduction of 0.14 in. Although dimensional changes were less pronounced in S-1 through S-6, initial specimen elevations were adjusted based on pre-irradiation length measurements.

Thermal growth of the capsule wall and the graphite specimens also effects specimen position. Because the capsule and reactor are both made of similar material, their relative positions will not substantially change if they both experience the same reactor coolant temperature. However, the capsule wall's temperature in the region of the core will be an average of 102°C while the reactor coolant will be an average of 51.7°C. Thus, the core section of the capsule will grow approximately 0.042 in., which places the lower isolation weld plate 0.042 in. lower when the reactor is operating. The graphite specimens and holders, all of which sit on the lower isolation weld plate, experience an average temperature of 611°C. As a result, the lower specimens experience minimal thermal growth elevation change, while the uppermost specimens can have an upward thermal growth change of 0.20 in.

All specimens in the AGC-2 test experience some degree of radiation-induced shrinkage. During the course of irradiation, neutron damage to the graphite specimens causes the specimens to shrink and move downward. In addition to the irradiation effects, the compressed specimens in S-1 through S-6 are also subject to load-induced creep. The compressed specimen stacks have a graphite pushrod that applies a gas cylinder load. The top of the pushrod (TOP) displacement is measured by a radiation-resistant linear variable differential transducer (LVDT) that is located 94 to 107 in. above the core mid-plane; its position is recorded throughout the test in the Nuclear Data Management and Analysis System (NDMAS). The bottom of each of the compressed specimen stacks is supported by a piston that rests on the lower portion of the compressed specimen holder assembly (shown in Figure 1). The compressed specimen assembly is vertically supported by the uncompressed specimen assembly and a graphite insulator. As a result, there are graphite components from a nominal

28.375 in. above the reactor mid-plane to a nominal 24.75 in. below the reactor mid-plane. All of these components are subject to radiation effects and compressive loads that cause them to shrink and substantially affect their position in the ATR reactor. As documented in ECAR-2291 [3], the displacements per atom (DPA) vary approximately by a factor of four from the reactor mid-plane to the top of the core. Therefore, as the specimen elevation changes during the course of irradiation, there is a significant change in specimen dose and, to a lesser extent, specimen temperature. During the course of the AGC-2 experiment, the upper compressed specimens moved downward as much as 1.4 in. and, thus, into an 18% higher dose region.

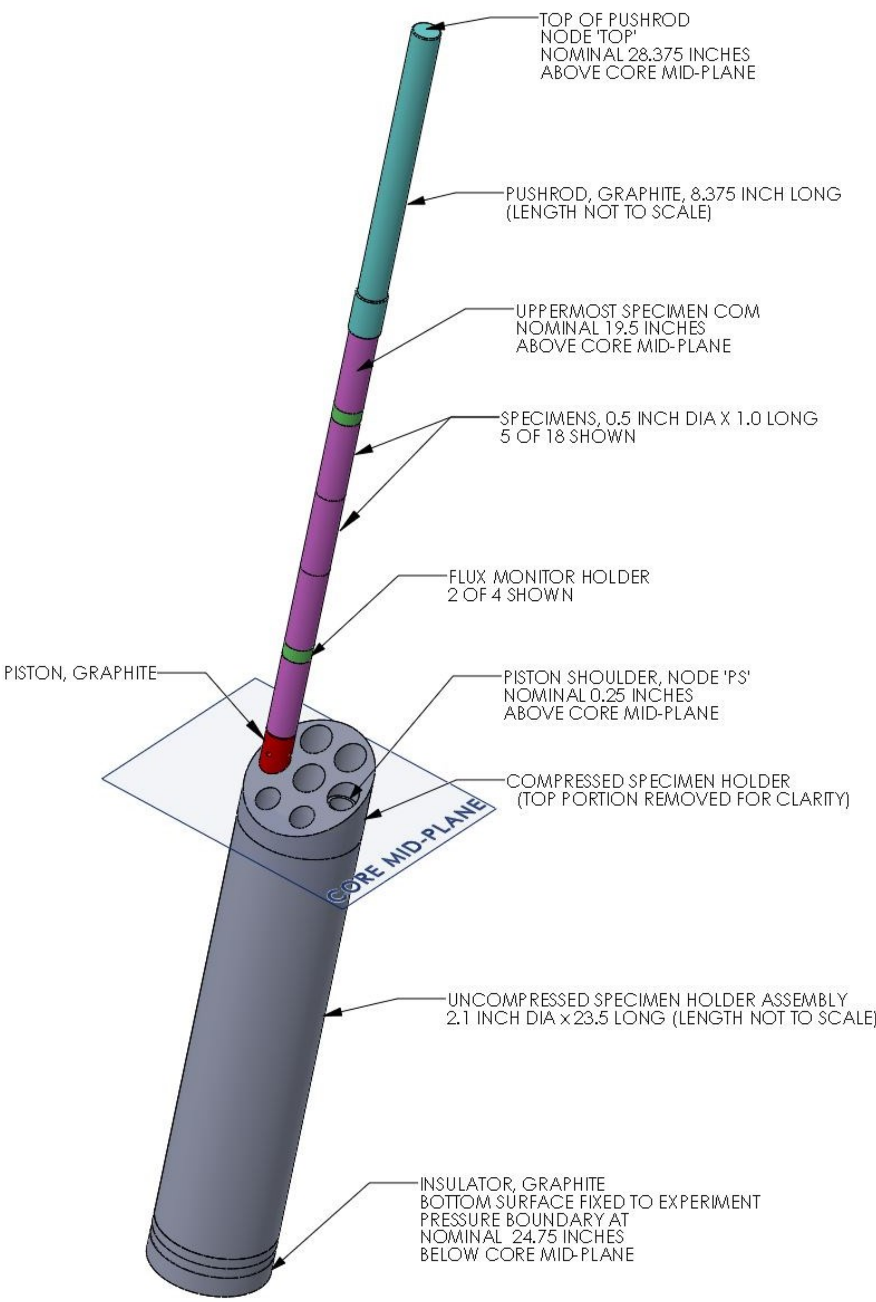

Figure 1. AGC-2 graphite component stack-up (length of some items not to scale).

Because compressed specimens experience the highest displacement, this is the primary focus of this analysis. To calculate the individual compressed specimen positions, three sources of AGC-2 data are used. First is the pre-irradiation length of all specimens, second is the post-irradiation length of all specimens, and third is displacement of TOP. As seen in Figure 2, specimen stack creep is nearly linear. Therefore, if the specimen positions are known before the start of irradiation and their length is known after irradiation, then using a linear position change versus reactor integrated power, the movement of these specimens should be predictable throughout the test. However, the lengths of the specimen support components were not measured pre or post-irradiation and the pushrod was cut during packaging of the competed experiment prior to shipment to PIE. Moreover there are flux monitor holders that do not have pre or post-irradiation measurements. Therefore, the initial lengths of these items are taken to be the average dimensions shown on their respective drawings. The post-irradiation lengths of all NBG-25 components are calculated using PIE measured IG-110 creep data. IG-110 data were used in the absence of NBG-25 data, with the assumption that the properties of IG-110 are similar to NBG-25 due to their similar composition and grain size.

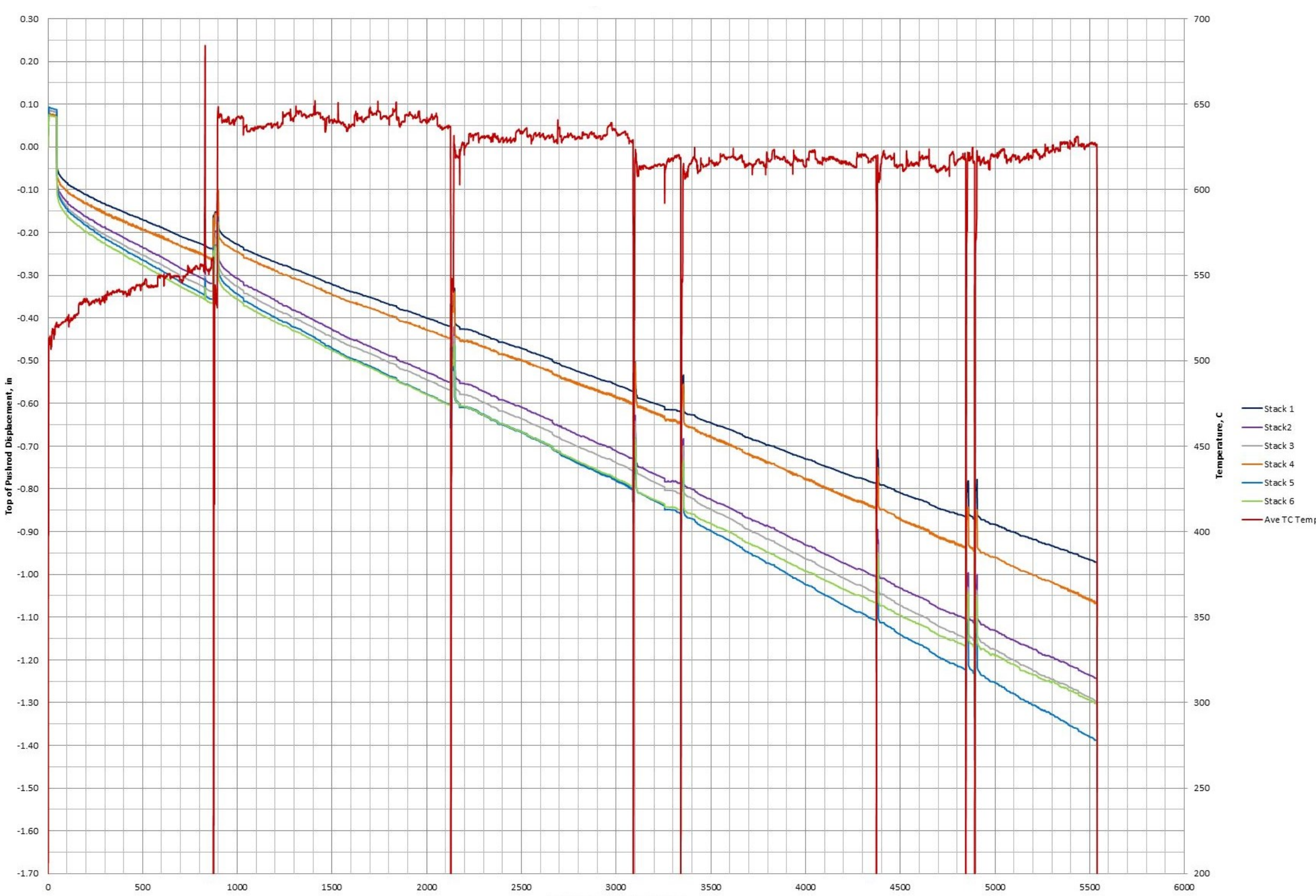

Figure 2. AGC-2 pushrod displacement versus integrated reactor power: Cycles 149A through 151B.

By knowing the pre and post-irradiation lengths of all components and having the pre and post-irradiation coefficient of thermal expansion (CTE) and Young's modulus properties, it should be possible to accurately predict specimen elevations at the beginning and end of the test. However, the calculated position of TOP does not always match the measured LVDT displacement recorded during the experiment. The calculated thermal response of the stack at 5 MW-d (before load is applied) coincides very well with the measured thermal response. However, when the pushrod load is first applied (i.e., about 24 MW-d), there is much greater stack displacement than would be calculated. This can be explained because all components are not perfectly machined and there is some accommodation at the component interfacing surfaces that must occur before the stack goes 'solid'. As can be seen in Figure 2, there is an accommodation period of about 75 MW-d (3 days elapsed time) before the stack goes solid and the creep rate becomes constant. At 100 MW-d, the creep rate stabilizes and remains constant throughout the remainder of the test (5,539 MW-d). However, at the end of the test, there is a considerable discrepancy between the calculated and measured TOP positions.

In an attempt to resolve the TOP discrepancy, the LVDT, temperature, and load data were examined during two unscheduled shutdowns that occurred in Cycle 151B. During these shutdowns, the reactor power went from zero to full power without load being applied (see page 12-13 "AGC-2 Specimen Position Adjustments" Excel workbook, "In-situ Properties" sheet at days 3/26 and 4/07). A short time later, specimen load was applied while the temperature remained stable. This allowed an overall CTE of the graphite stack to be calculated, in addition to an effective overall stack modulus. Data from the six LVDTs during the two shutdowns were examined, which resulted in 12 data points for each property. The 94 to 107-in. stainless steel upper cylinder pushrod (i.e., Drawing 630428-13 and 14 [4]) was not considered due to its calculated minimal length change of less than 0.010 in. The calculated in-situ CTE was within 4% of the expected power-weighted CTE of the pre and post-irradiation properties. However the calculated average in-situ Young's modulus for the stack was approximately one half of the PIE measured modulus. Moreover, the late test in-situ modulus was much closer to the pre-irradiation values than the post-irradiation values. In addition to the in-situ derived modulus discussed above, an in-situ derived modulus for the start-up of each reactor cycle was also performed. These results compared favorably and it was noted that the modulus was observed to be relatively constant for each cycle, with a small modulus increase throughout the test. The in-situ decreased modulus was used to recalculate an end of test (EOT) TOP displacement and is noted on Figure 3. This resulted in only a small improvement in the correlation between the calculated and measured TOP positions.

A decision was made to use the LVDT measurement rather than the PIE measured lengths for determining the specimen elevation. Each specimen/component was shortened by an amount proportional to its load-induced strain, such that the in-situ stack-up length would match the LVDT data. Thus, those items with a higher stress and a longer length would be shortened more than those with a lower stress and a shorter length. Using the TOP displacement data at stable creep initiation (SCI) and EOT, a linear relationship between these two points closely matched LVDT data. Using this linear relationship, the TOP position and the specimen elevation can be calculated as a function of reactor integrated power. For this analysis, specimen elevation at the midpoint of each cycle is tabulated in Appendix A. These adjusted elevations will be used to adjust the specimen dose and temperature in other ECAR analyses.

A calculation was made to gage the approximate dose change in using LVDT data verses the calculated specimen position. The power-averaged position of the uppermost specimens in each stack was found through a linear change between the SCI and EOT values for the calculated and LVDT measured elevations. These two different average elevations were then used to calculate the approximate specimen dose. As shown in Table 1, the largest difference of 4.1% is seen in Stack 5, which also has the largest position change. All specimens will have differences smaller than this value by virtue of their smaller overall position change.

Figure 3. AGC-2 Stack 1 compressed specimens, TOP displacement versus integrated reactor power: Cycles 149A through 151 B.

Table 1. Comparison of the elevation and dose for the uppermost compressed specimens.

Elevation and Dose Comparison of the Uppermost Compressed	**Stack 1**	**Stack 2**	**Stack 3**	**Stack 4**	**Stack 5**	**Stack 6**
Nominal Uppermost Specimen Elevation, in. (these experience the largest elevation change)	19.500	19.500	19.500	19.500	19.500	19.500
EOT Calculated Elevation, in. (post-irradiation lengths and properties)	19.126	19.060	19.009	19.152	19.080	19.002
EOT LVDT Based Elevation, in. (LVDT-based lengths and in-situ properties)	18.873	18.656	18.614	18.799	18.545	18.608
Calculated Mid-Test Elevation, in. (pre and post- irradiation lengths and properties)	19.454	19.418	19.390	19.468	19.429	19.387
Mid-Test LVDT-Based Elevation, in. (LVDT-based lengths and in-situ properties)	19.296	19.173	19.150	19.253	19.113	19.139
Nominal Elevation Total Dose, DPA (elevation constant throughout test)	1.96	1.96	1.94	1.91	1.94	1.97
Calculated Position Total Dose, DPA (pre and post-irradiation lengths and properties)	1.97	1.98	1.96	1.92	1.96	1.99
LVDT Position Total Dose, DPA (LVDT-based lengths and in-situ properties)	2.01	2.04	2.02	1.97	2.04	2.06
LVDT versus Calculated Dose Difference	**2.0%**	**3.1%**	**3.0%**	**2.8%**	**4.1%**	**3.1%**

The uncompressed Stack 1 through Stack 6 and Stack 7 do not have LVDT data to measure position during the experiment. Because load-induced creep was not present, the overall length change was much smaller. However, similar to the compressed stacks, there are flux wire holders that do not have pre and post-irradiation measurements. Similar to the compressed specimens, the equivalent PIE lengths of these items were calculated using IG-110 properties. Also similar to the compressed specimens, the specimens are assumed to shrink linearly with reactor integrated power. Thus, specimen elevation at any reactor integrated power can be calculated. The specimen elevations for each cycle are tabulated in Appendix A.

A propagation of error analysis was performed to obtain an estimate of the position values uncertainty. This analysis takes into consideration the uncertainties of all variables that make up the position calculation. The position is a function with the following variables:

$$Position = f(P, L_0, A, E, CTE, T, L_{End})$$

where P = applied load
L_0 = specimen pre-irradiated length
A = specimen cross-sectional area
E = specimen pre-irradiated Young's modulus
CTE = specimen pre-irradiated CTE
T = specimen temperature
L_{End} = specimen post-irradiated length.

Error in the position calculation of the specimens in the lower housing was not considered because these specimens were not subjected to any load; therefore, they did not move as much as the specimens in the upper housing. The precision and accuracy of the dimensional (i.e., length and diameter), CTE, and Young's Modulus measurements were obtained from TEV-2530, "AGC Inter-laboratory Comparison of Graphite Testing Procedures" [5]. Both the thermocouples' (manufactured by Idaho Laboratories Corporation) and the load cells' (Honeywell Corp., Model 31/AL311CV) precision and accuracy were obtained from their respective manufacturer specifications.

Table 2 shows each of the components precision and accuracy, which go into the position's overall uncertainty calculation. A root sum square of the individual elements was computed to provide a comprehensive uncertainty for the specimen position calculations. This gave a worst case uncertainty value for the position of a specimen within the experiment (the worst case being a specimen at the top of a compressed stack at the end of the experiment). This resulted in a total uncertainty of ±4% of the position as related to the reactor mid-plane.

Table 2. Precision and accuracy of position calculation variables.

	Precision (±%)	Accuracy (±%)
Pre-Irradiated Length	0.07	0.008
Post-Irradiated Length	0.07	0.008
Area	—	0.56
Thermal Growth	—	3.0
Young's Modulus	2.3	—
Temperature (ILC TCs)	—	1.0
Load Cell	0.3 [a]	0.05 [a]

a. of full scale

DESIGN OR TECHNICAL PARAMETER INPUT AND SOURCES

1. NDMAS Data from ATR Reactor from September 4, 2009, through January 8, 2011

2. Spreadsheet "AGC graphite body dimensions" from Philip Winston (see attached e-mail, Appendix B).

RESULTS OF LITERATURE SEARCHES AND OTHER BACKGROUND DATA

NA.

ASSUMPTIONS

Length changes of the specimens were assumed to be linear with respect to dose and reactor integrated power (i.e., megawatt-days).

The creep/dose properties of IG-110 were assumed to be similar to NBG-25.

COMPUTER CODE VALIDATION

Excel software results were validated by random hand calculation checks performed by the checker as allowed per LWP-10200, Appendix E [6].

DISCUSSION/ANALYSIS

The calculations performed in this analysis are accomplished in two separate workbooks and are individually discussed in the following subsections.

'AGC-2 Specimen Support Creep' Workbook

Because the compressed specimens are supported by the lower graphite specimen holder and the length of these support components change during irradiation, it is necessary to know the length of these items as a function of integrated reactor power. Because no PIE data on the length of these graphite support components existed, an equivalent PIE length of these items was calculated using the length measurement obtained in the AGC-1 PIE. Because AGC-1 and AGC-2 graphite components were identical, their respective creep values can be approximated by a ratio of their received dose. Unfortunately, two AGC-1 components did not have pre and post-irradiation lengths: the 0.75-in. long graphite insulator and the 0.75-in. long compressed section of the upper specimen holder assembly. The creep of these items was calculated based on the measured creep of the specimen holders. This calculation is complicated by the fact that these components are subject to an axial variation in reactor flux. Further, the upper specimen holder had both compressed and uncompressed sections, but only the total length of the holder was measured. The specimen holders were broken into 1/8-in. increments and their incremental creep as a function of dose and load was obtained. Thus, the total expected dimension change for the complete graphite support items in AGC-1 was calculated. This result was compared against IG-110 PIE data for compressed specimens. The results of these two methods agreed within 7%. An equivalent creep value for AGC-2 components was obtained by a ratio of their dose. A more detailed description of the purpose of each of the sheets in this workbook is shown as follows:

1. *AGC-1 Total Dose.* This sheet curve fits the total stack averaged dose for AGC-1. These data were taken from ECAR-1406 [7]. This dose equation was used to calculate the incremental elevational dose for the AGC-1 support components.

2. *Specimen Holder Stress.* This sheet uses the dimensions in Drawing 630427 [8] and load data from ECAR-1943 [9] to calculate the area and stress for each of the support components.

3. *IG-110 Data.* This sheet uses the IG-110 data from AGC-1 PIE to obtain a relationship between the measured creep/dose and the specimen axial stress. This relationship was used for comparison to the measured specimen holder lengths. The specimen support components were made from NBG-25, not IG-110. However, because of the similar composition and grain structure of these graphite types, they were assumed to possess similar creep/dose properties.

4. *AGC-1 Displacement Results.* This sheet calculates and compares the AGC-1 measured creep data for holders versus the calculated creep based on IG-110 data.

5. *AGC-2 Displacement Results.* This sheet provides a calculated creep result for AGC-2, based on the results calculated for AGC-1. The results of this sheet are used to calculate the specimen positions in the 'AGC-2 Specimen Position Adjustment' workbook.

'AGC-2 Specimen Position Adjustment' Workbook

1. *Input Specimen Dimension Data.* This sheet is the tabulation of the pre and post-irradiation lengths for all specimens. This is the basis for the calculation of the pre and post-irradiation stack heights and the specimen position change during the course of the experiment.

2. *Cumulative DPA Input.* These data are copied from ECAR-2291 [8] and are used to calculate the total experiment dose for items that do not have pre and post-irradiation measurements. Dose is necessary to calculate an equivalent PIE length to predict total post-irradiation stack height.

3. *Total Dose Curve Fit.* A curve fit for the total dose for each position was obtained in this sheet. The curve fit equation was used to calculate position dose verses reactor elevation.

4. *Input from NDMAS.* This sheet tabulates results from the modified 10-minute NDMAS reactor cycle data. The original NDMAS sheets were modified to add columns for reactor integrated power, average experiment temperature, and power-averaged pushrod position. The pushrod position was also adjusted to set the 'zero' position of the LVDT to the elevation of the TOP position at reactor startup.

5. *Component Areas.* Because the components react to variable stress levels, area of the components is necessary to calculate stress. These values are copied from the areas calculated in the 'AGC-2 Specimen Support Creep' workbook.

6. *Initial Positon Correction.* This sheet tabulates the difference between construction/fabrication drawings and as-built measurements. Also this sheet calculates the position of the lower isolation weld plate as the experiment heats up. Because the capsule wall (i.e., experiment pressure boundary) gets longer as the experiment heats up, the lower isolation weld plate moves to a lower position. These initial corrections are used in all calculations.

7. *Stack 1 Creep Adjustment through Stack 6 Creep Adjustment.* These sheets calculate the average specimen position for each of the five reactor cycles. To accomplish this, the EOT length of the non-measured components is calculated using the total dose and IG-110 data. Four calculated points are also plotted on a pushrod position versus reactor integrated power chart. The first position calculated is the TOP position at stable temperature initiation. This point occurs at 5 MW-d, where the reactor has reached a stable temperature, but before load is applied to the specimens. This calculated TOP position can be compared to the measured LVDT TOP position. Good correlation between these two positions is evident in Figure 3. The second point is SCI; this is the point after the specimen load is applied and the creep rate becomes stable. This point is calculated using the pre-irradiation specimen length, CTE, and modulus. The LVDT data indicate a much lower positon of the TOP than what is calculated. This is attributed to an initial accommodation creep of the specimen interfacing surfaces that occur before the column becomes 'solid' and the creep rate becomes stable. The final calculated TOP position is at the EOT position and is predicted using the post-irradiation specimen lengths and properties. EOT is also calculated using an in-situ derived value for the Young's modulus. These calculated positions are compared in the chart to the linear fit of the two LVDT data points at SCI and EOT. To calculate the average specimen position for each reactor cycle, the LVDT linear data fit was used. The lengths of all components in the graphite stack were proportionally adjusted to reflect the product of length X stress. Those components that experienced the highest stress and had the longer lengths were adjusted the most. The converse was also true. The total length adjustment was the difference between the calculated and LVDT positions. With the SCI and EOT specimen positons calculated, the average specimen position for each reactor cycle was then a linear relationship with respect to integrated reactor power.

8. *Uncompressed S-1 through S-6 Adjustment.* The calculation method on this sheet is similar to the compressed specimen sheets without LVDT data. The unmeasured component's post-irradiation length was calculated; this provided information necessary to calculate the pre and post-irradiation positions of each of the samples. The average position of the specimens for each reactor cycle was based on a linear movement between the pre and post-irradiation calculated end points as a function of integrated reactor power.

9. *S-7 Adjustment.* This adjustment is similar to the other uncompressed specimens in Stack 1 through Stack 6.

10. *S1-S6 Creep Chart.* This chart was plotted to provide an overall view of all LVDT data for all compressed stacks for all reactor cycles. The average temperature of the experiment is plotted to show the response of the stacks to temperature changes.

11. *In-situ Properties.* This sheet references NDMAS data for two unscheduled outages in Cycle 151B and startup data for Cycle 149B through Cycle 151B. These data were used to calculate the whole stack in-situ CTE and modulus.

12. *Calculated vs LVDT Chart.* This chart compares the worst case dose change of the uppermost compressed specimens when using LVDT elevations versus calculated elevations.

13. *Specimen Adjustment Results.* The specimen positions for each reactor cycle are tabulated onto one sheet for insertion into separate dose and temperature adjustment worksheets performed in other analyses.

14. *Specimen Adjustment Printout.* The specimen positions for each cycle are arranged for printed insertion into Appendix A.

REFERENCES

1. INL Drawing 600001, “ATR TMIST-1 Oxidation Experiment In-Vessel Installation,” Revision 2

2. INL Drawing 601266, “ATR Advanced Graphite Capsule Number 2 (AGC-2) Capsule Facility Assemblies,” Revision 2.

3. ECAR-2291, “As-Run Physics Analysis for the AGC-2 Experiment Irradiated in the ATR,” Revision 0, March 2014.

4. INL Drawing 630428, “ATR Advanced Graphite Capsule (AGC) Stainless Steel and Aluminum Component Details.”

5. TEV-2530 “AGC Inter-laboratory Comparison of Graphite Testing Procedures”, Draft

6. LWP-10200, “Engineering Calculations and Analysis Report,” Revision 7, April 10, 2012.

7. ECAR-1406, As-Run Neutronic Analysis of the AGC-1 Experiment Irradiated in the ATR South Flux Trap”, Revision 0, March 2011

8. INL Drawing 630427, ATR Advanced Graphite Capsule (AGC) Specimen Holder and Insulator Details and Assemblies”, Revision 3.

9. ECAR-1943, AGC-1 Individual Specimen Fluence, Temperature, and Load Calculation and Tabulation”, September 2012.

Appendix A

Tabulation of Specimen Elevations at Each Reactor Mid Cycle

Stack 1 - Compressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
CW1 01	1	19.500	19.652	19.490	19.321	19.149	18.962
1A	1	18.875	19.029	18.868	18.701	18.531	18.347
DW1 01	1	18.250	18.406	18.247	18.082	17.914	17.731
BW1 01	1	17.250	17.409	17.253	17.091	16.927	16.747
EW01 02	1	16.250	16.412	16.259	16.100	15.939	15.764
FW01 01	1	15.250	15.415	15.266	15.111	14.954	14.782
DW1 02	1	14.250	14.418	14.273	14.122	13.969	13.802
AY	1	13.625	13.794	13.652	13.503	13.353	13.189
BW1 02	1	13.000	13.171	13.031	12.884	12.736	12.574
FW01 02	1	12.000	12.175	12.038	11.895	11.750	11.593
EW01 04	1	11.000	11.177	11.044	10.906	10.766	10.613
DW10 01	1	10.000	10.180	10.052	9.919	9.783	9.636
BW1 03	1	9.000	9.184	9.060	8.932	8.801	8.659
FW01 03	1	8.000	8.187	8.068	7.943	7.817	7.680
1H	1	7.375	7.564	7.447	7.325	7.202	7.067
CW1 02	1	6.750	6.941	6.827	6.709	6.589	6.457
EW02 01	1	5.750	5.945	5.836	5.723	5.609	5.484
DW10 02	1	4.750	4.948	4.845	4.738	4.629	4.510
BW10 01	1	3.750	3.952	3.854	3.752	3.648	3.536
FW01 04	1	2.750	2.955	2.862	2.764	2.665	2.558
8H	1	2.125	2.332	2.241	2.146	2.050	1.945
AW1 01	1	1.500	1.709	1.621	1.529	1.436	1.334

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Stack 2 - Compressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
EW03 01	2	19.500	19.609	19.410	19.203	18.993	18.764
AW17 07	2	18.875	18.987	18.790	18.586	18.378	18.152
FW03 01	2	18.250	18.364	18.170	17.968	17.763	17.540
DA4 02	2	17.250	17.369	17.179	16.982	16.782	16.565
BP4 02	2	16.250	16.374	16.189	15.997	15.802	15.590
AW1 03	2	15.250	15.378	15.198	15.011	14.821	14.613
EW03 02	2	14.250	14.383	14.208	14.026	13.841	13.639
2B	2	13.625	13.761	13.589	13.410	13.229	13.031
DW11 03	2	13.000	13.139	12.971	12.795	12.617	12.423
BW11 03	2	12.000	12.144	11.981	11.811	11.639	11.451
CW10 03	2	11.000	11.149	10.992	10.828	10.661	10.480
AW10 01	2	10.000	10.154	10.002	9.845	9.685	9.511
EW03 03	2	9.000	9.159	9.013	8.862	8.709	8.541
DA4 03	2	8.000	8.164	8.025	7.881	7.734	7.575
AW17 08	2	7.375	7.542	7.407	7.267	7.124	6.969
BP4 03	2	6.750	6.920	6.789	6.652	6.513	6.362
FW03 02	2	5.750	5.925	5.800	5.669	5.536	5.391
AP4 02	2	4.750	4.930	4.810	4.685	4.559	4.421
CW11 01	2	3.750	3.935	3.822	3.704	3.584	3.453
DW11 04	2	2.750	2.941	2.835	2.724	2.612	2.490
37	2	2.125	2.319	2.217	2.111	2.003	1.886
BW12 01	2	1.500	1.697	1.599	1.496	1.392	1.279

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Stack 3 - Compressed			Specimen COM at Mid Cycle				
Specimen ID#	**Stack #**	**Nominal Elevation**	**Cycle 149A**	**Cycle 149B**	**Cycle 150B**	**Cycle 151A**	**Cycle 151B**
CW12 02	3	19.500	19.602	19.396	19.181	18.964	18.727
TP 27	3	18.875	18.980	18.776	18.564	18.350	18.116
DW12 03	3	18.250	18.358	18.157	17.948	17.737	17.506
BW13 01	3	17.250	17.363	17.168	16.964	16.757	16.532
EW04 03	3	16.250	16.369	16.178	15.979	15.778	15.558
FW04 01	3	15.250	15.374	15.189	14.996	14.800	14.586
DW12 04	3	14.250	14.379	14.200	14.013	13.823	13.616
2U	3	13.625	13.758	13.582	13.398	13.212	13.009
BW13 02	3	13.000	13.136	12.963	12.783	12.600	12.401
FW04 02	3	12.000	12.142	11.974	11.799	11.623	11.430
EW04 04	3	11.000	11.147	10.986	10.818	10.647	10.461
DW13 01	3	10.000	10.153	9.999	9.838	9.675	9.497
BW13 03	3	9.000	9.159	9.012	8.858	8.702	8.532
FW04 04	3	8.000	8.165	8.023	7.876	7.727	7.564
TP 12	3	7.375	7.543	7.405	7.262	7.116	6.958
CW12 03	3	6.750	6.921	6.788	6.649	6.508	6.354
EW05 01	3	5.750	5.927	5.801	5.670	5.537	5.392
DW13 02	3	4.750	4.933	4.815	4.692	4.568	4.432
BW14 01	3	3.750	3.940	3.829	3.714	3.597	3.469
FW05 01	3	2.750	2.945	2.841	2.733	2.623	2.503
8Y	3	2.125	2.324	2.224	2.119	2.013	1.898
AW11 01	3	1.500	1.702	1.606	1.506	1.404	1.294

Stack 4 - Compressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
EW06 01	4	19.500	19.635	19.461	19.279	19.095	18.895
AX	4	18.875	19.012	18.839	18.660	18.478	18.279
FW06 02	4	18.250	18.388	18.218	18.040	17.860	17.664
DA5 03	4	17.250	17.391	17.224	17.050	16.874	16.681
BP5 03	4	16.250	16.395	16.231	16.060	15.887	15.699
AW11 03	4	15.250	15.398	15.238	15.071	14.901	14.717
EW06 02	4	14.250	14.401	14.245	14.082	13.916	13.736
18	4	13.625	13.778	13.624	13.464	13.301	13.124
DW14 03	4	13.000	13.155	13.004	12.846	12.686	12.512
BW15 03	4	12.000	12.159	12.012	11.858	11.703	11.533
CW13 03	4	11.000	11.162	11.019	10.870	10.719	10.555
AW12 01	4	10.000	10.166	10.027	9.883	9.737	9.577
EW06 03	4	9.000	9.169	9.036	8.896	8.755	8.601
DA6 01	4	8.000	8.173	8.045	7.911	7.775	7.627
AR	4	7.375	7.550	7.425	7.294	7.162	7.018
BP6 01	4	6.750	6.927	6.805	6.677	6.548	6.407
FW06 03	4	5.750	5.931	5.813	5.690	5.565	5.429
AP5 01	4	4.750	4.935	4.821	4.703	4.583	4.452
CW2 01	4	3.750	3.939	3.830	3.717	3.603	3.478
DW14 04	4	2.750	2.943	2.840	2.733	2.624	2.506
3F	4	2.125	2.320	2.221	2.117	2.012	1.897
BW16 01	4	1.500	1.697	1.601	1.500	1.398	1.286

Stack 5 - Compressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
CW3 01	5	19.500	19.592	19.373	19.146	18.915	18.664
EW15 11	5	18.875	18.970	18.754	18.530	18.302	18.054
DW15 04	5	18.250	18.347	18.135	17.913	17.689	17.444
BW2 01	5	17.250	17.352	17.144	16.928	16.708	16.469
EW07 03	5	16.250	16.357	16.155	15.943	15.729	15.496
FW07 03	5	15.250	15.362	15.165	14.959	14.751	14.523
DW16 01	5	14.250	14.367	14.175	13.976	13.773	13.552
57	5	13.625	13.745	13.557	13.361	13.162	12.945
BW2 02	5	13.000	13.124	12.938	12.746	12.550	12.337
FW07 04	5	12.000	12.129	11.949	11.762	11.573	11.366
EW07 04	5	11.000	11.134	10.961	10.780	10.597	10.398
DW16 02	5	10.000	10.140	9.973	9.800	9.624	9.433
BW2 03	5	9.000	9.145	8.985	8.818	8.649	8.465
FW08 01	5	8.000	8.151	7.997	7.836	7.673	7.496
AW17 10	5	7.375	7.529	7.378	7.222	7.063	6.889
CW3 02	5	6.750	6.907	6.761	6.608	6.454	6.286
EW08 01	5	5.750	5.913	5.774	5.629	5.483	5.323
DW16 03	5	4.750	4.919	4.788	4.651	4.512	4.361
BW3 01	5	3.750	3.925	3.801	3.671	3.540	3.397
FW08 02	5	2.750	2.931	2.813	2.690	2.565	2.429
AL	5	2.125	2.309	2.195	2.076	1.955	1.824
AW13 01	5	1.500	1.687	1.577	1.462	1.346	1.219

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Stack 6 - Compressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
EW09 01	6	19.500	19.587	19.383	19.170	18.955	18.720
TP 16	6	18.875	18.966	18.764	18.554	18.341	18.109
FW09 03	6	18.250	18.344	18.145	17.938	17.727	17.498
DA3 03	6	17.250	17.349	17.155	16.952	16.747	16.524
BP4 01	6	16.250	16.355	16.165	15.968	15.768	15.549
AW13 03	6	15.250	15.361	15.176	14.983	14.788	14.575
EW09 02	6	14.250	14.367	14.187	14.000	13.811	13.605
5F	6	13.625	13.745	13.569	13.386	13.200	12.998
DW2 01	6	13.000	13.124	12.952	12.772	12.590	12.392
BW4 03	6	12.000	12.130	11.963	11.790	11.615	11.423
CW4 02	6	11.000	11.136	10.976	10.809	10.640	10.455
AW14 01	6	10.000	10.142	9.989	9.828	9.666	9.489
EA9 02	6	9.000	9.148	9.001	8.848	8.693	8.523
DA3 02	6	8.000	8.154	8.015	7.870	7.723	7.562
TP 17	6	7.375	7.533	7.398	7.258	7.116	6.961
BP3 03	6	6.750	6.912	6.781	6.644	6.506	6.355
FW09 04	6	5.750	5.918	5.794	5.664	5.532	5.388
AP5 03	6	4.750	4.925	4.806	4.683	4.558	4.421
CW4 03	6	3.750	3.931	3.820	3.704	3.586	3.458
DW2 02	6	2.750	2.937	2.834	2.726	2.617	2.498
5H	6	2.125	2.317	2.218	2.115	2.011	1.898
BW5 01	6	1.500	1.696	1.601	1.502	1.402	1.292

Stack 1 - Uncompressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
AW1 02	1	-1.750	-1.480	-1.481	-1.553	-1.553	-1.583
AO	1	-2.375	-2.105	-2.106	-2.175	-2.175	-2.204
FW02 01	1	-3.000	-2.731	-2.732	-2.800	-2.800	-2.828
BW10 02	1	-4.000	-3.732	-3.733	-3.798	-3.798	-3.825
DW10 03	1	-5.000	-4.733	-4.733	-4.794	-4.794	-4.819
EW02 02	1	-6.000	-5.734	-5.734	-5.789	-5.789	-5.812
CW1 03	1	-7.000	-6.735	-6.734	-6.785	-6.785	-6.806
AL14 02	1	-7.625	-7.360	-7.358	-7.406	-7.406	-7.426
FW02 02	1	-8.250	-7.985	-7.984	-8.029	-8.029	-8.048
BW10 03	1	-9.250	-8.986	-8.984	-9.027	-9.027	-9.044
DW10 04	1	-10.250	-9.987	-9.985	-10.023	-10.023	-10.039
EW02 03	1	-11.250	-10.987	-10.985	-11.019	-11.019	-11.033
FW02 03	1	-12.250	-11.988	-11.986	-12.017	-12.017	-12.029
BW11 01	1	-13.250	-12.989	-12.987	-13.015	-13.015	-13.026
8U	1	-13.875	-13.615	-13.613	-13.639	-13.639	-13.649
DW11 01	1	-14.500	-14.241	-14.238	-14.262	-14.262	-14.271
FW02 04	1	-15.500	-15.242	-15.239	-15.260	-15.260	-15.267
EW02 04	1	-16.500	-16.243	-16.241	-16.258	-16.258	-16.264
BW11 02	1	-17.500	-17.244	-17.242	-17.256	-17.256	-17.261
DW11 02	1	-18.500	-18.245	-18.243	-18.254	-18.254	-18.259
AE	1	-19.125	-18.870	-18.869	-18.879	-18.879	-18.883
CW10 02	1	-19.750	-19.496	-19.495	-19.503	-19.503	-19.506
BP7 06	1	-20.375	-20.122	-20.121	-20.127	-20.127	-20.130
L2 08	1	-20.625	-20.371	-20.370	-20.376	-20.376	-20.379
K2 09	1	-20.875	-20.621	-20.620	-20.626	-20.626	-20.628
P2-08	1	-21.125	-20.871	-20.870	-20.875	-20.875	-20.877
DW18 03	1	-21.375	-21.121	-21.120	-21.125	-21.125	-21.127
M2-07	1	-21.625	-21.371	-21.370	-21.374	-21.374	-21.376
S2 07	1	-21.875	-21.621	-21.620	-21.624	-21.624	-21.626
FW15 01	1	-22.125	-21.870	-21.870	-21.873	-21.873	-21.875
EW14 01	1	-22.375	-22.120	-22.121	-22.123	-22.123	-22.125
J2 06	1	-22.625	-22.370	-22.371	-22.373	-22.373	-22.374
RW2 09	1	-22.875	-22.620	-22.621	-22.622	-22.622	-22.624
H562	1	-23.125	-22.869	-22.870	-22.871	-22.871	-22.872
TP 18	1	-23.375	-23.119	-23.120	-23.120	-23.120	-23.121

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Stack 2 - Uncompressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
BW12 02	2	-1.750	-1.480	-1.484	-1.530	-1.563	-1.596
AW17 09	2	-2.375	-2.105	-2.109	-2.153	-2.185	-2.218
DW12 01	2	-3.000	-2.730	-2.733	-2.776	-2.806	-2.837
CW11 02	2	-4.000	-3.731	-3.733	-3.772	-3.801	-3.829
AP4 03	2	-5.000	-4.732	-4.733	-4.770	-4.796	-4.823
FW03 03	2	-6.000	-5.733	-5.734	-5.769	-5.794	-5.819
BP5 01	2	-7.000	-6.733	-6.735	-6.767	-6.791	-6.814
EW15 09	2	-7.625	-7.359	-7.360	-7.391	-7.413	-7.436
DA5 01	2	-8.250	-7.985	-7.986	-8.015	-8.036	-8.057
EW03 04	2	-9.250	-8.986	-8.986	-9.013	-9.032	-9.051
AW10 02	2	-10.250	-9.987	-9.987	-10.011	-10.028	-10.046
CW11 03	2	-11.250	-10.988	-10.987	-11.009	-11.025	-11.040
BW12 03	2	-12.250	-11.989	-11.988	-12.007	-12.021	-12.034
DW12 02	2	-13.250	-12.990	-12.988	-13.006	-13.018	-13.029
7D	2	-13.875	-13.615	-13.614	-13.629	-13.640	-13.651
EW04 01	2	-14.500	-14.241	-14.239	-14.254	-14.264	-14.274
AW10 03	2	-15.500	-15.242	-15.240	-15.253	-15.261	-15.270
BP5 02	2	-16.500	-16.243	-16.241	-16.252	-16.259	-16.267
DA5 02	2	-17.500	-17.244	-17.242	-17.251	-17.257	-17.264
FW03 04	2	-18.500	-18.245	-18.244	-18.251	-18.256	-18.261
EW15 10	2	-19.125	-18.871	-18.870	-18.876	-18.881	-18.885
EW04 02	2	-19.750	-19.497	-19.496	-19.501	-19.505	-19.509
J2 07	2	-20.375	-20.122	-20.122	-20.126	-20.129	-20.132
RW2 10	2	-20.625	-20.372	-20.371	-20.375	-20.378	-20.381
H571	2	-20.875	-20.621	-20.621	-20.624	-20.627	-20.629
TP 19	2	-21.125	-20.871	-20.870	-20.873	-20.875	-20.877
BP7 07	2	-21.375	-21.120	-21.120	-21.122	-21.124	-21.126
L2 09	2	-21.625	-21.370	-21.370	-21.372	-21.373	-21.375
K2 10	2	-21.875	-21.620	-21.620	-21.621	-21.623	-21.625
P2-09	2	-22.125	-21.870	-21.870	-21.871	-21.872	-21.874
DW18 04	2	-22.375	-22.119	-22.120	-22.120	-22.122	-22.123
M2-08	2	-22.625	-22.369	-22.370	-22.370	-22.372	-22.373
S2 08	2	-22.875	-22.619	-22.620	-22.620	-22.621	-22.622
FW15 02	2	-23.125	-22.869	-22.870	-22.869	-22.871	-22.871
EW14 02	2	-23.375	-23.119	-23.120	-23.119	-23.120	-23.121

Stack 3 - Uncompressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
AW11 02	3	-1.750	-1.480	-1.482	-1.527	-1.559	-1.591
TP 24	3	-2.375	-2.105	-2.108	-2.151	-2.181	-2.212
FW05 02	3	-3.000	-2.731	-2.733	-2.775	-2.805	-2.835
BW14 02	3	-4.000	-3.732	-3.734	-3.773	-3.802	-3.830
DW13 03	3	-5.000	-4.732	-4.734	-4.771	-4.797	-4.824
EW05 02	3	-6.000	-5.733	-5.734	-5.768	-5.792	-5.817
CW13 01	3	-7.000	-6.734	-6.734	-6.766	-6.788	-6.810
TP 25	3	-7.625	-7.359	-7.359	-7.389	-7.409	-7.430
FW05 03	3	-8.250	-7.985	-7.984	-8.013	-8.032	-8.052
BW14 03	3	-9.250	-8.986	-8.985	-9.011	-9.030	-9.048
DW13 04	3	-10.250	-9.986	-9.985	-10.009	-10.026	-10.042
EW05 03	3	-11.250	-10.987	-10.986	-11.007	-11.021	-11.036
FW05 04	3	-12.250	-11.988	-11.987	-12.006	-12.019	-12.032
BW15 01	3	-13.250	-12.989	-12.988	-13.005	-13.017	-13.028
1Y	3	-13.875	-13.615	-13.613	-13.629	-13.640	-13.651
DW14 01	3	-14.500	-14.240	-14.239	-14.253	-14.264	-14.274
FW06 01	3	-15.500	-15.242	-15.240	-15.253	-15.261	-15.270
EW05 04	3	-16.500	-16.243	-16.241	-16.252	-16.259	-16.267
BW15 02	3	-17.500	-17.244	-17.242	-17.251	-17.258	-17.264
DW14 02	3	-18.500	-18.245	-18.244	-18.251	-18.256	-18.262
TP 26	3	-19.125	-18.870	-18.869	-18.875	-18.880	-18.885
CW13 02	3	-19.750	-19.496	-19.495	-19.500	-19.504	-19.508
DW18 05	3	-20.375	-20.121	-20.121	-20.125	-20.129	-20.132
M2-09	3	-20.625	-20.371	-20.371	-20.375	-20.378	-20.381
S2 09	3	-20.875	-20.621	-20.621	-20.624	-20.627	-20.630
FW15 03	3	-21.125	-20.871	-20.871	-20.874	-20.877	-20.880
EW14 03	3	-21.375	-21.122	-21.122	-21.124	-21.127	-21.129
J2 08	3	-21.625	-21.372	-21.372	-21.374	-21.376	-21.379
RW4 01	3	-21.875	-21.622	-21.622	-21.624	-21.626	-21.628
H572	3	-22.125	-21.871	-21.872	-21.873	-21.875	-21.877
TP 20	3	-22.375	-22.121	-22.121	-22.122	-22.124	-22.125
L3 04	3	-22.625	-22.371	-22.371	-22.372	-22.373	-22.374
L2 10	3	-22.875	-22.621	-22.621	-22.621	-22.623	-22.624
K3 01	3	-23.125	-22.870	-22.871	-22.870	-22.872	-22.872
P2-10	3	-23.375	-23.119	-23.120	-23.120	-23.121	-23.121

Stack 4 - Uncompressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
BW16 02	4	-1.750	-1.479	-1.481	-1.525	-1.556	-1.588
5B	4	-2.375	-2.104	-2.106	-2.149	-2.179	-2.210
DW15 02	4	-3.000	-2.730	-2.732	-2.773	-2.802	-2.831
CW2 02	4	-4.000	-3.731	-3.732	-3.770	-3.797	-3.824
AP5 02	4	-5.000	-4.732	-4.733	-4.768	-4.793	-4.818
FW06 04	4	-6.000	-5.733	-5.734	-5.767	-5.791	-5.814
BP6 02	4	-7.000	-6.734	-6.734	-6.766	-6.788	-6.810
AL14 03	4	-7.625	-7.359	-7.359	-7.389	-7.410	-7.431
DA6 02	4	-8.250	-7.984	-7.984	-8.012	-8.032	-8.052
EW06 04	4	-9.250	-8.985	-8.985	-9.011	-9.029	-9.047
AW12 02	4	-10.250	-9.986	-9.985	-10.009	-10.025	-10.042
CW2 03	4	-11.250	-10.988	-10.986	-11.007	-11.022	-11.036
BW16 03	4	-12.250	-11.989	-11.987	-12.006	-12.019	-12.031
DW15 03	4	-13.250	-12.990	-12.988	-13.005	-13.016	-13.027
2Y	4	-13.875	-13.616	-13.614	-13.629	-13.640	-13.650
EW07 01	4	-14.500	-14.241	-14.239	-14.253	-14.263	-14.272
AW12 03	4	-15.500	-15.242	-15.240	-15.252	-15.260	-15.268
BP6 03	4	-16.500	-16.242	-16.240	-16.251	-16.258	-16.265
DA7 01	4	-17.500	-17.244	-17.242	-17.251	-17.257	-17.263
FW07 01	4	-18.500	-18.245	-18.244	-18.251	-18.256	-18.261
8Z	4	-19.125	-18.871	-18.870	-18.877	-18.881	-18.886
EW07 02	4	-19.750	-19.497	-19.497	-19.502	-19.506	-19.510
L3 05	4	-20.375	-20.123	-20.122	-20.127	-20.130	-20.133
L3 01	4	-20.625	-20.373	-20.372	-20.376	-20.379	-20.383
K3 02	4	-20.875	-20.623	-20.622	-20.626	-20.629	-20.632
P3-01	4	-21.125	-20.872	-20.872	-20.875	-20.878	-20.881
DW18 06	4	-21.375	-21.122	-21.122	-21.125	-21.127	-21.130
M2-10	4	-21.625	-21.372	-21.372	-21.374	-21.377	-21.379
S2 10	4	-21.875	-21.622	-21.622	-21.624	-21.626	-21.628
P3-06	4	-22.125	-21.872	-21.872	-21.874	-21.876	-21.878
K3 05	4	-22.375	-22.121	-22.122	-22.123	-22.125	-22.127
J2 09	4	-22.625	-22.371	-22.372	-22.373	-22.374	-22.376
RW4 02	4	-22.875	-22.620	-22.621	-22.622	-22.623	-22.625
H581	4	-23.125	-22.870	-22.871	-22.871	-22.872	-22.873
TP 21	4	-23.375	-23.119	-23.120	-23.120	-23.121	-23.121

Stack 5 - Uncompressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
AW13 02	5	-1.750	-1.474	-1.475	-1.518	-1.548	-1.578
EW15 08	5	-2.375	-2.100	-2.100	-2.142	-2.171	-2.200
FW08 03	5	-3.000	-2.726	-2.726	-2.766	-2.794	-2.823
BW3 02	5	-4.000	-3.727	-3.727	-3.765	-3.792	-3.819
DW16 04	5	-5.000	-4.727	-4.728	-4.763	-4.788	-4.814
EW08 02	5	-6.000	-5.728	-5.728	-5.761	-5.784	-5.808
CW3 03	5	-7.000	-6.730	-6.729	-6.759	-6.780	-6.802
EW15 07	5	-7.625	-7.356	-7.354	-7.383	-7.403	-7.423
FW08 04	5	-8.250	-7.982	-7.980	-8.008	-8.027	-8.046
BW3 03	5	-9.250	-8.982	-8.981	-9.007	-9.024	-9.042
DW17 01	5	-10.250	-9.984	-9.982	-10.005	-10.021	-10.037
EW08 03	5	-11.250	-10.985	-10.983	-11.004	-11.018	-11.032
FW09 01	5	-12.250	-11.986	-11.984	-12.003	-12.016	-12.029
BW4 01	5	-13.250	-12.987	-12.986	-13.003	-13.014	-13.026
7Z	5	-13.875	-13.613	-13.611	-13.627	-13.638	-13.649
DW17 02	5	-14.500	-14.239	-14.237	-14.252	-14.262	-14.272
FW09 02	5	-15.500	-15.241	-15.239	-15.252	-15.261	-15.269
EW08 04	5	-16.500	-16.242	-16.240	-16.251	-16.259	-16.267
BW4 02	5	-17.500	-17.243	-17.242	-17.251	-17.258	-17.264
DW17 04	5	-18.500	-18.244	-18.243	-18.251	-18.257	-18.262
EW15 06	5	-19.125	-18.870	-18.869	-18.876	-18.881	-18.886
CW4 01	5	-19.750	-19.496	-19.496	-19.501	-19.506	-19.510
J2 10	5	-20.375	-20.122	-20.122	-20.126	-20.130	-20.133
RW4 03	5	-20.625	-20.372	-20.371	-20.375	-20.378	-20.382
H582	5	-20.875	-20.621	-20.621	-20.624	-20.627	-20.630
TP 22	5	-21.125	-20.871	-20.870	-20.873	-20.876	-20.878
L3 06	5	-21.375	-21.120	-21.120	-21.123	-21.125	-21.127
L3 02	5	-21.625	-21.370	-21.370	-21.372	-21.374	-21.376
K3 03	5	-21.875	-21.620	-21.620	-21.622	-21.624	-21.626
P3-02	5	-22.125	-21.870	-21.870	-21.871	-21.873	-21.875
DW18 07	5	-22.375	-22.119	-22.120	-22.121	-22.122	-22.124
M2-11	5	-22.625	-22.369	-22.370	-22.371	-22.372	-22.373
S2 11	5	-22.875	-22.619	-22.620	-22.620	-22.621	-22.622
P3-05	5	-23.125	-22.869	-22.870	-22.870	-22.871	-22.872
EW14 05	5	-23.375	-23.119	-23.120	-23.119	-23.120	-23.121

Stack 6 - Uncompressed			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
BW5 02	6	-1.750	-1.481	-1.482	-1.525	-1.554	-1.585
TP13	6	-2.375	-2.107	-2.107	-2.149	-2.178	-2.207
DW2 03	6	-3.000	-2.732	-2.732	-2.772	-2.800	-2.827
CW5 01	6	-4.000	-3.733	-3.733	-3.769	-3.795	-3.820
AP6 01	6	-5.000	-4.734	-4.734	-4.768	-4.792	-4.815
FW10 01	6	-6.000	-5.735	-5.735	-5.767	-5.790	-5.813
BP3 02	6	-7.000	-6.736	-6.736	-6.766	-6.788	-6.809
TP 14	6	-7.625	-7.361	-7.361	-7.390	-7.410	-7.431
DA2 03	6	-8.250	-7.987	-7.986	-8.014	-8.033	-8.052
EW09 04	6	-9.250	-8.988	-8.987	-9.012	-9.030	-9.047
AW14 02	6	-10.250	-9.989	-9.987	-10.011	-10.027	-10.042
CW5 03	6	-11.250	-10.990	-10.988	-11.008	-11.022	-11.036
BW5 03	6	-12.250	-11.990	-11.988	-12.006	-12.019	-12.031
DW2 04	6	-13.250	-12.991	-12.988	-13.005	-13.016	-13.027
7Y	6	-13.875	-13.616	-13.614	-13.629	-13.639	-13.648
EW10 01	6	-14.500	-14.242	-14.239	-14.253	-14.262	-14.271
AW14 03	6	-15.500	-15.242	-15.240	-15.251	-15.259	-15.266
BP3 01	6	-16.500	-16.243	-16.241	-16.250	-16.257	-16.263
DA2 02	6	-17.500	-17.244	-17.242	-17.250	-17.255	-17.261
FW10 02	6	-18.500	-18.246	-18.244	-18.250	-18.255	-18.259
TP 15	6	-19.125	-18.871	-18.870	-18.875	-18.879	-18.883
EW10 02	6	-19.750	-19.497	-19.495	-19.500	-19.503	-19.507
CW14 06	6	-20.375	-20.122	-20.121	-20.125	-20.127	-20.130
M2-12	6	-20.625	-20.372	-20.371	-20.374	-20.377	-20.379
S2 12	6	-20.875	-20.622	-20.621	-20.624	-20.626	-20.628
K3 06	6	-21.125	-20.871	-20.871	-20.873	-20.876	-20.878
EW14 06	6	-21.375	-21.121	-21.121	-21.123	-21.125	-21.127
J2 11	6	-21.625	-21.371	-21.371	-21.373	-21.375	-21.377
RW4 04	6	-21.875	-21.621	-21.621	-21.622	-21.624	-21.626
H591	6	-22.125	-21.871	-21.870	-21.872	-21.873	-21.874
TP 23	6	-22.375	-22.120	-22.120	-22.121	-22.122	-22.123
P3-04	6	-22.625	-22.370	-22.370	-22.370	-22.371	-22.372
L3 03	6	-22.875	-22.620	-22.620	-22.620	-22.621	-22.622
K3 04	6	-23.125	-22.869	-22.870	-22.870	-22.871	-22.872
P3-03	6	-23.375	-23.119	-23.120	-23.120	-23.120	-23.121

Stack 7 - Uncompressed (1 of 5)			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
A3-P43-Z12	7	18.375	18.589	18.593	18.513	18.460	18.407
J1 11	7	18.125	18.339	18.343	18.264	18.211	18.158
K2 02	7	17.875	18.090	18.094	18.014	17.962	17.909
L2 01	7	17.625	17.840	17.844	17.765	17.713	17.660
M1-12	7	17.375	17.590	17.594	17.515	17.463	17.411
TP 11	7	17.125	17.341	17.344	17.266	17.214	17.162
P2-01	7	16.875	17.091	17.094	17.016	16.965	16.913
RW2 02	7	16.625	16.841	16.844	16.767	16.716	16.664
S1 11	7	16.375	16.592	16.595	16.517	16.466	16.415
CPB101	7	16.125	16.341	16.344	16.268	16.217	16.165
BP7 08	7	15.875	16.092	16.094	16.018	15.967	15.916
DW18 08	7	15.625	15.842	15.845	15.769	15.718	15.667
BP7 09	7	15.375	15.592	15.595	15.519	15.469	15.419
FW15 04	7	15.125	15.343	15.345	15.270	15.220	15.170
EW14 04	7	14.875	15.092	15.095	15.020	14.971	14.920
CW14 05	7	14.625	14.842	14.845	14.771	14.721	14.671
A3-H08-Z19	7	14.375	14.593	14.596	14.522	14.473	14.423
J1 10	7	14.125	14.344	14.347	14.273	14.225	14.175
K2 01	7	13.875	14.094	14.097	14.024	13.976	13.927
L1 10	7	13.625	13.845	13.847	13.775	13.727	13.679
M1-11	7	13.375	13.595	13.598	13.526	13.478	13.430
TP 10	7	13.125	13.345	13.348	13.276	13.229	13.181
P1-10	7	12.875	13.096	13.098	13.027	12.980	12.932
RW2 01	7	12.625	12.846	12.848	12.777	12.730	12.682
S1 10	7	12.375	12.596	12.598	12.528	12.481	12.434
CPB91	7	12.125	12.346	12.348	12.278	12.232	12.185
BP7 10	7	11.875	12.096	12.098	12.029	11.983	11.936
DA8 05	7	11.625	11.847	11.849	11.780	11.734	11.687
AP7 08	7	11.375	11.597	11.599	11.530	11.485	11.439
FW15 05	7	11.125	11.347	11.349	11.281	11.236	11.190
EW15 03	7	10.875	11.097	11.099	11.031	10.986	10.941
CW14 04	7	10.625	10.847	10.849	10.782	10.737	10.692
H521	7	10.375	10.597	10.599	10.533	10.488	10.444
J1 09	7	10.125	10.347	10.349	10.284	10.240	10.195

Stack 7 - Uncompressed (2 of 5)			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
K1 10	7	9.875	10.098	10.100	10.035	9.991	9.948
L1 09	7	9.625	9.848	9.850	9.786	9.743	9.700
M1-10	7	9.375	9.599	9.601	9.537	9.494	9.451
TP 09	7	9.125	9.349	9.351	9.288	9.245	9.203
P1-09	7	8.875	9.099	9.101	9.038	8.996	8.954
RW1 10	7	8.625	8.849	8.852	8.789	8.747	8.705
S1 09	7	8.375	8.600	8.602	8.540	8.499	8.457
CPB81	7	8.125	8.350	8.352	8.291	8.250	8.208
BW17 01	7	7.875	8.100	8.102	8.041	8.000	7.959
DA8 04	7	7.625	7.850	7.853	7.792	7.752	7.711
AP7 09	7	7.375	7.600	7.603	7.543	7.503	7.462
FW15 06	7	7.125	7.351	7.353	7.293	7.254	7.213
EW15 02	7	6.875	7.101	7.103	7.044	7.004	6.964
CW14 03	7	6.625	6.851	6.853	6.794	6.755	6.716
H512	7	6.375	6.601	6.603	6.545	6.506	6.467
J1 08	7	6.125	6.351	6.353	6.295	6.257	6.218
K1 09	7	5.875	6.101	6.103	6.046	6.008	5.970
L1 08	7	5.625	5.852	5.854	5.797	5.759	5.721
M1-09	7	5.375	5.602	5.604	5.548	5.510	5.473
TP 08	7	5.125	5.352	5.354	5.299	5.261	5.224
P1-08	7	4.875	5.103	5.105	5.049	5.012	4.975
RW1 09	7	4.625	4.853	4.855	4.800	4.763	4.726
S1 08	7	4.375	4.604	4.605	4.551	4.514	4.477
CPB71	7	4.125	4.354	4.355	4.301	4.265	4.229
BW17 09	7	3.875	4.104	4.105	4.052	4.016	3.980
DA8 03	7	3.625	3.854	3.856	3.803	3.767	3.731
AP7 10	7	3.375	3.604	3.606	3.553	3.518	3.483
FW16 01	7	3.125	3.355	3.356	3.304	3.269	3.234
EW15 01	7	2.875	3.104	3.106	3.054	3.019	2.984
CPB151	7	2.625	2.854	2.856	2.804	2.770	2.735
A3-P33-Z09	7	2.375	2.604	2.605	2.553	2.519	2.484
J1 07	7	2.125	2.353	2.354	2.303	2.269	2.234
K1 08	7	1.875	2.104	2.105	2.054	2.020	1.986
L1 07	7	1.625	1.854	1.855	1.805	1.772	1.738

Title: AGC-2 Specimen Position Adjustment

ECAR No.: 2549 Rev. No.: 0 Project No.: 23747 Date: 06/01/2016

Stack 7 - Uncompressed (3 of 5)			**Specimen COM at Mid Cycle**				
Specimen ID#	**Stack #**	**Nominal Elevation**	**Cycle 149A**	**Cycle 149B**	**Cycle 150B**	**Cycle 151A**	**Cycle 151B**
M1-08	7	1.375	1.605	1.606	1.556	1.523	1.490
TP 07	7	1.125	1.355	1.356	1.307	1.274	1.241
P1-07	7	0.875	1.106	1.107	1.058	1.025	0.992
RW1 08	7	0.625	0.856	0.857	0.808	0.776	0.743
S1 07	7	0.375	0.606	0.607	0.559	0.527	0.494
CPB61	7	0.125	0.356	0.357	0.310	0.278	0.246
BW17 08	7	-0.125	0.106	0.107	0.060	0.029	-0.003
DA8 02	7	-0.375	-0.144	-0.143	-0.189	-0.220	-0.251
AW17 01	7	-0.625	-0.393	-0.392	-0.438	-0.468	-0.499
FW15 12	7	-0.875	-0.642	-0.641	-0.686	-0.717	-0.747
EW14 12	7	-1.125	-0.892	-0.891	-0.936	-0.966	-0.996
CPB141	7	-1.375	-1.143	-1.141	-1.186	-1.215	-1.245
A3-H08-Z07	7	-1.625	-1.392	-1.392	-1.436	-1.466	-1.496
J1 06	7	-1.875	-1.642	-1.642	-1.685	-1.715	-1.745
K1 07	7	-2.125	-1.891	-1.891	-1.934	-1.963	-1.993
L1 06	7	-2.375	-2.141	-2.140	-2.183	-2.211	-2.240
M1-07	7	-2.625	-2.391	-2.390	-2.432	-2.460	-2.488
TP 06	7	-2.875	-2.640	-2.639	-2.681	-2.709	-2.737
P1-06	7	-3.125	-2.890	-2.889	-2.930	-2.957	-2.985
RW1 07	7	-3.375	-3.139	-3.139	-3.179	-3.206	-3.234
S1 06	7	-3.625	-3.389	-3.388	-3.428	-3.455	-3.482
CPB51	7	-3.875	-3.639	-3.638	-3.677	-3.704	-3.731
BW17 07	7	-4.125	-3.889	-3.888	-3.927	-3.953	-3.979
DA8 01	7	-4.375	-4.139	-4.138	-4.176	-4.202	-4.227
AW17 02	7	-4.625	-4.389	-4.388	-4.425	-4.451	-4.476
FW15 11	7	-4.875	-4.639	-4.638	-4.675	-4.700	-4.725
EW14 11	7	-5.125	-4.889	-4.888	-4.924	-4.949	-4.973
CPB131	7	-5.375	-5.139	-5.138	-5.174	-5.198	-5.222
A3-P43-Z03	7	-5.625	-5.389	-5.388	-5.424	-5.448	-5.472
J1 05	7	-5.875	-5.639	-5.638	-5.673	-5.697	-5.720
K1 06	7	-6.125	-5.888	-5.887	-5.922	-5.945	-5.968
L1 05	7	-6.375	-6.138	-6.136	-6.170	-6.193	-6.216
M1-06	7	-6.625	-6.387	-6.386	-6.419	-6.441	-6.464
TP 05	7	-6.875	-6.637	-6.635	-6.668	-6.690	-6.712

Stack 7 - Uncompressed (4 of 5)			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
P1-05	7	-7.125	-6.886	-6.885	-6.917	-6.938	-6.960
RW1 06	7	-7.375	-7.136	-7.134	-7.166	-7.187	-7.208
S1 05	7	-7.625	-7.385	-7.384	-7.415	-7.436	-7.457
CPB41	7	-7.875	-7.635	-7.634	-7.664	-7.685	-7.705
BW17 05	7	-8.125	-7.885	-7.884	-7.914	-7.934	-7.953
DW18 12	7	-8.375	-8.135	-8.133	-8.163	-8.182	-8.202
AW17 03	7	-8.625	-8.385	-8.383	-8.412	-8.431	-8.450
FW15 10	7	-8.875	-8.635	-8.633	-8.661	-8.679	-8.698
EW14 10	7	-9.125	-8.885	-8.882	-8.910	-8.928	-8.946
CPB121	7	-9.375	-9.135	-9.133	-9.160	-9.178	-9.195
H491	7	-9.625	-9.385	-9.383	-9.410	-9.427	-9.444
J1 04	7	-9.875	-9.635	-9.632	-9.658	-9.676	-9.693
K1 05	7	-10.125	-9.884	-9.882	-9.907	-9.924	-9.940
L1 04	7	-10.375	-10.134	-10.131	-10.156	-10.172	-10.188
M1-05	7	-10.625	-10.383	-10.380	-10.405	-10.420	-10.436
TP 04	7	-10.875	-10.633	-10.630	-10.654	-10.669	-10.684
P1-04	7	-11.125	-10.882	-10.879	-10.903	-10.917	-10.932
RW1 05	7	-11.375	-11.132	-11.129	-11.152	-11.166	-11.181
S1 04	7	-11.625	-11.381	-11.379	-11.401	-11.415	-11.429
CPB31	7	-11.875	-11.631	-11.628	-11.650	-11.664	-11.677
BW17 04	7	-12.125	-11.881	-11.878	-11.900	-11.913	-11.926
DW18 11	7	-12.375	-12.131	-12.128	-12.149	-12.162	-12.175
AW17 06	7	-12.625	-12.381	-12.378	-12.398	-12.410	-12.423
FW15 09	7	-12.875	-12.631	-12.628	-12.647	-12.659	-12.671
EW14 09	7	-13.125	-12.881	-12.878	-12.896	-12.908	-12.920
CPB111	7	-13.375	-13.131	-13.128	-13.146	-13.158	-13.169
H482	7	-13.625	-13.381	-13.378	-13.396	-13.407	-13.418
J1 03	7	-13.875	-13.631	-13.627	-13.644	-13.655	-13.665
K1 04	7	-14.125	-13.880	-13.877	-13.893	-13.903	-13.913
L1 03	7	-14.375	-14.130	-14.126	-14.142	-14.152	-14.161
M1-04	7	-14.625	-14.379	-14.376	-14.391	-14.401	-14.410
TP 03	7	-14.875	-14.629	-14.625	-14.640	-14.650	-14.658
P1-03	7	-15.125	-14.879	-14.875	-14.890	-14.899	-14.907
RW1 04	7	-15.375	-15.129	-15.125	-15.139	-15.148	-15.156

Stack 7 - Uncompressed (5 of 5)			Specimen COM at Mid Cycle				
Specimen ID#	Stack #	Nominal Elevation	Cycle 149A	Cycle 149B	Cycle 150B	Cycle 151A	Cycle 151B
S1 03	7	-15.625	-15.379	-15.375	-15.389	-15.397	-15.405
CPB21	7	-15.875	-15.629	-15.625	-15.639	-15.647	-15.654
BW17 03	7	-16.125	-15.879	-15.875	-15.888	-15.896	-15.903
DW18 10	7	-16.375	-16.128	-16.125	-16.137	-16.145	-16.152
AW17 05	7	-16.625	-16.378	-16.375	-16.387	-16.394	-16.401
FW15 08	7	-16.875	-16.628	-16.625	-16.636	-16.643	-16.650
EW14 08	7	-17.125	-16.878	-16.875	-16.886	-16.893	-16.899
CA11 02	7	-17.375	-17.128	-17.125	-17.136	-17.142	-17.148
A3-P33-Z20	7	-17.625	-17.377	-17.375	-17.385	-17.391	-17.397
J1 02	7	-17.875	-17.627	-17.624	-17.634	-17.639	-17.645
K1 03	7	-18.125	-17.877	-17.874	-17.883	-17.888	-17.893
L1 02	7	-18.375	-18.126	-18.123	-18.132	-18.137	-18.142
M1-02	7	-18.625	-18.376	-18.373	-18.381	-18.386	-18.390
TP 02	7	-18.875	-18.626	-18.623	-18.631	-18.635	-18.639
P1-02	7	-19.125	-18.875	-18.873	-18.880	-18.884	-18.888
RW1 03	7	-19.375	-19.125	-19.123	-19.130	-19.134	-19.138
S1 02	7	-19.625	-19.375	-19.373	-19.380	-19.384	-19.387
CPB11	7	-19.875	-19.626	-19.623	-19.630	-19.633	-19.637
BW17 02	7	-20.125	-19.875	-19.873	-19.879	-19.883	-19.886
DW18 09	7	-20.375	-20.125	-20.123	-20.129	-20.132	-20.135
AW17 04	7	-20.625	-20.375	-20.373	-20.379	-20.382	-20.385
FW15 07	7	-20.875	-20.625	-20.623	-20.628	-20.631	-20.634
EW14 07	7	-21.125	-20.875	-20.873	-20.878	-20.881	-20.883
CA11 01	7	-21.375	-21.125	-21.124	-21.128	-21.131	-21.133
H472	7	-21.625	-21.375	-21.374	-21.377	-21.380	-21.382
J1 01	7	-21.875	-21.625	-21.623	-21.626	-21.628	-21.630
K1 01	7	-22.125	-21.874	-21.873	-21.875	-21.877	-21.879
L1 01	7	-22.375	-22.123	-22.122	-22.124	-22.126	-22.127
M1-01	7	-22.625	-22.372	-22.371	-22.373	-22.375	-22.376
TP 01	7	-22.875	-22.621	-22.620	-22.622	-22.624	-22.625
P1-01	7	-23.125	-22.871	-22.870	-22.872	-22.873	-22.874
RW1 02	7	-23.375	-23.120	-23.120	-23.121	-23.122	-23.123
CPB1	7	-23.625	-23.370	-23.370	-23.371	-23.372	-23.373
S1 01	7	-23.875	-23.620	-23.620	-23.621	-23.622	-23.623

Title: AGC-2 Specimen Position Adjustment

ECAR No.: 2549 Rev. No.: 0 Project No.: 23747 Date: 06/01/2016

Appendix B

PIE Specimen Holder Data

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Phone: (208) 526-8088

Philip L Winston/WINSPL/CC01/INEEL/US

Philip L Winston/WINSPL/CC01/INEEL/US
03/14/2012 07:26 AM

To: Kevin L Skinner/VKS/CC01/INEEL/US@INEL
cc:
Subject: Holder

AGC graphite body dimensions.xlsx

Tube Number	Graphite Body Section	Dimensions		
		OD Left (Upper End)	OD Right (Lower End)	Length at OD
TUB-AGC1-021	Bottom section, no end cap	2.07	2.036	11 3/4
		2.068	2.036	
		2.068	2.035	
TUB-AGC1-022	Lower middle section	2.074	2.069	11 3/16
		2.072	2.066	
		2.074	2.071	
TUB-AGC1-023	Upper middle section	2.055	2.0595	12 9/16
		2.063	2.064	
		2.059	2.058	
TUB-AGC1-024	Top section	2.0115	2.053	8 13/16
		2.012	2.057	
		2.0185	2.071	