RPP-RPT-46309
PNNL-19242

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
Under Contract DE-AC05-76RL01830

Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks

DR Weier
AF Pardini

March 2010

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Richland, Washington 99352

Executive Summary

The original Double-Shell Tank (DST) Integrity Project (DSTIP) required the ultrasonic wall thickness measurement of two vertical scans of the tank primary wall using a single riser location. The resulting measurements have been used in extreme value methodology to predict the maximum wall thickness expected for the entire tank were its walls 100% inspected. The representativeness of using a single riser in this manner to draw conclusions about the entire circumference of a tank was questioned. The only data available with which to address the representativeness question at that time came from Tank 241-AY-101 since only for that tank had multiple risers been used for such inspection. Initial analyses of the measurement data from four different risers suggested significant riser differences.

In that work statistical variance component modeling for measurements within the Plate 2 and Plate 3 shell courses had suggested a standard deviation associated with such riser differences might be estimated as 0.009 inch. This result led to the desirability for either 1) adding additional uncertainty to extreme value analyses based on single riser inspection to accommodate what might have occurred if multiple risers were instead used, or 2) performing inspections from more than one riser. The latter approach has been used up through present inspections with two vertical paths inspected from each of two risers.

It is now suspected that at least some of that original riser difference was due to grouping all available UT measurement data in the original 241-AY-101 analyses, including significant numbers of measurements in horizontal scans along horizontal welds under some risers and not others. Since plates tend to be thinner due to rolling operations along such welds, this resulted in substantial numbers of thinner measurements under some risers than others.

When six tanks became available with two-riser inspections, and without using horizontal scan weld data, riser differences were indicated to be much less significant. Two-riser inspections were continued thereafter, and now UT measurement data from two risers are available from 13 tanks. Analyses are again performed that suggest riser differences are indeed quite minimal compared to differences between plates, and arguments can be made that inspection from a single riser is sufficient.

With Plate variability being much more impactful than Riser variability, concern regarding sufficient numbers of risers in DST inspections is better replaced by concern about sufficient numbers of plates. And whether such plates are all located under one riser or under multiple risers is not of particular importance. Because of the much greater plate variability than riser variability, inspection improvement could therefore be made by using only a single riser, but ensuring that more plates are encountered.

However, since a typical plate horizontal dimension can be as great as 40 feet, and air lines that prevent scanner access are often as close together as 30 feet, only as many as 10 separate plates could be accessed from a single riser, but more likely only 9 or even 8 plates would be accessible. If the full 10 were accessible, this would be the same number currently accessed with the adjacent two paths from each of two risers. Under a single riser, the number of accessible plates would depend on the location of the vertical welds on the plate courses under the riser relative to the blocking air lines.

Additional discussion is needed regarding this plate access from a single riser and also the current use of adjacent paths. But basically the number of risers inspected is not as important as the number of plates inspected. Options for inspection from a single riser follow that will generally include 8 to 10 separate plates:

1) Three paths separated nearly as much as possible with one relatively close to the air line to the left of the riser, one relatively close to air line to the right, and the other somewhat centered between those two.
2) Two adjacent paths near the riser, and a third “hopscotch” path that does another vertical path in each plate course beyond a vertical weld with respect to the two adjacent paths.
3) Only the two outside paths in option 1.
4) Option 1 with an adjacent path added beside the center path.
5) Option 3 with adjacent paths beside both paths.

The first option would reduce the number of UT images in a typical tank to 105 from the 140 under the current two riser / two path pattern. The second option would give somewhat greater reduction depending on the number of additional accessible plates inspected using the hopscotch pattern. The third option would give only 70 UT images, but still eight to ten plates inspected. The fourth and fifth options generate the same number of UT images as the current two-riser inspections.

The primary shortcoming of the third option would be in extreme value analyses. With so many fewer measurements made, the distribution-fitting would be impractical for separate plate courses and would likely be done only over the combined plate courses. Then any differences between plate courses, and the impact of smaller numbers of measurements, would increase the uncertainty bounds on the estimates. The same effect would result from the other options (except the fifth), but to a lesser degree. Note that riser differences would obviously no longer be examined with these single riser inspections, but old-to-new comparisons could still be performed suffering much less impact than extreme value estimation from the then reduced numbers of UT images.

Acronyms and Abbreviations

DST	Double-Shell Tank
DSTIP	Double-Shell Tank Integrity Project
PNNL	Pacific Northwest National Laboratory
UT	Ultrasonic Testing

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1.0 Introduction

The DST Integrity Project (DSTIP) required the ultrasonic wall thickness measurement of two vertical scans of the tank primary wall while using a single riser location. The resulting measurements were used in extreme value methodology to predict the minimum wall thickness expected for the entire tank. The representativeness of using a single riser in this manner to draw conclusions about the entire circumference of a tank was originally questioned. The only data available with which to address this representativeness question at that time came from Tank 241-AY-101 since only for that tank had multiple risers been used for such inspection. Initial analyses in Weier (2002) did not specifically address riser differences, but that was examined and discussed in the later presentation Weier (2004).

The same results are included in Weier et. al. (2005). In that work statistical variance component modeling for minimum measurements from 12 x 15 inch UT images within the Plate 2 and Plate 3 shell courses had suggested a standard deviation associated with such riser differences might be estimated at 0.009 inch. This result led to the need for either 1) adding additional uncertainty to extreme value analyses based on single riser inspection to accommodate what might have occurred if multiple risers were instead used, or 2) performing inspections from more than one riser. The latter approach has been used up through present inspections with two vertical paths inspected down each of two risers[1].

It is now suspected that at least some of that original riser difference was due to combining all available UT measurement data in the original 241-AY-101 analyses, including significant numbers of measurements in horizontal paths along horizontal welds under some risers and not others. Since plates tend to be thinner due to rolling operations along such welds, this resulted in substantial numbers of thinner measurements under some risers than others.

When more tanks became available with these two riser inspections, and without using horizontal weld data, riser differences were indicated to be less dramatic in Weier et. al. (2007). These analyses included six DSTs including a re-inspection of Tank 241-AY-101. Two-riser inspections were continued thereafter, and now UT measurement data from two risers are available for 13 DSTs. These data are used in this study and Appendix A provides the data.

Analyses were again performed that indicate riser differences are indeed quite minimal, and arguments can be made that inspection from a single riser is sufficient since the wall thickness encountered from that riser is indeed representative of that which would be obtained from other risers as well. However, recommendations will be made that more plates be inspected down that single riser if possible since plate variability is the more significant contributor.

[1] RPP-7574, 2006, *Double-Shell Tank Integrity Program Plan*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington

2.0 Riser Difference Discussion

Figure 1 illustrates the current typical tank inspection pattern for DST wall thickness. Two risers are used within each tank, and two adjacent vertical paths are inspected from each riser. These vertical paths intersect five plate courses generally with five distinct plates encountered under each riser. Only rarely might a vertical weld separate the two adjacent paths, thereby giving an extra plate. The nominal thicknesses of the plates in these courses depend on the tank design, but they start out at the top of the tank at either 0.375-in. or 0.5-in., and then continue through various thicknesses through as much as 0.875-in. The tank illustrated in Figure 1 would have elevations within each plate course as shown, and the elevations are the same for each of the four paths under the two risers. The elevation value would indicate the elevation in the tank of the top edge of a 12-inch vertical by 15-inch horizontal UT image.

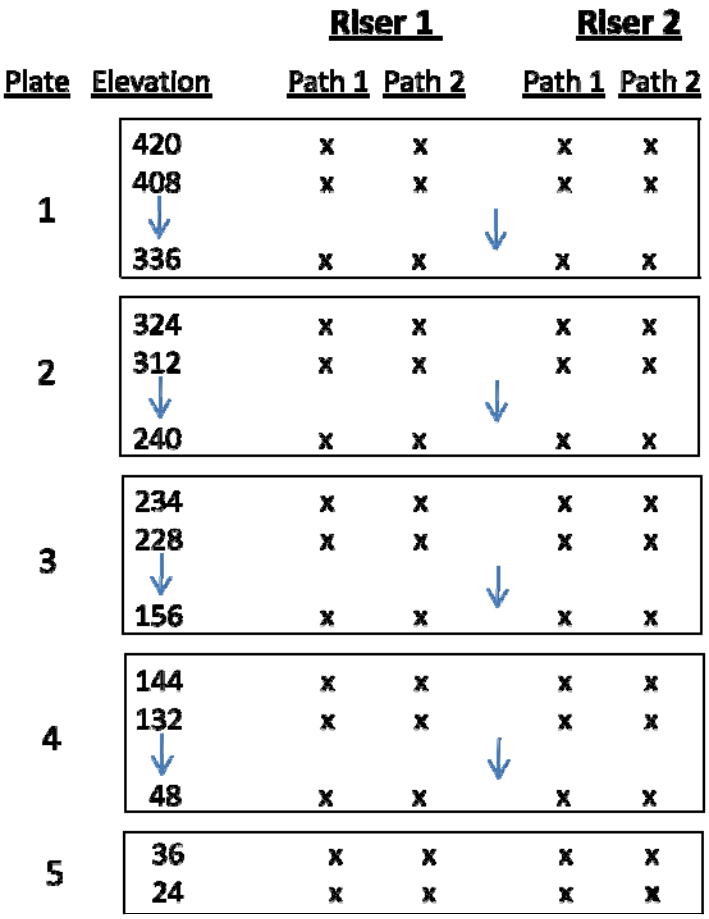

Figure 1 - Typical DST UT Wall Thickness Data

The column of x's for a particular path typically has 35 measured values at the 35 distinct elevations. Each value is obtained from a 12-in. by 15-in. UT image that contains nearly 150,000 pixels at which wall

thickness measurements are generated. The x-values reported for each image include a minimum, average, and maximum thickness value for the associated image. To examine riser differences, this report will consider only the minimum and average values.

Twelve tanks will first be used which give a desirable balanced model with each tank indeed having two paths down each of two risers. A 13th tank (241-AY-101) has only a single path down each riser in its March, 2007 re-inspection. Additional inspection done in that tank in October, 2007, only generated path measurements from a single riser, so the October measurements are not included. The single paths from March, 2007 will be included later in the report. Other data also included later are for a tank that had a third path inspected in one plate.

Between tanks, systematic differences in measured values include differing plate nominal drawing thicknesses, actual thickness differences between manufacturing plate lots used in different tanks, and potentially different corrosion impact. Within each tank are additional systematic causes of measurement differences within vertical paths. The most obvious is again the differing plate nominal drawing thicknesses. Another difference is the plates consistently being thinner at their top and bottom edges than in their middle due to the steel rolling operation. Yet another systematic effect over different elevations is a persistent corrosion pattern around the tank; a good example is a level liquid air interface (LAI) around the circumference of the tank at a particular elevation region.

These between and within tank systematic differences that would make x's different from each other occur in the vertical direction but are not expected to make x's change horizontally between the paths or risers at any given elevation. These vertical differences are not really of interest in the current application since they interfere with recognizing differences between risers, the objective in this report. For this reason the four path values at each elevation, two from each riser, are averaged, and then the four path deviations from that mean are computed for each elevation. In this manner the nominal plate thicknesses are no longer present as a difference. Neither is the vertical bowing pattern within the plates. Neither is a vertical corrosion pattern like an LAI. Also removed through the application of these elevation means are any systematic tank to tank wall thickness differences. In this manner the four path deviation values at each elevation are compared to see if differences between risers can be identified relative to the different plates inspected from each riser.

Sources of variability in the x's that have not been removed are inherent plate thickness departures away from their nominal thickness due to manufacturing, departures at the different elevations within a plate from the bowed thickness pattern of the plates from rolling, and departures from corrosion patterns around the tank. Additional unidentified/un-quantified sources of variability are present as well, for example, measurement error. It is against these types of variabilities that riser differences need be examined to see if they are significant.

In other words we first estimate the mean at each elevation by averaging the four path values, and then compute their four differences from the mean. All such differences will be evaluated over all tanks, risers within the tanks, plates within the risers, and elevations within the plates. The model that contains these terms will consider them as "nested", that is, each set of values in one of these factors is simply considered a random sample of values that could have been obtained. Note however that this approach

has “zeroed out” differences between elevations by making each of the four path values sum to zero. We’ll see later that “Elevation” need not be in the model. The original 241-AY-101 analysis involving four risers was not done in this manner since the data didn’t support it, especially with the weld data being at different elevations than most of the vertical path data. Alternative modeling was used in that case in the original 241-AY-101 studies.

As an example explanation of the “nesting” of a factor within another factor, consider plates within a riser. From each riser five plate courses are encountered as indicated in Figure 1 with the numbering 1 through 5. Originally these plate courses shared nominal thicknesses across risers through the plate course, through the departures from that nominal thickness due to the bowing pattern, and through any corrosion pattern consistent around the tank. When the elevation means and deviations from those means are computed and used, only the departures from these patterns remain. Then the departures of the plates under a riser no longer share the systematic patterns and only reflect deviations from the patterns. Therefore we could say the particular plates under Riser 1 are now called 1, 2, 3, 4, 5 and under Riser 2 the five different plates are called 6, 7, 8, 9, 10. That is, we simply have random departures from the vertical patterns, with a random sample of five plates/departures under Riser 1 and a different random sample of five plates/departures under Riser 2. This configuration is the modeling approach that gives the factor Plate as being “nested” in the factor Riser.

The analogous description can be given for the other factors as well. When the departures from elevation means are considered, the two risers represent random samples of risers from each tank, the five plates represent random samples of plates from those that could have been used under each riser, and the typically 70 elevation departures (35 from each of the two paths) a random sample of elevation departures from that riser. The four path values then generate a “within elevation” or error term in the model. The pertinent question is how different those path departure values at each elevation are between risers, in particular with respect to the variability in them between plates.

This underlying nested model can be written for the departure values X (using UT image minima or averages) as:

$$X = \text{Tank} + \text{Riser(Tank)} + \text{Plate(Riser,Tank)} + \text{Elevation(Plate, Riser, Tank)} + \text{Within\_Error},$$

where X is the path value deviation from the elevation mean. The entire analysis is done separately using each of the average and minimum thicknesses from the UT images.

Figures 3 and 4 display the data respectively for UT image averages and minima. Tank 241-AY-101 is not included until later in the report since its inspection data would include only a single path under each riser. Also the third path from a single plate in Tank 241-AY-102 is not included until later in the report. These additional data will be added later in the report and be shown to have no impact on conclusions. Plotted points in the top sections of the figures are the four path deviations from the elevation means. The bottom rows of the top plots in each figure show the tank, riser within tank, plate within riser, and elevation with plate. The elevation values (as shown in Figures 3 and 4) are unreadable since there are so many within each plate. Plotted above each elevation are the two path values (per riser) with a vertical

line connecting them. It is the variability in all those deviations from elevation mean values that we are trying to explain, and in particular if the factor Riser is important in causing them.

An “eyeball” answer can potentially be obtained simply by comparing the points across the two risers in each tank. A hint at the result that we are heading for is to note how things change considerably from plate to plate, which makes it rather difficult to see if they are really changing much from plate to plate.

For more formal illustration consider the first two tanks in Figure 3 (for UT image average values as opposed to the minimum values in Figure 4). For the first 241-AN-102 with Risers 25 and 26, note how the points change dramatically from plate to plate. At each elevation, the four values across the two risers have to sum to zero, but that is not true for the entire plates. Since the plate values vary so extremely, it’s difficult to tell if values differ between the risers or not. In contrast consider the second tank, 241-AN-106, again with risers 25 and 26. Now the differences between plates are much more stable, and a difference between risers can be observed.

Variance components for these two tanks under the model described (without the Tank factor) are in Figure 2. The final column contains standard deviations associated with the various factors; these are the square roots of the variance component values in the first columns of numbers. The orange bars indicate the percent of the total variance attributed to each factor. Such tables are used throughout this report. For 241-AN-102, 83% of the variability (and standard deviation 0.0081-in.) is because of plate to plate differences with only 4.8% of the variability (standard deviation 0.0019-in.) because of riser to riser differences. In contrast, for 241-AN-106 only 6.5% of the variability (and standard deviation 0.0021-in.) is because of plate to plate differences with 58.9% of the variability (standard deviation 0.0063-in.) because of riser to riser differences.

Response: UT Image Average Deviations from Mean of Elevation Averages for Tank 241-AN-102

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Riser	0.00000378	4.8		0.00194
Plate[Riser]	0.00006604	83.0		0.00813
Elevation[Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00000974	12.2		0.00312
Total	0.00007956	100.0		0.00892

Response: UT Image Average Deviations from Mean of Elevation Averages for Tank 241-AN-106

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Riser	0.00003911	58.9		0.00625
Plate[Riser]	0.00000433	6.5		0.00208
Elevation[Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00002296	34.6		0.00479
Total	0.00006640	100.0		0.00815

Figure 2 – Variance Component Summary for Example Individual Tanks 241-AN-102 and 241-AN-106

It is these riser and plate comparisons that we wish to make, but summarized over all 12 tanks combined. It turns out that Tank 241-AN-106 with its larger riser variability than plate variability is more the exception than the rule.

The plots in Figures 3 (averages) and 4 (minima) use the same vertical axis scales, so the variability in elevation deviations between UT image averages can be compared to that between UT image means. The minima data can be seen to be considerably more variable. The minima variability for Tank 241-AY-102 appears to be greater than that for the other tanks, but that doesn't apply to the averages.

Variance component analyses for these balanced data combined over tanks are given in Figure 5. Discussion follows that figure.

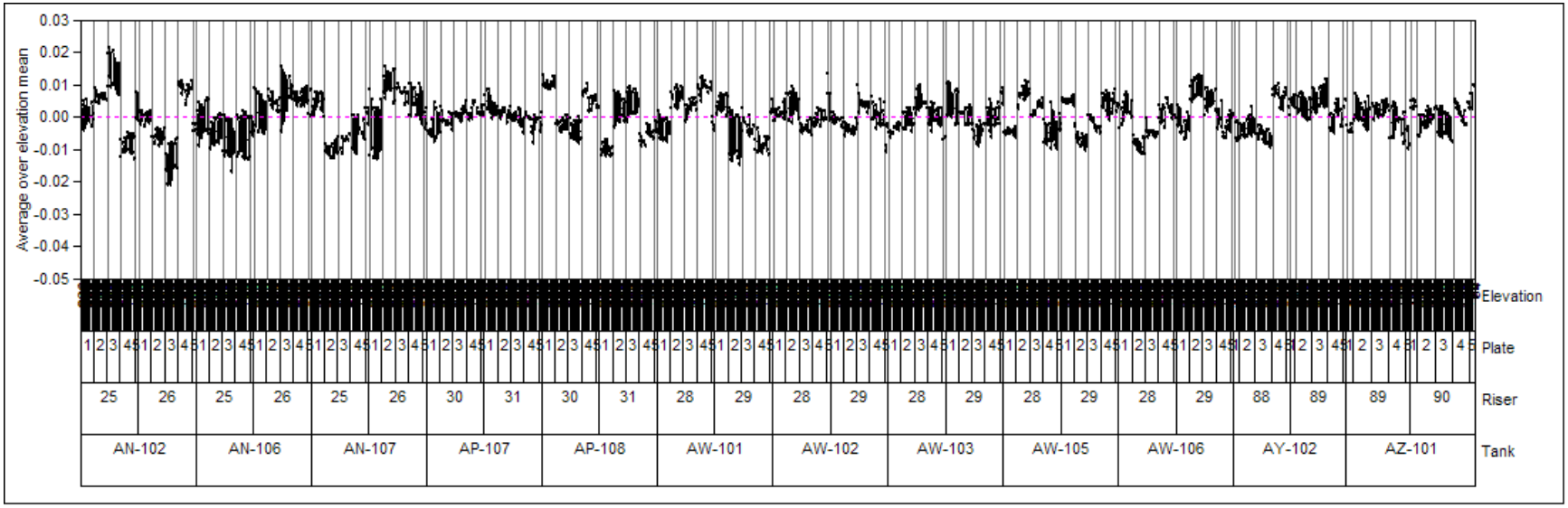

Figure 3 - Variability Chart for UT Image Average Deviations from Mean of Elevation Averages (balanced)

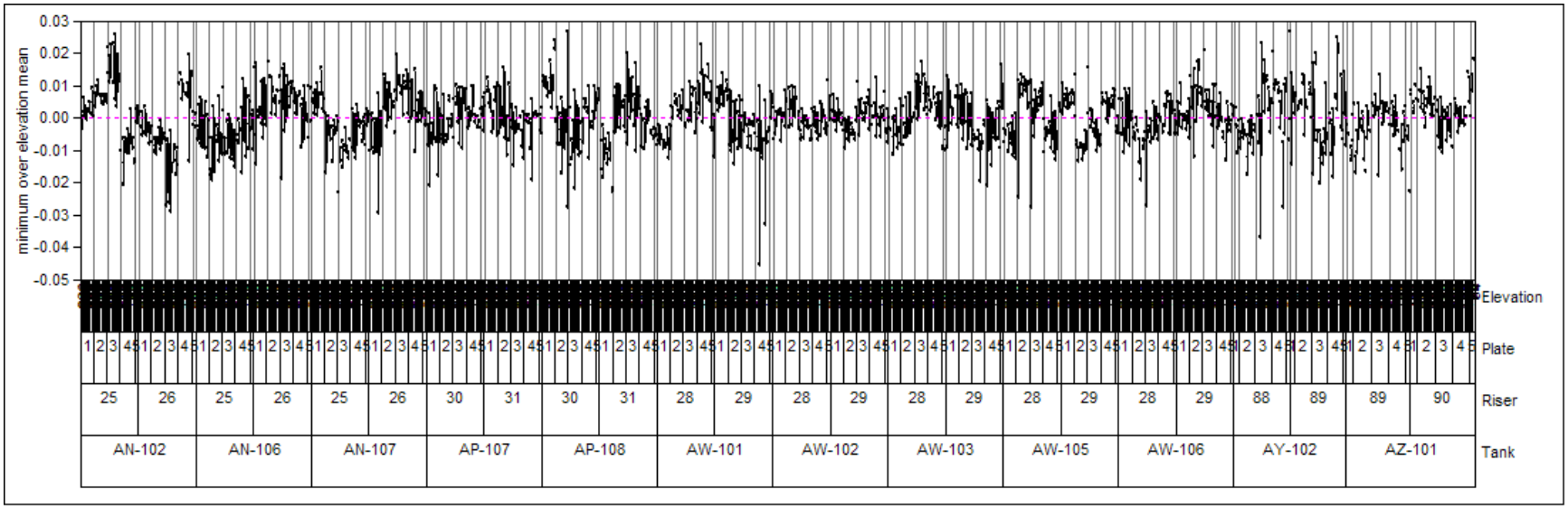

Figure 4 - Variability Chart for UT Image Minima Deviations from Mean of Elevation Minima (balanced)

Response: UT Image Average Deviations from Mean of Elevation Averages (balanced)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000128	3.8		0.00113
Plate[Tank,Riser]	0.00002318	68.2		0.00482
Elevation[Tank,Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00000950	28.0		0.00308
Total	0.00003397	100.0		0.00583

Response: UT Image Minima Deviations from Mean of Elevation Minima (balanced)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000006	0.1		0.00025
Plate[Tank,Riser]	0.00002510	38.8		0.00501
Elevation[Tank,Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00003946	61.1		0.00628
Total	0.00006462	100.0		0.00804

Figure 5 – Variance Component Summary (balanced model)

Because the deviations from elevation means are used in these analyses, the sum and/or mean of the four path deviations over the two risers at every elevation is always zero. For this reason there is no variation left between elevations. Elevation, being the "lowest" level term in the model, could therefore be left out with its "zero variability" incorporated into the "Within/error". But since this Elevation variability is in fact zero, this is really no change to the model at all. This fact is shown in the Figure 6 variance component summary that leaves Elevation out of the model. Note the results are precisely the same as those in Figure 5 where Elevation is in the model.

An analogous thing happens for the factor Tanks as well. Since for every elevation the "elevation deviations" sum to zero, the sum over all the elevations in a tank must also sum to zero. This is not the case for the factors Riser and Plate since not all elevation deviations are included in every Riser and Plate. In fact this was the intent in using the elevation deviations from elevation means, that is, to remove the systematic effects due to Tank and Elevation to focus on the Plate and Riser variability.

But even though no tank differences are indicated in these elevation deviation data, since Tank is a "higher level" factor, deleting it from the model groups the deviations in a different manner than in the case when Tank is included. This changes the Within_Error structure in the model and the resulting variance component estimates. This is shown in Figure 7 where Tank is left out of the model as well as Elevation. Then the changes from Figure 5 or 6 to Figure 7 indicate the increase in the Within_Error variability, which in turn reduces the relative amount of variability attributed to Plate and Riser.

The result of these previous comments is that it doesn't matter if Elevation is left out of the models being considered, but Tank should be included so that the Within_Error variability is correctly assigned, thereby giving proper Riser and Plate variability estimates. So for the balanced case being considered currently, the variance components estimates in Figures 5 or 6 should be used, not the changed values illustrated in Figure 7.

Response: UT Image Average Deviations from Mean of Elevation Averages (balanced without Elevation as Factor)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000128	3.8		0.00113
Plate[Tank,Riser]	0.00002318	68.2		0.00482
Within	0.00000950	28.0		0.00308
Total	0.00003397	100.0		0.00583

Response: UT Image Minima Deviations from Mean of Elevation Minima (balanced without Elevation as Factor)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000006	0.1		0.00025
Plate[Tank,Riser]	0.00002510	38.8		0.00501
Within	0.00003946	61.1		0.00628
Total	0.00006462	100.0		0.00804

Figure 6 – Variance Component Summary (balanced model – no Elevation)

The two predominant sources are variability therefore between plates and within elevations with very little variability attributed to riser. For the average and minima deviations respectively, standard deviation contributions to variability from riser are 0.00113-in. and 0.00025-in. These are essentially completely overwhelmed by the corresponding plate standard deviations of 0.00482-in. and 0.00501-in. Variability between plates in these deviations from elevation means could most likely be manufacturing differences in individual plate thickness differences from nominal. Another less likely cause could be differences in plate composition leading to different corrosion impact.

Response: UT Image Average Deviations from Mean of Elevation Averages (balanced without Elevation as Factor)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Riser	0.00000000	0.0		0.00000
Plate[Riser]	0.00000725	20.1		0.00269
Within	0.00002886	79.9		0.00537
Total	0.00003611	100.0		0.00601

Response: UT Image Minima Deviations from Mean of Elevation Minima (balanced without Elevation and Tank as Factors)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Riser	0.00000000	0.0		0.00000
Plate[Riser]	0.00000507	7.7		0.00225
Within	0.00006068	92.3		0.00779
Total	0.00006575	100.0		0.00811

Figure 7 – Variance Component Summary (balanced model – no Elevation or Tank)

This report could essentially end here, and accordingly conclusions will be stated now, but additional analyses are given on the following pages that address small amounts of additional data and revisit the original 2001 four-riser data that led to the earlier conclusions that risers can be significantly different from each other. But the initial conclusion from previous discussion here is that Riser is an insignificant contributor to measured wall thickness variability. Plate is the much more important factor. Over the 12 tanks considered in the balanced model, variability between the differing plates within and between the two risers overwhelms any riser differences.

The standard deviation associated with Riser differences in the above modeling is 0.00113-in. for UT image average thickness while that associated with Plate differences is about 0.00482-in. (from Figures 5 or 6). For UT image minimum thickness the Riser standard deviation is 0.00025-in. while the Plate standard deviation is 0.00501-in. Therefore concern about sufficient numbers of risers during inspections is better replaced by concern about sufficient numbers of plates; this is the case whether such plates are located under one riser or multiple risers.

Note that overall variability in the models above (Figures 5 or 6) is greater for UT image minima than averages as would be expected. An overall standard deviation for the averages is about 0.006-in. while it is about 0.008-in. for the minima. Also recall these represent the variability in the four path values at an elevation after deviations from their mean are obtained. This data preparation step removed the persistent systematic patterns over elevations around the tank, such as nominal plate thickness, the bowing of plates due to rolling, and any corrosion patterns such as an LAI. This was done to better investigate variability around the circumference of the tanks, in particular between risers and the plates under those risers.

Because of the much greater Plate variability than Riser variability, improvements could therefore be made by using only a single riser, but ensuring that more plates are encountered under that riser. However, since a typical plate horizontal dimension can be as great as 40 feet, and air lines that prevent scanner access are often as close together as 30 feet, only as many as 10 separate plates could be accessed from a single riser, but more likely only 9 or even 8 plates would be accessible. If the full 10 were accessible, this would be the same number currently accessed with the adjacent two paths from each of two risers. Under a single riser, the number of accessible plates would depend on the location of the vertical welds on the plate courses under the riser relative to the blocking air lines.

Additional discussion is needed regarding this plate access from a single riser and also the current use of adjacent paths. But basically the number of risers inspected is not as important as the number of plates inspected. Options for inspection from a single riser follow that will generally include 8 to 10 separate plates:

1) Three paths separated nearly as much as possible with one relatively close to the air line to the left of the riser, one relatively close to air line to the right, and the other somewhat centered between those two.
2) Two adjacent paths near the riser, and a third “hopscotch” path that does another vertical path in each plate course beyond a vertical weld with respect to the two adjacent paths.
3) Only the two outside paths in option 1.
4) Option 1 with an adjacent path added beside the center path.

5) Option 3 with adjacent paths beside both paths.

The first option would reduce the number of UT images in a typical tank to 105 from the 140 under the current two riser / two path pattern. The second option would give somewhat greater reduction depending on the number of additional accessible plates inspected using the hopscotch pattern. The third option would give only 70 UT images, but still eight to ten plates inspected. The fourth and fifth options generate the same number of UT images as the current two-riser inspections.

The primary shortcoming of the third option would be in extreme value analyses. With so many fewer measurements made, the distribution-fitting would be impractical for separate plate courses and would likely be done only over the combined plate courses. Then any differences between plate courses, and the impact of smaller numbers of measurements, would increase the uncertainty bounds on the estimates. The same effect would result from the other options (except the fifth), but to a lesser degree. Note that riser differences would obviously no longer be examined with these single riser inspections, but old-to-new comparisons could still be performed suffering much less impact than extreme value estimation from the then reduced numbers of UT images.

These conclusions will be repeated in the Conclusions section, but attention now turns to other data that are also available.

3.0 Discussion of Additional Data

The remaining content shows that using additional data does not change the conclusions already stated; that is, variability between plates far outweighs that between risers. Also explanations are offered as to why the riser differences reported for the 2001 241-AY-101four-riser inspection were greater.

Figures 8 and 9 are like the earlier Figures 3 and 4 but also contain data from the March, 2007, Tank 241-AY-101 inspection. Only one path was available for each of the two risers used as can be seen by the individual plotted points which cannot be connected as is the case for other tanks. Additional vertical scans were done in October, 2007, but only from a single riser, so it is not considered supportive of riser difference comparisons.

Also in Figures 8 and 9 are data from a third scan path under one riser in Plate 4 of Tank 241-AY-102. This isn't evident in the figure, but there are three points in the associated vertical line segments rather than the usual two.

These two changes then accommodate all pertinent data available from two-riser tank inspections performed in 13 DST's. The only non-trivial change shown in Figure 10 from previous variance component results (Figure 5 or 6) is a reduction of the Riser variability for the UT averages to essentially zero. This change is due to the rather extreme variability between plates in Tank 241-AY-101 as seen in Figure 8. Since even more plate variability is shown than was the case in the earlier balanced case, riser variability becomes even less significant. Recall the balanced case was first analyzed since it gives the "purest" estimates of the relative variabilities, but results are basically unchanged for this larger data set. Attention turns in discussion given after Figure 10 to the 2001 241-AY-101 inspection data.

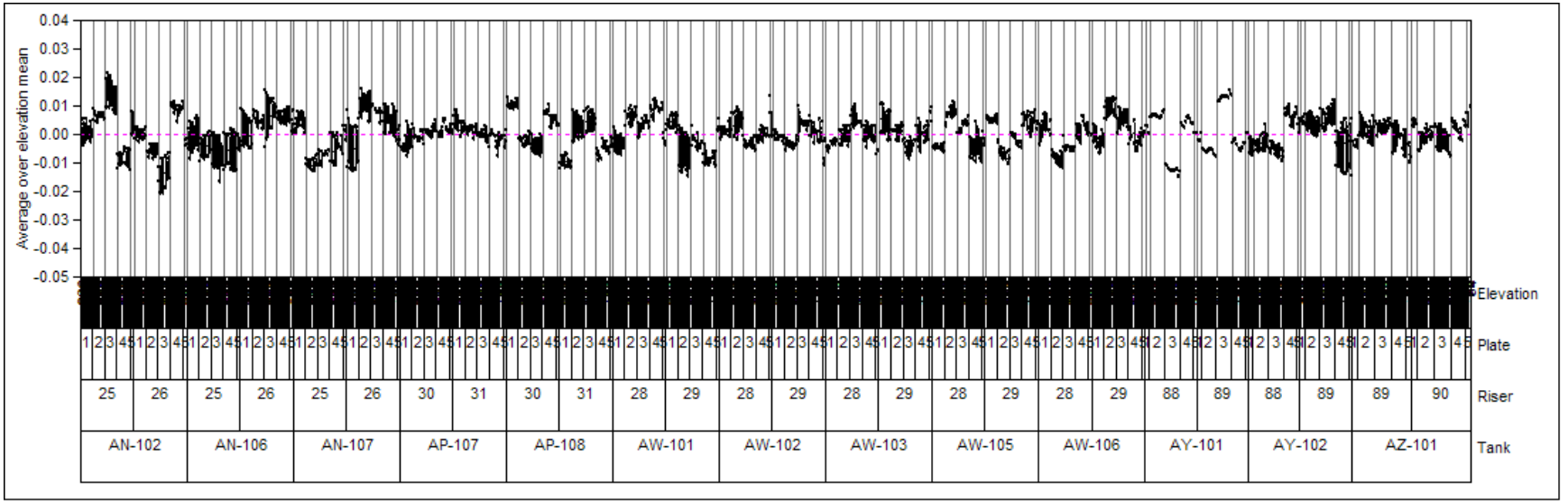

Figure 8 - Variability Chart for UT Image Average Deviations from Mean of Elevation Averages (all data)

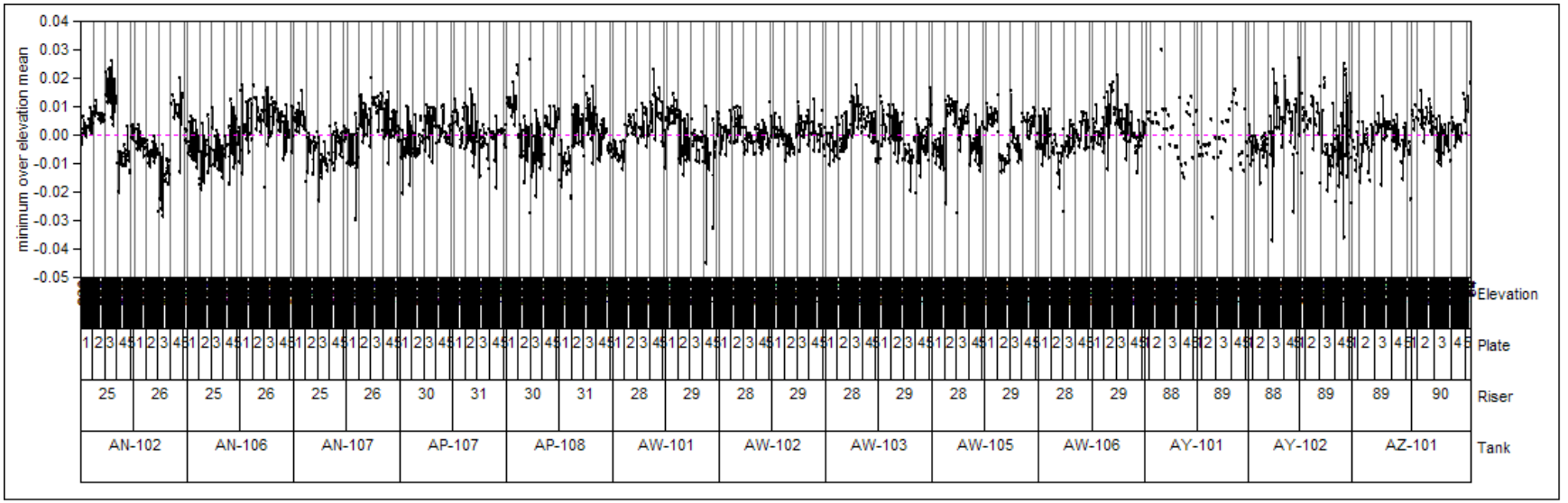

Figure 9 - Variability Chart for UT Image Minimum Deviations from Mean of Elevation Minima (all data)

Data was unbalanced, so a REML Fit was performed.

Response: UT Image Average Deviations from Mean of Elevation Averages (all data)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000000	0.0		0.00000
Plate[Tank,Riser]	0.00002599	72.3		0.00510
Elevation[Tank,Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00000993	27.7		0.00315
Total	0.00003592	100.0		0.00599

Response: UT Image Minimum Deviations from Mean of Elevation Minima (all data)

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000012	0.2		0.00035
Plate[Tank,Riser]	0.00002407	36.2		0.00491
Elevation[Tank,Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00004234	63.6		0.00651
Total	0.00006653	100.0		0.00816

Figure 10 – Variance Component Summary (all data)

In Figure 11 the March, 2007, 241-AY-101 data included in Figures 8 and 9 is replaced by the 2001 241-AY-101four-riser data on which original riser differences were established in the reports referenced earlier. Here elevation means, and deviations from those means, are again computed as in the earlier analyses in this report; however, the 2001 data do not so readily support that approach since some elevations are represented only under selected risers. In particular this includes horizontal scans that could appear in only a single riser at that elevation. For this reason a different modeling approach was used in the earlier 2005 work on riser differences. Although it was not realized at the time, this trend could introduce riser differences if the horizontal scans were located near welds where the plates are thinner due to rolling operations. These differences in earlier analyses and the current analyses lead to the earlier greater differences between risers than will be observed in the following.

Only UT minimum thickness data were made available for those earliest riser difference studies, so an average case is not shown here. As in the earlier Tank 241-AY-101 work, the LAI measurements are not included here. The considerably greater variability in these deviations of UT minima from elevation means for Tank 241-AY-101 is obvious in Figure 11. Note the vertical scale on the top plot is larger than those of the previous plots of this type going down to -0.10 instead of only -0.05 in the previous plots.

The riser differences for the combined tanks with the older Tank 241-AY-101data still show no contribution to riser differences in the variance component results in the top half of Figure 12. When Tank 241-AY-101 is used alone, as was the case in original analyses, the bottom half of Figure 12 results. Then the Riser and Plate standard deviations are respectively 0.00329-in. and 0.00452-in. From Figure 11 this increased riser variability can be seen to result from riser 88 deviations being greater than the other three risers. In this case the riser variability is nearly as great as the plate variability.

But recall these results are based on the elevation deviations from elevation means, and this approach isn't as appropriate for these older data due to the very unbalanced nature of the data under different

risers. Alternative modeling used in Weier (2005), as mentioned earlier, identified even greater riser differences. Some of these greater differences likely were caused by the inequity between risers due to including horizontal weld measurements under only some risers. The earlier analysis in this report using the balanced model is much improved over what could be done using the earlier 241-AY-101 data.

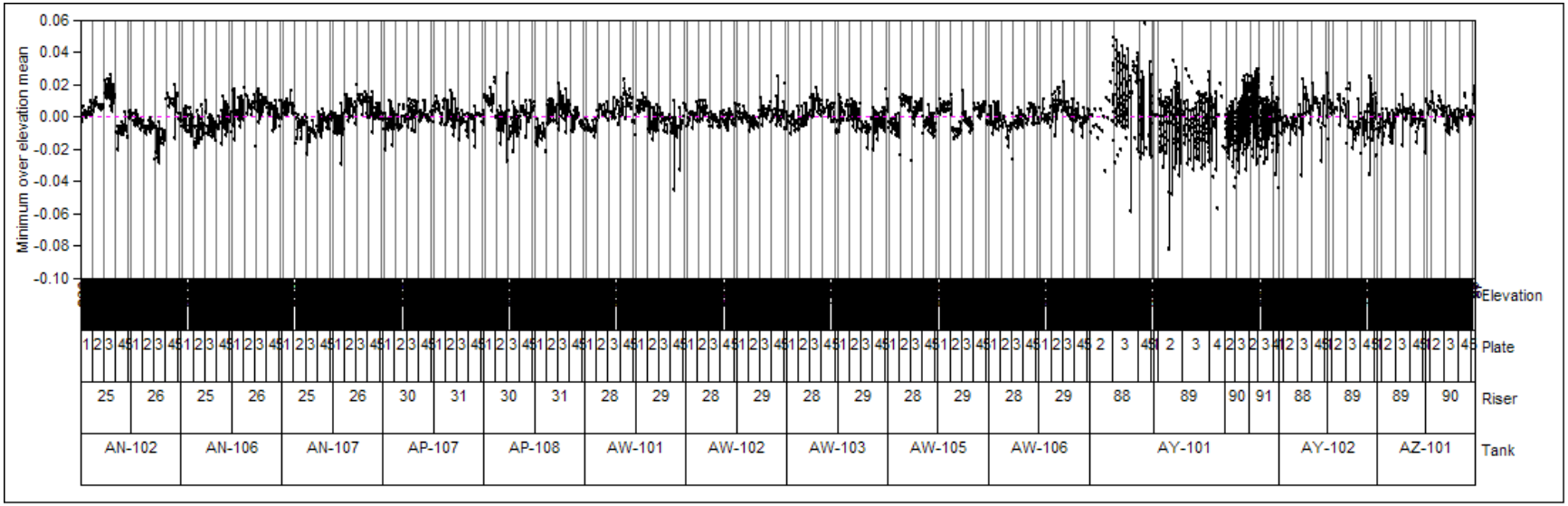

Figure 11 - Variability Chart for UT Image Minimum Deviations from Mean of Elevation Minima with March, 2001 241-AY-101 Data

Data were unbalanced, so a REML Fit was performed.

Response: UT Image Minimum Deviations from Mean of Elevation Minima with March, 2001 241-AY-101 Data

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Tank	0.00000000	0.0		0.00000
Riser[Tank]	0.00000000	0.0		0.00000
Plate[Tank,Riser]	0.00002218	19.4		0.00471
Elevation[Tank,Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00009202	80.6		0.00959
Total	0.00011420	100.0		0.01069

Response: UT Image Minimum Deviations from Mean of Elevation Minima with only March, 2001 241-AY-101 Data

Variance Components

Component	Var Component	% of Total	Plot%	Sqrt(Var Comp)
Riser	0.00001080	4.9		0.00329
Plate[Riser]	0.00002040	9.2		0.00452
Elevation[Riser,Plate]	0.00000000	0.0		0.00000
Within	0.00019112	86.0		0.01382
Total	0.00022232	100.0		0.01491

Figure 12 – Variance Component Summary with March, 2001 241-AY-101 Data

4.0 Conclusions

"Balanced" data from 12 DST's that include average and minimum UT image measurements from two vertical paths under each of two different risers were used to examine riser differences. To remove vertical systematic effects common across each of the measurement paths, the elevation means were computed from the four path values at that elevation, and then the four path deviations from that elevation mean were used for subsequent analyses. The elevation systematic effects removed in this manner were plate nominal thicknesses, the bowing pattern of plates (thinner on top and bottom edges) due to the rolling operation, and any systematic corrosion pattern by elevation around the tank in a tank such as a liquid air interface. This better facilitates identifying the differences between risers and the plates within those risers.

Those analyses lead to the conclusion that Riser is an insignificant contributor to measured wall thickness variability. Plate is the much more important factor. Over the 12 tanks considered in the balanced model, variability between the differing plates within and between the two risers overwhelms any riser differences.

The standard deviation associated with Riser differences in this balanced modeling case is about a mil for UT image average thickness while that associated with Plate differences is about 0.005-in. For UT image minimum thickness the Riser standard deviation is even less at essentially zero while the Plate standard deviation remains at about 0.005-in. With Plate variability being much more prevalent than Riser variability, concern regarding sufficient numbers of risers is better replaced by concern about sufficient numbers of plates. And whether such plates are all located under one riser or under multiple risers is not of particular importance.

Overall variability in the models is greater for UT image minima than for UT image averages as would be expected. An overall standard deviation for the averages is about 0.006-in. while it is about 0.008-in. for the minima. The main source of these differing standard deviations is due to the greater within elevation variability between the pair of path values at each Tank/Riser/Plate/Elevation combination.

Because of the much greater Plate variability than Riser variability, improvements could therefore be made by using only a single riser, but ensuring that more plates are encountered under that riser. However, since a typical plate horizontal dimension can be as great as 40 feet, and air lines that prevent scanner access are often as close together as 30 feet, only as many as 10 separate plates could be accessed from a single riser, but more likely only 9 or even 8 plates would be accessible. If the full 10 were accessible, this would be the same number currently accessed with the adjacent two paths from each of two risers. Under a single riser, the number of accessible plates would depend on the location of the vertical welds on the plate courses under the riser relative to the blocking air lines.

Additional discussion is needed regarding this plate access from a single riser and also the current use of adjacent paths. But basically the number of risers inspected is not as important as the number of plates inspected. Options for inspection from a single riser follow that will generally include 8 to 10 separate plates:

1) Three paths separated nearly as much as possible with one relatively close to the air line to the left of the riser, one relatively close to air line to the right, and the other somewhat centered between those two.
2) Two adjacent paths near the riser, and a third “hopscotch” path that does another vertical path in each plate course beyond a vertical weld with respect to the two adjacent paths.
3) Only the two outside paths in option 1.
4) Option 1 with an adjacent path added beside the center path.
5) Option 3 with adjacent paths beside both paths.

The first option would reduce the number of UT images in a typical tank to 105 from the 140 under the current two riser / two path pattern. The second option would give somewhat greater reduction depending on the number of additional accessible plates inspected using the hopscotch pattern. The third option would give only 70 UT images, but still eight to ten plates inspected. The fourth and fifth options generate the same number of UT images as the current two-riser inspections.

The primary shortcoming of the third option would be in extreme value analyses. With so many fewer measurements made, the distribution-fitting would be impractical for separate plate courses and would likely be done only over the combined plate courses. Then any differences between plate courses, and the impact of smaller numbers of measurements, would increase the uncertainty bounds on the estimates. The same effect would result from the other options (except the fifth), but to a lesser degree. Note that riser differences would obviously no longer be examined with these single riser inspections, but old-to-new comparisons could still be performed suffering much less impact than extreme value estimation from the then reduced numbers of UT images.

5.0 References

D. R. Weier, (2002), *Statistical Analyses of AY-101 Ultrasonic Measurements of Wall Thickness*, PNNL-14106, October, 2002.

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APPENDIX A

Appendix A provides the minimum, maximum, and average ultrasonic measurement values for the 13 tanks used in this study.

AW-103 (2006) - Riser 29

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.535	0.479	0.555	0.525	0.470	0.545
408	0.500	0.540	0.513	0.555	0.530	0.501	0.545
396	0.500	0.540	0.511	0.555	0.530	0.511	0.545
384	0.500	0.540	0.503	0.555	0.535	0.504	0.550
372	0.500	0.540	0.508	0.555	0.533	0.503	0.550
360	0.500	0.545	0.513	0.555	0.535	0.509	0.550
348	0.500	0.545	0.519	0.555	0.535	0.504	0.550
336	0.500	0.540	0.518	0.555	0.530	0.496	0.545
324	0.500	0.525	0.489	0.540	0.530	0.505	0.545
312	0.500	0.530	0.503	0.540	0.533	0.509	0.545
300	0.500	0.530	0.499	0.545	0.535	0.509	0.550
288	0.500	0.530	0.495	0.545	0.535	0.512	0.550
276	0.500	0.530	0.503	0.545	0.535	0.513	0.550
264	0.500	0.535	0.501	0.545	0.535	0.515	0.550
252	0.500	0.535	0.501	0.545	0.535	0.513	0.550
240	0.500	0.530	0.504	0.540	0.530	0.511	0.545
234	0.500	0.525	0.495	0.540	0.525	0.494	0.535
228	0.500	0.525	0.495	0.540	0.525	0.495	0.535
216	0.500	0.528	0.490	0.540	0.525	0.494	0.535
204	0.500	0.530	0.479	0.540	0.524	0.491	0.535
192	0.500	0.529	0.502	0.540	0.523	0.496	0.535
180	0.500	0.530	0.499	0.540	0.525	0.499	0.535
168	0.500	0.527	0.499	0.540	0.525	0.498	0.535
156	0.500	0.527	0.501	0.540	0.525	0.496	0.535
144	0.750	0.750	0.719	0.770	0.760	0.734	0.770
132	0.750	0.755	0.730	0.770	0.765	0.742	0.775
120	0.750	0.760	0.734	0.775	0.765	0.747	0.775
108	0.750	0.760	0.718	0.775	0.765	0.744	0.775
96	0.750	0.765	0.737	0.775	0.770	0.751	0.780
84	0.750	0.765	0.740	0.775	0.770	0.751	0.780
72	0.750	0.760	0.736	0.775	0.765	0.745	0.775
60	0.750	0.755	0.729	0.770	0.760	0.734	0.770
48	0.750	0.755	0.728	0.770	0.755	0.734	0.770
36	0.875	0.890	0.861	0.905	0.895	0.868	0.905
24	0.875	0.895	0.864	0.905	0.895	0.877	0.905
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AW-103 (2006) - Riser 28

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.525	0.479	0.535	0.525	0.465	0.540
408	0.500	0.528	0.500	0.540	0.530	0.499	0.540
396	0.500	0.529	0.501	0.540	0.530	0.495	0.540
384	0.500	0.530	0.496	0.540	0.530	0.504	0.540
372	0.500	0.530	0.505	0.540	0.530	0.504	0.540
360	0.500	0.530	0.494	0.540	0.530	0.505	0.540
348	0.500	0.528	0.504	0.540	0.530	0.504	0.540
336	0.500	0.525	0.505	0.535	0.525	0.502	0.540
324	0.500	0.525	0.498	0.540	0.530	0.499	0.540
312	0.500	0.525	0.504	0.540	0.530	0.505	0.545
300	0.500	0.530	0.501	0.540	0.535	0.513	0.545
288	0.500	0.530	0.500	0.540	0.535	0.512	0.545
276	0.500	0.530	0.499	0.540	0.535	0.504	0.545
264	0.500	0.530	0.502	0.540	0.535	0.514	0.545
252	0.500	0.530	0.501	0.540	0.535	0.497	0.545
240	0.500	0.525	0.496	0.540	0.530	0.508	0.540
234	0.500	0.530	0.499	0.540	0.530	0.497	0.540
228	0.500	0.533	0.508	0.545	0.533	0.513	0.540
216	0.500	0.535	0.502	0.545	0.535	0.513	0.545
204	0.500	0.535	0.509	0.545	0.538	0.516	0.545
192	0.500	0.535	0.511	0.545	0.542	0.515	0.550
180	0.500	0.535	0.506	0.545	0.542	0.518	0.550
168	0.500	0.535	0.504	0.545	0.540	0.518	0.550
156	0.500	0.530	0.508	0.540	0.535	0.516	0.545
144	0.750	0.760	0.743	0.770	0.755	0.740	0.770
132	0.750	0.764	0.743	0.770	0.755	0.744	0.770
120	0.750	0.765	0.749	0.770	0.760	0.746	0.770
108	0.750	0.765	0.746	0.775	0.760	0.748	0.770
96	0.750	0.765	0.744	0.770	0.770	0.754	0.775
84	0.750	0.763	0.743	0.770	0.765	0.751	0.775
72	0.750	0.760	0.740	0.770	0.765	0.750	0.775
60	0.750	0.757	0.736	0.765	0.760	0.742	0.770
48	0.750	0.754	0.732	0.765	0.757	0.737	0.770
36	0.875	0.880	0.855	0.900	0.880	0.848	0.900
24	0.875	0.880	0.851	0.900	0.880	0.852	0.900
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AY-102 (2007) - Riser 89

		UT Path 1			UT Path 2			UT Path 3		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
420.0	0.375	0.391	0.385	0.400	0.388	0.379	0.400			
408.0	0.375	0.388	0.382	0.395	0.386	0.378	0.400			
396.0	0.375	0.385	0.375	0.390	0.384	0.347	0.395			
384.0	0.500	0.485	0.472	0.500	0.489	0.479	0.500			
372.0	0.500	0.483	0.476	0.500	0.489	0.479	0.500			
360.0	0.500	0.485	0.477	0.500	0.490	0.477	0.500			
348.0	0.500	0.490	0.482	0.500	0.495	0.483	0.500			
336.0	0.500	0.492	0.470	0.500	0.498	0.488	0.505			
324.0	0.500	0.492	0.488	0.500	0.499	0.491	0.505			
312.0	0.500	0.493	0.488	0.500	0.499	0.487	0.505			
300.0	0.500	0.493	0.481	0.500	0.498	0.481	0.505			
288.0	0.500	0.493	0.476	0.500	0.498	0.477	0.505			
276.0	0.500	0.495	0.486	0.500	0.499	0.487	0.505			
264.0	0.500	0.491	0.459	0.500	0.499	0.458	0.505			
252.0	0.500	0.491	0.443	0.500	0.499	0.465	0.505			
240.0	0.500	0.493	0.445	0.500	0.500	0.449	0.505			
228.0	0.500	0.497	0.448	0.505	0.502	0.443	0.510			
216.0	0.500	0.498	0.447	0.505	0.503	0.450	0.510			
204.0	0.500	0.498	0.441	0.505	0.503	0.457	0.510			
192.0	0.500	0.497	0.444	0.505	0.502	0.447	0.510			
180.0	0.500	0.496	0.460	0.505	0.502	0.457	0.510			
168.0	0.500	0.498	0.463	0.505	0.504	0.478	0.510			
156.0	0.500	0.498	0.450	0.505	0.504	0.484	0.510			
144.0	0.750	0.740	0.719	0.750	0.735	0.714	0.745	0.728	0.716	0.740
132.0	0.750	0.740	0.721	0.750	0.736	0.700	0.745	0.730	0.713	0.740
120.0	0.750	0.742	0.724	0.750	0.737	0.714	0.745	0.730	0.719	0.740
108.0	0.750	0.742	0.692	0.750	0.738	0.695	0.745	0.730	0.670	0.740
96.0	0.750	0.740	0.672	0.750	0.738	0.675	0.745	0.730	0.670	0.740
84.0	0.750	0.745	0.714	0.755	0.740	0.698	0.750	0.730	0.686	0.740
72.0	0.750	0.749	0.696	0.755	0.744	0.694	0.750	0.730	0.666	0.740
60.0	0.750	0.744	0.709	0.750	0.740	0.687	0.750	0.725	0.648	0.735
48.0	0.750	0.742	0.715	0.750	0.740	0.714	0.750	0.725	0.694	0.735
36.0	0.875	0.890	0.791	0.910	0.890	0.775	0.900	0.870	0.759	0.890
24.0	0.875	0.885	0.815	0.910	0.885	0.828	0.900	0.870	0.813	0.890
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AY-102 (2007) - Riser 88

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.375	0.377	0.371	0.385	0.382	0.377	0.390
408.0	0.375	0.375	0.362	0.385	0.381	0.370	0.390
396.0	0.375	0.373	0.364	0.385	0.378	0.359	0.385
384.0	0.500	0.483	0.470	0.500	0.479	0.468	0.495
372.0	0.500	0.483	0.457	0.500	0.479	0.462	0.495
360.0	0.500	0.489	0.474	0.500	0.480	0.468	0.495
348.0	0.500	0.490	0.477	0.500	0.484	0.470	0.495
336.0	0.500	0.492	0.470	0.500	0.487	0.474	0.495
324.0	0.500	0.491	0.472	0.500	0.486	0.460	0.495
312.0	0.500	0.489	0.479	0.500	0.485	0.478	0.495
300.0	0.500	0.488	0.470	0.500	0.485	0.474	0.495
288.0	0.500	0.488	0.469	0.500	0.489	0.473	0.495
276.0	0.500	0.486	0.470	0.500	0.490	0.475	0.495
264.0	0.500	0.481	0.470	0.495	0.479	0.470	0.495
252.0	0.500	0.482	0.460	0.495	0.478	0.450	0.495
240.0	0.500	0.486	0.462	0.495	0.482	0.455	0.495
228.0	0.500	0.489	0.470	0.500	0.485	0.469	0.500
216.0	0.500	0.489	0.460	0.500	0.486	0.476	0.500
204.0	0.500	0.490	0.474	0.500	0.487	0.472	0.500
192.0	0.500	0.492	0.440	0.500	0.490	0.474	0.500
180.0	0.500	0.492	0.441	0.500	0.490	0.403	0.500
168.0	0.500	0.493	0.476	0.500	0.489	0.462	0.500
156.0	0.500	0.490	0.468	0.500	0.490	0.468	0.500
144.0	0.750	0.750	0.733	0.760	0.747	0.730	0.760
132.0	0.750	0.750	0.730	0.760	0.748	0.729	0.760
120.0	0.750	0.750	0.735	0.760	0.748	0.734	0.760
108.0	0.750	0.750	0.714	0.760	0.748	0.698	0.760
96.0	0.750	0.750	0.691	0.760	0.748	0.687	0.760
84.0	0.750	0.750	0.711	0.760	0.749	0.696	0.760
72.0	0.750	0.750	0.666	0.760	0.746	0.646	0.760
60.0	0.750	0.744	0.686	0.760	0.742	0.692	0.760
48.0	0.750	0.744	0.713	0.760	0.741	0.705	0.760
36.0	0.875	0.890	0.783	0.910	0.885	0.810	0.900
24.0	0.875	0.885	0.807	0.900	0.885	0.807	0.900
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AY-101 (2007) - Riser 88 (Exam performed in March 2007)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.375	0.385	0.372	0.400			
408.0	0.375	0.385	0.374	0.400			
396.0	0.375	0.385	0.374	0.400			
384.0	0.500	0.509	0.476	0.520			
372.0	0.500	0.505	0.485	0.520			
360.0	0.500	0.500	0.456	0.520			
348.0	0.500	0.499	0.434	0.510			
336.0	0.500	0.500	0.486	0.510			
324.0	0.500	0.499	0.487	0.510			
312.0	0.500	0.499	0.492	0.510			
300.0	0.500	0.498	0.475	0.510			
288.0	0.500	0.496	0.478	0.510			
276.0	0.500	0.494	0.485	0.510			
264.0	0.500	0.485	0.471	0.500			
252.0	0.500	0.482	0.444	0.500			
240.0	0.500	0.484	0.430	0.500			
228.0	0.500	0.484	0.439	0.500			
216.0	0.500	0.484	0.444	0.500			
204.0	0.500	0.484	0.450	0.500			
192.0	0.500	0.484	0.442	0.500			
180.0	0.500	0.484	0.444	0.500			
168.0	0.500	0.484	0.440	0.500			
156.0	0.500	0.485	0.454	0.500			
144.0	0.750	0.748	0.684	0.760			
132.0	0.750	0.747	0.670	0.760			
120.0	0.750	0.748	0.667	0.760			
108.0	0.750	0.750	0.697	0.760			
96.0	0.750	0.750	0.688	0.760			
84.0	0.750	0.750	0.727	0.760			
72.0	0.750	0.750	0.728	0.760			
60.0	0.750	0.752	0.724	0.760			
48.0	0.750	0.751	0.725	0.760			
36.0	0.875	0.875	0.857	0.890			
24.0	0.875	0.875	0.858	0.890			
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AY-101 (2007) - Riser 89 (Exam performed in March 2007)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.375	0.385	0.362	0.400			
408.0	0.375	0.380	0.359	0.400			
396.0	0.375	0.380	0.368	0.400			
384.0	0.500	0.493	0.473	0.510			
372.0	0.500	0.490	0.468	0.500			
360.0	0.500	0.488	0.397	0.500			
348.0	0.500	0.488	0.444	0.500			
336.0	0.500	0.489	0.479	0.500			
324.0	0.500	0.487	0.479	0.495			
312.0	0.500	0.486	0.478	0.495			
300.0	0.500	0.485	0.467	0.495			
288.0	0.500	0.484	0.470	0.495			
276.0	0.500	0.483	0.470	0.495			
264.0	0.500	0.512	0.446	0.520			
252.0	0.500	0.512	0.461	0.520			
240.0	0.500	0.509	0.439	0.520			
228.0	0.500	0.510	0.448	0.520			
216.0	0.500	0.510	0.439	0.520			
204.0	0.500	0.510	0.446	0.520			
192.0	0.500	0.510	0.450	0.520			
180.0	0.500	0.509	0.431	0.520			
168.0	0.500	0.507	0.437	0.520			
156.0	0.500	0.507	0.437	0.520			
144.0	0.750	0.740	0.705	0.760			
132.0	0.750	0.743	0.701	0.760			
120.0	0.750	0.743	0.695	0.760			
108.0	0.750	0.743	0.719	0.760			
96.0	0.750	0.743	0.705	0.760			
84.0	0.750	0.743	0.701	0.760			
72.0	0.750	0.740	0.715	0.760			
60.0	0.750	0.740	0.703	0.760			
48.0	0.750	0.740	0.710	0.760			
36.0	0.875	0.875	0.841	0.900			
24.0	0.875	0.875	0.852	0.900			
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AY-101 (2007) - Riser 88 (Exam performed in October 2007)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.375	0.380	0.370	0.400	0.391	0.368	0.405
408.0	0.375	0.380	0.371	0.400	0.391	0.379	0.405
396.0	0.375	0.380	0.326	0.400	0.392	0.326	0.405
384.0	0.500	0.504	0.477	0.515	0.503	0.491	0.515
372.0	0.500	0.505	0.484	0.515	0.502	0.483	0.515
360.0	0.500	0.502	0.460	0.515	0.498	0.451	0.510
348.0	0.500	0.502	0.437	0.515	0.497	0.464	0.510
336.0	0.500	0.502	0.488	0.515	0.498	0.450	0.510
324.0	0.500	0.500	0.478	0.510	0.500	0.456	0.515
312.0	0.500	0.497	0.489	0.510	0.500	0.488	0.515
300.0	0.500	0.493	0.474	0.500	0.497	0.473	0.515
288.0	0.500	0.491	0.472	0.500	0.495	0.475	0.510
276.0	0.500	0.490	0.483	0.500	0.494	0.477	0.510
264.0	0.500	0.48	0.467	0.495	0.495	0.485	0.505
252.0	0.500	0.478	0.44	0.495	0.492	0.459	0.505
240.0	0.500	0.481	0.427	0.495	0.493	0.453	0.505
228.0	0.500	0.48	0.443	0.495	0.493	0.449	0.505
216.0	0.500	0.482	0.442	0.495	0.492	0.453	0.505
204.0	0.500	0.482	0.447	0.495	0.491	0.440	0.505
192.0	0.500	0.482	0.441	0.495	0.492	0.455	0.505
180.0	0.500	0.484	0.440	0.495	0.494	0.456	0.505
168.0	0.500	0.483	0.439	0.495	0.492	0.450	0.505
156.0	0.500	0.485	0.450	0.495	0.494	0.463	0.505
144.0	0.750	0.753	0.677	0.765	0.744	0.709	0.755
132.0	0.750	0.752	0.665	0.765	0.745	0.705	0.755
120.0	0.750	0.752	0.675	0.765	0.748	0.716	0.755
108.0	0.750	0.754	0.716	0.765	0.750	0.695	0.755
96.0	0.750	0.754	0.704	0.765	0.750	0.714	0.755
84.0	0.750	0.754	0.734	0.765	0.750	0.722	0.755
72.0	0.750	0.755	0.734	0.765	0.750	0.718	0.755
60.0	0.750	0.757	0.734	0.765	0.749	0.720	0.755
48.0	0.750	0.755	0.731	0.765	0.748	0.723	0.755
36.0	0.875	0.883	0.862	0.900			
24.0	0.875	0.881	0.864	0.900			
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AY-101 (2007) - Riser 89 (Exam performed in October 2007)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.375						
408.0	0.375						
396.0	0.375						
384.0	0.500						
372.0	0.500						
360.0	0.500						
348.0	0.500						
336.0	0.500						
324.0	0.500						
312.0	0.500						
300.0	0.500						
288.0	0.500						
276.0	0.500						
264.0	0.500						
252.0	0.500						
240.0	0.500						
228.0	0.500						
216.0	0.500						
204.0	0.500						
192.0	0.500						
180.0	0.500						
168.0	0.500						
156.0	0.500						
144.0	0.750						
132.0	0.750						
120.0	0.750						
108.0	0.750						
96.0	0.750						
84.0	0.750						
72.0	0.750						
60.0	0.750						
48.0	0.750						
36.0	0.875				0.894	0.852	0.905
24.0	0.875				0.891	0.866	0.905
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AN-107 (2007) - Riser 26

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.515	0.500	0.525	0.530	0.510	0.535
408	0.500	0.518	0.504	0.525	0.530	0.517	0.540
396	0.500	0.520	0.482	0.530	0.535	0.519	0.540
384	0.500	0.520	0.508	0.530	0.535	0.518	0.540
372	0.500	0.520	0.509	0.530	0.535	0.519	0.540
360	0.500	0.520	0.509	0.530	0.535	0.519	0.540
348	0.500	0.520	0.508	0.530	0.535	0.519	0.540
336	0.500	0.515	0.503	0.525	0.535	0.514	0.540
324	0.500	0.515	0.485	0.530	0.525	0.498	0.535
312	0.500	0.515	0.498	0.530	0.525	0.497	0.535
300	0.500	0.520	0.495	0.530	0.525	0.502	0.535
288	0.500	0.520	0.499	0.530	0.525	0.503	0.535
276	0.500	0.520	0.491	0.530	0.525	0.502	0.535
264	0.500	0.520	0.488	0.525	0.525	0.499	0.535
252	0.500	0.515	0.487	0.525	0.525	0.498	0.535
240	0.500	0.515	0.489	0.525	0.520	0.499	0.530
234	0.500	0.528	0.516	0.535	0.525	0.504	0.535
228	0.500	0.530	0.524	0.535	0.530	0.519	0.535
216	0.500	0.535	0.526	0.540	0.530	0.524	0.540
204	0.500	0.535	0.526	0.540	0.535	0.514	0.540
192	0.500	0.535	0.525	0.540	0.535	0.527	0.540
180	0.500	0.535	0.526	0.540	0.535	0.528	0.540
168	0.500	0.535	0.522	0.540	0.535	0.524	0.540
156	0.500	0.530	0.505	0.535	0.530	0.519	0.540
144	0.750	0.790	0.777	0.800	0.785	0.752	0.795
132	0.750	0.790	0.782	0.800	0.785	0.771	0.795
120	0.750	0.795	0.783	0.805	0.785	0.772	0.795
108	0.750	0.795	0.782	0.805	0.785	0.772	0.795
96	0.750	0.795	0.780	0.805	0.785	0.773	0.795
84	0.750	0.795	0.781	0.805	0.785	0.772	0.795
72	0.750	0.795	0.779	0.805	0.785	0.773	0.795
60	0.750	0.790	0.772	0.800	0.785	0.766	0.795
48	0.750	0.785	0.761	0.800	0.780	0.763	0.790
36	0.875	0.885	0.861	0.895	0.880	0.865	0.900
24	0.875	0.880	0.859	0.890	0.885	0.864	0.900
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AN-107 (2007) - Riser 25

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.525	0.510	0.535	0.530	0.514	0.540
408	0.500	0.530	0.518	0.540	0.535	0.523	0.540
396	0.500	0.535	0.519	0.540	0.540	0.527	0.545
384	0.500	0.538	0.526	0.540	0.540	0.522	0.545
372	0.500	0.536	0.520	0.540	0.540	0.530	0.545
360	0.500	0.535	0.523	0.540	0.540	0.528	0.545
348	0.500	0.530	0.519	0.535	0.535	0.525	0.540
336	0.500	0.528	0.519	0.535	0.530	0.518	0.540
324	0.500	0.499	0.486	0.505	0.503	0.490	0.515
312	0.500	0.500	0.489	0.505	0.503	0.490	0.515
300	0.500	0.499	0.490	0.505	0.503	0.494	0.515
288	0.500	0.499	0.490	0.505	0.503	0.479	0.515
276	0.500	0.499	0.489	0.505	0.502	0.485	0.515
264	0.500	0.500	0.486	0.505	0.502	0.491	0.515
252	0.500	0.498	0.471	0.505	0.500	0.483	0.515
240	0.500	0.497	0.487	0.500	0.499	0.469	0.510
234	0.500	0.515	0.496	0.530	0.515	0.496	0.530
228	0.500	0.515	0.497	0.530	0.515	0.499	0.530
216	0.500	0.520	0.504	0.530	0.520	0.506	0.530
204	0.500	0.520	0.510	0.530	0.520	0.503	0.530
192	0.500	0.520	0.509	0.530	0.520	0.509	0.530
180	0.500	0.515	0.508	0.530	0.520	0.500	0.530
168	0.500	0.515	0.498	0.530	0.515	0.502	0.530
156	0.500	0.510	0.476	0.530	0.515	0.498	0.530
144	0.750	0.770	0.754	0.785	0.780	0.766	0.790
132	0.750	0.770	0.758	0.790	0.780	0.771	0.790
120	0.750	0.775	0.762	0.790	0.785	0.772	0.795
108	0.750	0.775	0.764	0.790	0.785	0.776	0.795
96	0.750	0.780	0.764	0.790	0.790	0.773	0.795
84	0.750	0.780	0.767	0.790	0.785	0.773	0.795
72	0.750	0.780	0.764	0.790	0.780	0.770	0.790
60	0.750	0.780	0.766	0.790	0.780	0.764	0.790
48	0.750	0.775	0.761	0.790	0.780	0.763	0.790
36	0.875	0.885	0.862	0.900	0.880	0.865	0.900
24	0.875	0.885	0.859	0.900	0.885	0.864	0.900
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AN-106 (2007) - Riser 25

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.519	0.497	0.525	0.508	0.492	0.520
408	0.500	0.522	0.502	0.530	0.512	0.489	0.520
396	0.500	0.523	0.507	0.530	0.514	0.493	0.525
384	0.500	0.521	0.504	0.530	0.514	0.495	0.525
372	0.500	0.522	0.505	0.530	0.512	0.491	0.525
360	0.500	0.520	0.503	0.530	0.510	0.489	0.520
348	0.500	0.516	0.495	0.525	0.503	0.485	0.520
336	0.500	0.512	0.491	0.520	0.505	0.487	0.515
324	0.500	0.498	0.475	0.505	0.503	0.481	0.510
312	0.500	0.501	0.476	0.505	0.508	0.470	0.510
300	0.500	0.503	0.474	0.510	0.511	0.494	0.515
288	0.500	0.504	0.480	0.510	0.511	0.475	0.515
276	0.500	0.504	0.486	0.510	0.512	0.470	0.515
264	0.500	0.503	0.469	0.510	0.509	0.489	0.515
252	0.500	0.502	0.483	0.505	0.508	0.470	0.515
240	0.500	0.500	0.473	0.505	0.506	0.471	0.510
234	0.500	0.501	0.489	0.510	0.495	0.478	0.505
228	0.500	0.503	0.489	0.510	0.496	0.481	0.505
216	0.500	0.506	0.497	0.510	0..49	0.488	0.505
204	0.500	0.508	0.496	0.515	0.497	0.484	0.505
192	0.500	0.506	0.495	0.515	0.496	0.485	0.505
180	0.500	0.505	0.489	0..51	0.495	0.479	0.505
168	0.500	0.502	0.478	0.510	0.490	0.473	0.500
156	0.500	0.500	0.478	0.510	0.489	0.471	0.500
144	0.750	0.757	0.727	0.770	0.767	0.747	0.780
132	0.750	0.754	0.743	0.770	0.764	0.743	0.780
120	0.750	0.754	0.742	0.770	0.765	0.749	0.780
108	0.750	0.754	0.740	0.770	0.767	0.738	0.780
96	0.750	0.753	0.741	0.765	0.765	0.750	0.780
84	0.750	0.752	0.734	0.765	0.765	0.750	0.780
72	0.750	0.749	0.728	0.765	0.763	0.749	0.770
60	0.750	0.749	0.734	0.765	0.763	0.750	0.775
48	0.750	0.750	0.735	0.765	0.764	0.753	0.775
36	0.875	0.880	0.861	0.895	0.876	0.849	0.895
24	0.875	0.881	0.858	0.895	0.876	0.854	0.895
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AN-106 (2007) - Riser 26

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.518	0.508	0.530	0.510	0.496	0.520
408	0.500	0.520	0.513	0.530	0.511	0.501	0.520
396	0.500	0.523	0.514	0.530	0.513	0.496	0.525
384	0.500	0.525	0.515	0.535	0.515	0.502	0.525
372	0.500	0.525	0.503	0.535	0.515	0.501	0.525
360	0.500	0.524	0.499	0.530	0.512	0.497	0.525
348	0.500	0.520	0.508	0.530	0.509	0.477	0.520
336	0.500	0.519	0.509	0.530	0.506	0.488	0.520
324	0.500	0.510	0.499	0.525	0.506	0.491	0.520
312	0.500	0.512	0.489	0.525	0.509	0.489	0.520
300	0.500	0.515	0.494	0.525	0.515	0.488	0.525
288	0.500	0.516	0.487	0.530	0.516	0.488	0.525
276	0.500	0.520	0.495	0.530	0.515	0.496	0.525
264	0.500	0.519	0.487	0.530	0.515	0.498	0.525
252	0.500	0.515	0.502	0.525	0.515	0.502	0.525
240	0.500	0.516	0.506	0.525	0.518	0.506	0.525
234	0.500	0.513	0.504	0.520	0.515	0.502	0.530
228	0.500	0.513	0.502	0.520	0.517	0.505	0.530
216	0.500	0.513	0.503	0.520	0.519	0.510	0.530
204	0.500	0.511	0.497	0.520	0.520	0.509	0.535
192	0.500	0.510	0.493	0.520	0.520	0.504	0.535
180	0.500	0.505	0.486	0.520	0.519	0.506	0.530
168	0.500	0.500	0.487	0.515	0.516	0.499	0.530
156	0.500	0.495	0.450	0.515	0.515	0.477	0.525
144	0.750	0.772	0.751	0.780	0.773	0.752	0.785
132	0.750	0.768	0.748	0.780	0.772	0.753	0.785
120	0.750	0.770	0.751	0.780	0.773	0.757	0.785
108	0.750	0.772	0.750	0.780	0.774	0.754	0.785
96	0.750	0.770	0.746	0.780	0.775	0.744	0.785
84	0.750	0.770	0.748	0.780	0.774	0.743	0.785
72	0.750	0.765	0.734	0.775	0.770	0.750	0.780
60	0.750	0.766	0.734	0.780	0.770	0.747	0.780
48	0.750	0.766	0.745	0.780	0.770	0.732	0.780
36	0.875	0.882	0.858	0.910	0.890	0.868	0.900
24	0.875	0.882	0.851	0.905	0.886	0.867	0.900
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AZ-101 (2007) - Riser 89

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
422.0	0.375	0.374	0.359	0.385	0.376	0.364	0.380
410.0	0.375	0.376	0.358	0.385	0.378	0.368	0.380
398.0	0.375	0.376	0.363	0.385	0.378	0.355	0.380
381.0	0.500	0.487	0.479	0.500	0.493	0.477	0.505
369.0	0.500	0.488	0.475	0.500	0.498	0.483	0.510
357.0	0.500	0.490	0.463	0.505	0.495	0.483	0.510
345.0	0.500	0.493	0.472	0.510	0.500	0.460	0.510
333.0	0.500	0.497	0.483	0.505	0.500	0.468	0.510
321.0	0.500	0.498	0.486	0.505	0.501	0.483	0.510
309.0	0.500	0.499	0.489	0.505	0.504	0.482	0.515
297.0	0.500	0.499	0.481	0.505	0.505	0.479	0.515
285.0	0.500	0.500	0.469	0.505	0.506	0.470	0.515
273.0	0.500	0.500	0.488	0.505	0.508	0.467	0.515
263.0	0.500	0.512	0.499	0.520	0.510	0.497	0.520
251.0	0.500	0.510	0.500	0.520	0.508	0.501	0.520
239.0	0.500	0.509	0.496	0.520	0.507	0.499	0.515
227.0	0.500	0.510	0.493	0.520	0.506	0.499	0.515
215.0	0.500	0.510	0.498	0.520	0.507	0.500	0.515
203.0	0.500	0.509	0.469	0.520	0.507	0.500	0.515
191.0	0.500	0.510	0.497	0.520	0.506	0.496	0.515
179.0	0.500	0.507	0.499	0.515	0.505	0.495	0.510
167.0	0.500	0.505	0.498	0.510	0.503	0.496	0.510
155.0	0.500	0.507	0.497	0.515	0.501	0.489	0.510
145.0	0.750	0.756	0.742	0.770	0.752	0.737	0.770
133.0	0.750	0.760	0.753	0.770	0.755	0.744	0.770
121.0	0.750	0.763	0.754	0.770	0.755	0.746	0.770
109.0	0.750	0.763	0.756	0.770	0.754	0.746	0.770
97.0	0.750	0.763	0.754	0.770	0.755	0.749	0.770
85.0	0.750	0.763	0.755	0.770	0.755	0.749	0.765
73.0	0.750	0.764	0.755	0.770	0.755	0.749	0.765
61.0	0.750	0.764	0.753	0.770	0.757	0.748	0.765
49.0	0.750	0.765	0.734	0.770	0.760	0.728	0.770
37.0	0.875	0.899	0.882	0.910	0.894	0.862	0.905
25.0	0.875	0.899	0.873	0.910	0.893	0.872	0.905
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AZ-101 (2007) - Riser 90

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
422.0	0.375	0.384	0.371	0.390	0.382	0.372	0.390
410.0	0.375	0.385	0.374	0.390	0.383	0.369	0.390
398.0	0.375	0.385	0.378	0.390	0.383	0.376	0.390
381.0	0.500	0.490	0.481	0.500	0.493	0.487	0.500
369.0	0.500	0.490	0.482	0.500	0.492	0.485	0.500
357.0	0.500	0.492	0.484	0.500	0.495	0.489	0.500
345.0	0.500	0.493	0.486	0.505	0.497	0.489	0.505
333.0	0.500	0.495	0.487	0.505	0.501	0.487	0.505
321.0	0.500	0.495	0.488	0.505	0.500	0.490	0.505
309.0	0.500	0.498	0.487	0.505	0.500	0.482	0.505
297.0	0.500	0.495	0.488	0.500	0.500	0.493	0.505
285.0	0.500	0.494	0.489	0.500	0.500	0.496	0.505
273.0	0.500	0.495	0.489	0.500	0.501	0.492	0.505
263.0	0.500	0.506	0.499	0.510	0.499	0.486	0.505
251.0	0.500	0.505	0.496	0.510	0.498	0.491	0.505
239.0	0.500	0.506	0.500	0.510	0.499	0.493	0.505
227.0	0.500	0.506	0.496	0.515	0.500	0.492	0.505
215.0	0.500	0.508	0.495	0.515	0.502	0.488	0.505
203.0	0.500	0.510	0.490	0.515	0.502	0.489	0.510
191.0	0.500	0.509	0.500	0.515	0.500	0.483	0.505
179.0	0.500	0.506	0.492	0.510	0.498	0.483	0.505
167.0	0.500	0.504	0.500	0.510	0.496	0.485	0.500
155.0	0.500	0.506	0.495	0.510	0.498	0.487	0.500
145.0	0.750	0.755	0.744	0.770	0.751	0.741	0.760
133.0	0.750	0.756	0.745	0.770	0.754	0.744	0.760
121.0	0.750	0.760	0.754	0.770	0.757	0.750	0.765
109.0	0.750	0.763	0.754	0.770	0.761	0.750	0.765
97.0	0.750	0.765	0.754	0.770	0.762	0.749	0.765
85.0	0.750	0.766	0.755	0.770	0.764	0.747	0.765
73.0	0.750	0.767	0.754	0.775	0.765	0.755	0.775
61.0	0.750	0.769	0.760	0.775	0.770	0.761	0.775
49.0	0.750	0.770	0.758	0.775	0.768	0.756	0.775
37.0	0.875	0.905	0.893	0.915	0.912	0.903	0.920
25.0	0.875	0.910	0.879	0.915	0.910	0.892	0.920
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AP-107 - Riser 30 (2008)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.500	0.500	0.477	0.510	0.505	0.487	0.510
408.0	0.500	0.504	0.472	0.510	0.510	0.494	0.515
396.0	0.500	0.505	0.491	0.510	0.514	0.507	0.520
384.0	0.500	0.505	0.488	0.510	0.517	0.504	0.520
372.0	0.500	0.505	0.478	0.510	0.510	0.484	0.520
360.0	0.500	0.503	0.488	0.510	0.505	0.490	0.510
348.0	0.500	0.501	0.467	0.505	0.502	0.489	0.505
336.0	0.500	0.499	0.479	0.505	0.499	0.485	0.505
324.0	0.500	0.491	0.474	0.500	0.486	0.471	0.495
312.0	0.500	0.494	0.481	0.500	0.491	0.479	0.495
300.0	0.500	0.496	0.481	0.500	0.496	0.482	0.500
288.0	0.500	0.491	0.476	0.500	0.490	0.470	0.500
276.0	0.500	0.490	0.471	0.500	0.489	0.469	0.495
264.0	0.500	0.490	0.482	0.500	0.490	0.467	0.495
252.0	0.500	0.492	0.478	0.500	0.489	0.471	0.495
240.0	0.500	0.490	0.476	0.500	0.482	0.470	0.490
234.0	0.5625	0.565	0.548	0.570	0.562	0.554	0.570
228.0	0.5625	0.564	0.551	0.570	0.562	0.547	0.570
216.0	0.5625	0.564	0.536	0.570	0.561	0.555	0.570
204.0	0.5625	0.564	0.550	0.570	0.562	0.556	0.570
192.0	0.5625	0.563	0.540	0.570	0.562	0.557	0.570
180.0	0.5625	0.561	0.545	0.570	0.560	0.554	0.570
168.0	0.5625	0.559	0.545	0.565	0.558	0.551	0.565
156.0	0.5625	0.557	0.536	0.565	0.557	0.548	0.565
144.0	0.750	0.750	0.735	0.760	0.753	0.744	0.755
132.0	0.750	0.753	0.739	0.760	0.754	0.737	0.760
120.0	0.750	0.754	0.737	0.760	0.755	0.742	0.760
108.0	0.750	0.755	0.736	0.760	0.755	0.742	0.760
96.0	0.750	0.755	0.736	0.760	0.756	0.742	0.760
84.0	0.750	0.757	0.737	0.760	0.757	0.737	0.760
72.0	0.750	0.756	0.737	0.760	0.755	0.734	0.760
60.0	0.750	0.756	0.735	0.760	0.756	0.733	0.760
48.0	0.750	0.757	0.729	0.760	0.756	0.735	0.760
36.0	0.875	0.881	0.858	0.885	0.880	0.868	0.885
24.0	0.875	0.881	0.861	0.885	0.880	0.863	0.885
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AP-107 - Riser 31 (2008)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.500	0.507	0.495	0.515	0.505	0.479	0.515
408.0	0.500	0.513	0.499	0.520	0.510	0.495	0.520
396.0	0.500	0.515	0.500	0.520	0.512	0.495	0.520
384.0	0.500	0.517	0.496	0.520	0.512	0.490	0.520
372.0	0.500	0.517	0.493	0.520	0.512	0.489	0.520
360.0	0.500	0.517	0.503	0.520	0.511	0.499	0.520
348.0	0.500	0.515	0.500	0.520	0.509	0.496	0.515
336.0	0.500	0.510	0.495	0.520	0.507	0.491	0.515
324.0	0.500	0.493	0.472	0.500	0.491	0.476	0.500
312.0	0.500	0.495	0.492	0.500	0.493	0.475	0.500
300.0	0.500	0.495	0.476	0.500	0.493	0.464	0.500
288.0	0.500	0.495	0.490	0.500	0.494	0.470	0.500
276.0	0.500	0.494	0.492	0.500	0.493	0.474	0.500
264.0	0.500	0.493	0.474	0.500	0.492	0.478	0.500
252.0	0.500	0.491	0.487	0.500	0.490	0.475	0.500
240.0	0.500	0.489	0.485	0.500	0.488	0.471	0.495
234.0	0.5625	0.559	0.547	0.575	0.555	0.533	0.565
228.0	0.5625	0.560	0.538	0.575	0.558	0.533	0.565
216.0	0.5625	0.564	0.546	0.575	0.559	0.546	0.565
204.0	0.5625	0.566	0.547	0.575	0.562	0.548	0.570
192.0	0.5625	0.564	0.551	0.575	0.562	0.544	0.570
180.0	0.5625	0.561	0.545	0.575	0.559	0.542	0.570
168.0	0.5625	0.558	0.542	0.570	0.557	0.526	0.565
156.0	0.5625	0.556	0.546	0.570	0.555	0.539	0.565
144.0	0.750	0.750	0.734	0.760	0.750	0.725	0.760
132.0	0.750	0.753	0.738	0.760	0.753	0.736	0.760
120.0	0.750	0.756	0.740	0.765	0.755	0.738	0.760
108.0	0.750	0.754	0.740	0.765	0.754	0.740	0.760
96.0	0.750	0.754	0.740	0.760	0.754	0.740	0.760
84.0	0.750	0.755	0.739	0.760	0.754	0.740	0.760
72.0	0.750	0.750	0.738	0.760	0.754	0.738	0.760
60.0	0.750	0.750	0.735	0.760	0.743	0.735	0.760
48.0	0.750	0.747	0.731	0.755	0.749	0.706	0.760
36.0	0.875	0.877	0.857	0.885	0.881	0.865	0.885
24.0	0.875	0.873	0.856	0.880	0.877	0.861	0.880
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AP-108 - Riser 30 (2008)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.500	0.520	0.514	0.530	0.523	0.517	0.530
408.0	0.500	0.525	0.519	0.535	0.527	0.523	0.535
396.0	0.500	0.527	0.513	0.535	0.528	0.522	0.535
384.0	0.500	0.527	0.509	0.535	0.528	0.519	0.540
372.0	0.500	0.527	0.519	0.535	0.529	0.523	0.540
360.0	0.500	0.527	0.519	0.535	0.528	0.522	0.540
348.0	0.500	0.526	0.512	0.535	0.525	0.510	0.540
336.0	0.500	0.525	0.510	0.535	0.522	0.508	0.535
324.0	0.500	0.485	0.427	0.495	0.489	0.481	0.495
312.0	0.500	0.488	0.464	0.500	0.492	0.470	0.500
300.0	0.500	0.490	0.476	0.500	0.492	0.487	0.500
288.0	0.500	0.491	0.474	0.500	0.494	0.485	0.500
276.0	0.500	0.490	0.461	0.500	0.493	0.484	0.500
264.0	0.500	0.490	0.474	0.500	0.492	0.483	0.500
252.0	0.500	0.491	0.471	0.500	0.492	0.482	0.500
240.0	0.500	0.489	0.474	0.500	0.489	0.473	0.500
234.0	0.5625	0.557	0.538	0.565	0.562	0.547	0.570
228.0	0.5625	0.558	0.540	0.565	0.566	0.554	0.570
216.0	0.5625	0.561	0.541	0.570	0.567	0.554	0.570
204.0	0.5625	0.563	0.545	0.570	0.568	0.559	0.575
192.0	0.5625	0.563	0.528	0.570	0.568	0.558	0.575
180.0	0.5625	0.564	0.547	0.570	0.568	0.556	0.575
168.0	0.5625	0.564	0.541	0.570	0.568	0.547	0.575
156.0	0.5625	0.563	0.533	0.570	0.568	0.551	0.575
144.0	0.750	0.752	0.724	0.760	0.754	0.725	0.760
132.0	0.750	0.753	0.738	0.760	0.754	0.739	0.760
120.0	0.750	0.755	0.738	0.765	0.755	0.735	0.760
108.0	0.750	0.755	0.717	0.765	0.754	0.724	0.760
96.0	0.750	0.754	0.740	0.765	0.753	0.735	0.760
84.0	0.750	0.754	0.734	0.760	0.753	0.744	0.760
72.0	0.750	0.753	0.729	0.760	0.752	0.724	0.760
60.0	0.750	0.753	0.724	0.760	0.749	0.723	0.760
48.0	0.750	0.751	0.736	0.760	0.747	0.714	0.760
36.0	0.875	0.868	0.859	0.885	0.868	0.856	0.875
24.0	0.875	0.868	0.859	0.880	0.867	0.858	0.875
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AP-108 - Riser 31 (2008)

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420.0	0.500	0.501	0.471	0.515	0.499	0.470	0.505
408.0	0.500	0.505	0.502	0.515	0.503	0.497	0.510
396.0	0.500	0.507	0.505	0.515	0.508	0.500	0.515
384.0	0.500	0.507	0.487	0.515	0.511	0.490	0.515
372.0	0.500	0.506	0.503	0.515	0.511	0.506	0.515
360.0	0.500	0.507	0.501	0.515	0.510	0.497	0.515
348.0	0.500	0.505	0.482	0.515	0.508	0.498	0.515
336.0	0.500	0.500	0.481	0.510	0.502	0.490	0.510
324.0	0.500	0.493	0.450	0.505	0.488	0.461	0.500
312.0	0.500	0.497	0.473	0.505	0.490	0.465	0.500
300.0	0.500	0.499	0.490	0.510	0.494	0.489	0.500
288.0	0.500	0.501	0.492	0.510	0.493	0.479	0.505
276.0	0.500	0.502	0.488	0.510	0.493	0.479	0.505
264.0	0.500	0.501	0.492	0.510	0.493	0.479	0.505
252.0	0.500	0.500	0.488	0.510	0.491	0.475	0.505
240.0	0.500	0.499	0.481	0.505	0.488	0.470	0.500
234.0	0.5625	0.569	0.558	0.585	0.567	0.552	0.580
228.0	0.5625	0.573	0.561	0.585	0.568	0.552	0.580
216.0	0.5625	0.577	0.567	0.585	0.570	0.540	0.580
204.0	0.5625	0.578	0.561	0.590	0.571	0.552	0.580
192.0	0.5625	0.577	0.562	0.590	0.571	0.552	0.580
180.0	0.5625	0.580	0.569	0.590	0.572	0.557	0.580
168.0	0.5625	0.579	0.568	0.590	0.571	0.559	0.580
156.0	0.5625	0.576	0.568	0.585	0.567	0.540	0.580
144.0	0.750	0.735	0.725	0.745	0.735	0.715	0.750
132.0	0.750	0.738	0.733	0.745	0.738	0.724	0.750
120.0	0.750	0.738	0.733	0.745	0.741	0.723	0.755
108.0	0.750	0.740	0.731	0.750	0.742	0.727	0.755
96.0	0.750	0.741	0.726	0.750	0.743	0.729	0.755
84.0	0.750	0.742	0.730	0.750	0.743	0.729	0.755
72.0	0.750	0.742	0.728	0.750	0.745	0.729	0.755
60.0	0.750	0.742	0.725	0.750	0.744	0.731	0.755
48.0	0.750	0.740	0.725	0.750	0.743	0.731	0.755
36.0	0.875	0.863	0.842	0.875	0.861	0.845	0.875
24.0	0.875	0.863	0.848	0.875	0.860	0.850	0.875
12.0	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AN-102 (2008) - Riser 25

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.504	0.474	0.520	0.502	0.481	0.510
408	0.500	0.511	0.487	0.520	0.504	0.479	0.515
396	0.500	0.511	0.488	0.520	0.507	0.485	0.515
384	0.500	0.511	0.482	0.520	0.508	0.482	0.515
372	0.500	0.515	0.486	0.525	0.508	0.483	0.515
360	0.500	0.510	0.488	0.520	0.504	0.485	0.515
348	0.500	0.512	0.488	0.520	0.503	0.482	0.510
336	0.500	0.510	0.487	0.520	0.504	0.482	0.510
324	0.500	0.520	0.496	0.530	0.520	0.498	0.530
312	0.500	0.526	0.498	0.535	0.527	0.499	0.535
300	0.500	0.528	0.504	0.540	0.529	0.501	0.535
288	0.500	0.530	0.506	0.540	0.529	0.504	0.535
276	0.500	0.530	0.509	0.540	0.528	0.509	0.535
264	0.500	0.530	0.511	0.540	0.528	0.515	0.535
252	0.500	0.530	0.508	0.540	0.529	0.511	0.535
240	0.500	0.530	0.501	0.540	0.526	0.505	0.535
234	0.500	0.518	0.491	0.530	0.509	0.489	0.525
228	0.500	0.520	0.499	0.530	0.511	0.488	0.525
216	0.500	0.521	0.500	0.530	0.513	0.484	0.525
204	0.500	0.522	0.502	0.530	0.514	0.482	0.525
192	0.500	0.525	0.498	0.535	0.515	0.486	0.530
180	0.500	0.523	0.499	0.530	0.513	0.489	0.525
168	0.500	0.523	0.494	0.530	0.514	0.486	0.525
156	0.500	0.519	0.497	0.530	0.509	0.489	0.520
144	0.750	0.755	0.734	0.770	0.752	0.730	0.770
132	0.750	0.756	0.733	0.770	0.752	0.729	0.770
120	0.750	0.757	0.734	0.770	0.754	0.720	0.770
108	0.750	0.759	0.734	0.770	0.754	0.734	0.770
96	0.750	0.762	0.735	0.775	0.755	0.734	0.770
84	0.750	0.763	0.735	0.775	0.757	0.732	0.770
72	0.750	0.762	0.740	0.775	0.756	0.730	0.770
60	0.750	0.763	0.740	0.775	0.758	0.735	0.770
48	0.750	0.765	0.743	0.775	0.764	0.736	0.775
36	0.875	0.899	0.861	0.915	0.892	0.856	0.900
24	0.875	0.900	0.856	0.910	0.892	0.860	0.900
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AN-102 (2008) - Riser 26

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.505	0.471	0.515	0.502	0.469	0.510
408	0.500	0.508	0.476	0.515	0.505	0.470	0.510
396	0.500	0.510	0.481	0.515	0.507	0.479	0.510
384	0.500	0.510	0.480	0.515	0.508	0.474	0.510
372	0.500	0.510	0.487	0.515	0.507	0.479	0.510
360	0.500	0.509	0.486	0.515	0.506	0.479	0.510
348	0.500	0.509	0.479	0.515	0.505	0.479	0.510
336	0.500	0.508	0.487	0.515	0.505	0.486	0.510
324	0.500	0.511	0.485	0.525	0.508	0.486	0.525
312	0.500	0.515	0.489	0.530	0.512	0.485	0.525
300	0.500	0.518	0.496	0.530	0.514	0.487	0.525
288	0.500	0.519	0.496	0.530	0.514	0.491	0.525
276	0.500	0.520	0.496	0.535	0.517	0.495	0.525
264	0.500	0.520	0.492	0.535	0.518	0.496	0.530
252	0.500	0.516	0.495	0.530	0.514	0.491	0.525
240	0.500	0.515	0.495	0.530	0.515	0.490	0.525
234	0.500	0.486	0.463	0.500	0.495	0.468	0.505
228	0.500	0.489	0.462	0.500	0.497	0.470	0.505
216	0.500	0.489	0.467	0.500	0.496	0.472	0.505
204	0.500	0.485	0.460	0.500	0.496	0.462	0.505
192	0.500	0.484	0.446	0.500	0.496	0.471	0.505
180	0.500	0.484	0.450	0.500	0.495	0.468	0.505
168	0.500	0.481	0.452	0.495	0.490	0.468	0.505
156	0.500	0.483	0.448	0.495	0.488	0.468	0.500
144	0.750	0.771	0.751	0.780	0.772	0.749	0.785
132	0.750	0.770	0.751	0.780	0.774	0.745	0.785
120	0.750	0.774	0.754	0.785	0.775	0.754	0.785
108	0.750	0.776	0.755	0.785	0.777	0.755	0.785
96	0.750	0.777	0.761	0.785	0.779	0.762	0.785
84	0.750	0.777	0.745	0.785	0.777	0.754	0.785
72	0.750	0.775	0.757	0.785	0.777	0.724	0.785
60	0.750	0.775	0.752	0.785	0.778	0.756	0.785
48	0.750	0.774	0.754	0.785	0.778	0.754	0.785
36	0.875	0.890	0.855	0.895	0.888	0.859	0.895
24	0.875	0.890	0.859	0.895	0.888	0.855	0.895
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

		AW-101 (2009) - Riser 28					
		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.504	0.463	0.515	0.507	0.470	0.515
408	0.500	0.509	0.469	0.515	0.512	0.475	0.520
396	0.500	0.507	0.480	0.515	0.514	0.485	0.520
384	0.500	0.508	0.476	0.515	0.514	0.477	0.520
372	0.500	0.507	0.480	0.515	0.513	0.482	0.520
360	0.500	0.506	0.478	0.515	0.512	0.479	0.520
348	0.500	0.503	0.470	0.515	0.510	0.475	0.515
336	0.500	0.501	0.474	0.510	0.508	0.479	0.515
324	0.500	0.519	0.484	0.535	0.522	0.489	0.535
312	0.500	0.523	0.482	0.535	0.526	0.486	0.535
300	0.500	0.523	0.490	0.535	0.525	0.495	0.540
288	0.500	0.520	0.482	0.535	0.525	0.484	0.540
276	0.500	0.520	0.490	0.535	0.527	0.488	0.540
264	0.500	0.520	0.492	0.535	0.525	0.490	0.535
252	0.500	0.521	0.480	0.535	0.522	0.483	0.535
240	0.500	0.512	0.475	0.525	0.517	0.481	0.530
234	0.500	0.518	0.481	0.530	0.520	0.484	0.530
228	0.500	0.525	0.487	0.530	0.527	0.500	0.530
216	0.500	0.526	0.497	0.530	0.528	0.495	0.535
204	0.500	0.527	0.492	0.530	0.529	0.497	0.535
192	0.500	0.526	0.489	0.530	0.529	0.499	0.535
180	0.500	0.525	0.495	0.530	0.527	0.498	0.535
168	0.500	0.521	0.488	0.530	0.525	0.488	0.530
156	0.500	0.517	0.488	0.525	0.522	0.489	0.530
144	0.750	0.760	0.714	0.775	0.763	0.730	0.775
132	0.750	0.760	0.725	0.775	0.767	0.734	0.775
120	0.750	0.767	0.731	0.775	0.769	0.740	0.780
108	0.750	0.770	0.733	0.780	0.771	0.740	0.780
96	0.750	0.770	0.727	0.780	0.772	0.741	0.780
84	0.750	0.769	0.736	0.780	0.769	0.734	0.780
72	0.750	0.765	0.730	0.775	0.765	0.734	0.775
60	0.750	0.762	0.727	0.775	0.762	0.728	0.775
48	0.750	0.760	0.726	0.770	0.761	0.731	0.770
36	0.875	0.876	0.834	0.885	0.875	0.847	0.885
24	0.875	0.880	0.842	0.890	0.878	0.843	0.885
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

		AW-101 (2009) - Riser 29					
		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.515	0.479	0.525	0.510	0.478	0.520
408	0.500	0.521	0.493	0.530	0.514	0.490	0.520
396	0.500	0.521	0.496	0.530	0.517	0.492	0.525
384	0.500	0.521	0.499	0.530	0.517	0.489	0.525
372	0.500	0.521	0.499	0.525	0.516	0.497	0.525
360	0.500	0.519	0.493	0.525	0.515	0.488	0.520
348	0.500	0.514	0.480	0.525	0.512	0.487	0.520
336	0.500	0.509	0.487	0.520	0.507	0.486	0.515
324	0.500	0.511	0.479	0.520	0.501	0.472	0.515
312	0.500	0.516	0.489	0.525	0.502	0.474	0.515
300	0.500	0.518	0.490	0.530	0.505	0.479	0.520
288	0.500	0.517	0.487	0.530	0.506	0.475	0.520
276	0.500	0.517	0.489	0.530	0.506	0.470	0.520
264	0.500	0.518	0.481	0.530	0.503	0.478	0.520
252	0.500	0.517	0.488	0.525	0.502	0.470	0.515
240	0.500	0.512	0.486	0.520	0.498	0.469	0.510
234	0.500	0.513	0.482	0.530	0.513	0.479	0.525
228	0.500	0.517	0.490	0.530	0.516	0.489	0.530
216	0.500	0.518	0.478	0.530	0.517	0.482	0.530
204	0.500	0.519	0.492	0.530	0.525	0.491	0.535
192	0.500	0.519	0.479	0.530	0.521	0.486	0.535
180	0.500	0.522	0.497	0.530	0.522	0.494	0.530
168	0.500	0.520	0.486	0.530	0.521	0.482	0.530
156	0.500	0.514	0.491	0.525	0.521	0.496	0.530
144	0.750	0.740	0.714	0.755	0.741	0.705	0.755
132	0.750	0.745	0.666	0.760	0.749	0.721	0.760
120	0.750	0.750	0.720	0.765	0.757	0.729	0.765
108	0.750	0.751	0.724	0.765	0.754	0.719	0.765
96	0.750	0.750	0.727	0.765	0.755	0.726	0.765
84	0.750	0.750	0.721	0.765	0.754	0.724	0.765
72	0.750	0.749	0.685	0.765	0.751	0.723	0.760
60	0.750	0.743	0.714	0.755	0.744	0.714	0.755
48	0.750	0.739	0.706	0.755	0.741	0.711	0.750
36	0.875	0.884	0.853	0.900	0.881	0.851	0.895
24	0.875	0.881	0.846	0.900	0.881	0.854	0.895
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

		AW-105 (2009) - Riser 28					
		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.523	0.496	0.530	0.520	0.482	0.530
408	0.500	0.528	0.494	0.535	0.526	0.488	0.530
396	0.500	0.528	0.500	0.535	0.528	0.488	0.535
384	0.500	0.529	0.499	0.540	0.529	0.493	0.535
372	0.500	0.529	0.493	0.540	0.530	0.492	0.540
360	0.500	0.528	0.498	0.535	0.529	0.490	0.535
348	0.500	0.526	0.494	0.535	0.527	0.493	0.535
336	0.500	0.521	0.489	0.530	0.521	0.493	0.530
324	0.500	0.518	0.488	0.525	0.517	0.482	0.525
312	0.500	0.524	0.488	0.530	0.520	0.480	0.530
300	0.500	0.526	0.490	0.535	0.521	0.487	0.530
288	0.500	0.525	0.489	0.535	0.521	0.487	0.530
276	0.500	0.525	0.489	0.535	0.523	0.486	0.530
264	0.500	0.524	0.490	0.535	0.524	0.487	0.530
252	0.500	0.523	0.491	0.530	0.524	0.488	0.530
240	0.500	0.517	0.453	0.525	0.518	0.489	0.525
234	0.500	0.528	0.489	0.540	0.525	0.495	0.535
228	0.500	0.528	0.501	0.540	0.527	0.496	0.535
216	0.500	0.530	0.494	0.540	0.529	0.498	0.540
204	0.500	0.529	0.497	0.540	0.528	0.493	0.540
192	0.500	0.528	0.493	0.540	0.527	0.501	0.540
180	0.500	0.527	0.495	0.540	0.526	0.484	0.535
168	0.500	0.524	0.497	0.535	0.524	0.493	0.535
156	0.500	0.520	0.493	0.530	0.520	0.454	0.530
144	0.750	0.749	0.720	0.760	0.754	0.717	0.765
132	0.750	0.750	0.724	0.760	0.756	0.726	0.765
120	0.750	0.754	0.727	0.760	0.759	0.730	0.765
108	0.750	0.754	0.724	0.765	0.761	0.734	0.765
96	0.750	0.754	0.723	0.765	0.762	0.728	0.770
84	0.750	0.754	0.719	0.760	0.761	0.734	0.770
72	0.750	0.753	0.721	0.760	0.761	0.733	0.770
60	0.750	0.748	0.720	0.755	0.757	0.727	0.765
48	0.750	0.744	0.718	0.755	0.758	0.734	0.765
36	0.875	0.885	0.859	0.900	0.883	0.859	0.895
24	0.875	0.889	0.861	0.900	0.884	0.860	0.900
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

		AW-105 (2009) - Riser 29					
		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.530	0.499	0.545	0.533	0.502	0.545
408	0.500	0.536	0.507	0.545	0.538	0.506	0.545
396	0.500	0.538	0.507	0.545	0.538	0.504	0.545
384	0.500	0.538	0.508	0.545	0.539	0.504	0.545
372	0.500	0.538	0.507	0.545	0.539	0.501	0.545
360	0.500	0.537	0.507	0.545	0.538	0.506	0.545
348	0.500	0.537	0.502	0.545	0.537	0.504	0.545
336	0.500	0.531	0.507	0.540	0.532	0.498	0.540
324	0.500	0.501	0.468	0.515	0.504	0.473	0.515
312	0.500	0.503	0.467	0.515	0.507	0.473	0.520
300	0.500	0.506	0.468	0.520	0.508	0.470	0.520
288	0.500	0.507	0.464	0.520	0.510	0.468	0.520
276	0.500	0.507	0.471	0.520	0.509	0.470	0.520
264	0.500	0.512	0.463	0.525	0.509	0.467	0.525
252	0.500	0.510	0.473	0.520	0.511	0.474	0.520
240	0.500	0.512	0.491	0.520	0.511	0.478	0.520
234	0.500	0.517	0.476	0.530	0.519	0.479	0.530
228	0.500	0.521	0.484	0.530	0.521	0.488	0.530
216	0.500	0.522	0.480	0.535	0.521	0.489	0.535
204	0.500	0.521	0.485	0.535	0.522	0.489	0.535
192	0.500	0.525	0.488	0.535	0.526	0.489	0.535
180	0.500	0.524	0.489	0.535	0.525	0.492	0.535
168	0.500	0.523	0.492	0.530	0.524	0.497	0.530
156	0.500	0.520	0.497	0.530	0.520	0.483	0.530
144	0.750	0.764	0.721	0.775	0.758	0.729	0.770
132	0.750	0.765	0.734	0.775	0.764	0.734	0.775
120	0.750	0.768	0.739	0.775	0.764	0.739	0.775
108	0.750	0.769	0.742	0.775	0.765	0.739	0.775
96	0.750	0.772	0.741	0.780	0.768	0.739	0.775
84	0.750	0.770	0.735	0.780	0.767	0.741	0.775
72	0.750	0.765	0.738	0.775	0.761	0.735	0.775
60	0.750	0.762	0.732	0.775	0.754	0.727	0.770
48	0.750	0.760	0.732	0.770	0.754	0.726	0.770
36	0.875	0.890	0.853	0.905	0.891	0.857	0.905
24	0.875	0.890	0.852	0.905	0.890	0.854	0.905
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AW-106 (2009) - Riser 28

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.536	0.497	0.545	0.531	0.495	0.538
408	0.500	0.537	0.516	0.545	0.537	0.499	0.542
396	0.500	0.547	0.517	0.551	0.542	0.508	0.546
384	0.500	0.548	0.519	0.552	0.542	0.504	0.546
372	0.500	0.546	0.519	0.551	0.541	0.504	0.546
360	0.500	0.545	0.494	0.550	0.540	0.501	0.545
348	0.500	0.542	0.517	0.550	0.537	0.506	0.542
336	0.500	0.538	0.511	0.543	0.531	0.500	0.537
324	0.500	0.526	0.494	0.535	0.521	0.497	0.535
312	0.500	0.532	0.500	0.540	0.527	0.497	0.537
300	0.500	0.532	0.497	0.540	0.529	0.491	0.540
288	0.500	0.533	0.501	0.542	0.530	0.494	0.540
276	0.500	0.534	0.501	0.544	0.531	0.501	0.543
264	0.500	0.532	0.502	0.542	0.533	0.500	0.543
252	0.500	0.533	0.501	0.541	0.532	0.499	0.541
240	0.500	0.528	0.500	0.535	0.530	0.503	0.537
234	0.500	0.528	0.496	0.535	0.528	0.492	0.533
228	0.500	0.530	0.509	0.540	0.531	0.502	0.535
216	0.500	0.532	0.501	0.540	0.533	0.509	0.540
204	0.500	0.533	0.496	0.545	0.534	0.507	0.545
192	0.500	0.535	0.510	0.545	0.535	0.503	0.545
180	0.500	0.533	0.506	0.545	0.534	0.507	0.545
168	0.500	0.531	0.504	0.540	0.532	0.505	0.540
156	0.500	0.532	0.466	0.540	0.528	0.495	0.535
144	0.750	0.758	0.728	0.764	0.764	0.734	0.770
132	0.750	0.763	0.735	0.766	0.768	0.737	0.772
120	0.750	0.769	0.743	0.775	0.773	0.744	0.780
108	0.750	0.772	0.747	0.780	0.776	0.748	0.783
96	0.750	0.773	0.751	0.780	0.777	0.748	0.784
84	0.750	0.774	0.752	0.780	0.776	0.740	0.784
72	0.750	0.773	0.745	0.780	0.773	0.735	0.781
60	0.750	0.772	0.745	0.775	0.770	0.746	0.775
48	0.750	0.769	0.742	0.775	0.769	0.738	0.780
36	0.875	0.910	0.876	0.920	0.910	0.875	0.920
24	0.875	0.910	0.869	0.920	0.910	0.876	0.920
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AW-106 (2009) - Riser 29

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.531	0.501	0.538	0.527	0.489	0.533
408	0.500	0.537	0.509	0.543	0.533	0.506	0.537
396	0.500	0.539	0.507	0.545	0.534	0.511	0.539
384	0.500	0.539	0.512	0.546	0.534	0.511	0.541
372	0.500	0.536	0.511	0.542	0.535	0.507	0.541
360	0.500	0.543	0.515	0.548	0.536	0.509	0.544
348	0.500	0.542	0.513	0.547	0.537	0.509	0.541
336	0.500	0.538	0.500	0.546	0.532	0.510	0.537
324	0.500	0.545	0.510	0.549	0.539	0.505	0.545
312	0.500	0.550	0.514	0.555	0.545	0.516	0.554
300	0.500	0.553	0.528	0.557	0.548	0.525	0.557
288	0.500	0.553	0.525	0.557	0.548	0.512	0.558
276	0.500	0.553	0.504	0.558	0.548	0.515	0.559
264	0.500	0.553	0.517	0.558	0.547	0.490	0.557
252	0.500	0.551	0.515	0.557	0.545	0.509	0.555
240	0.500	0.545	0.519	0.550	0.541	0.503	0.550
234	0.500	0.535	0.499	0.546	0.541	0.509	0.551
228	0.500	0.540	0.497	0.549	0.543	0.516	0.552
216	0.500	0.542	0.504	0.551	0.546	0.511	0.555
204	0.500	0.542	0.503	0.552	0.546	0.503	0.555
192	0.500	0.543	0.519	0.554	0.546	0.511	0.554
180	0.500	0.540	0.512	0.550	0.547	0.515	0.556
168	0.500	0.540	0.513	0.549	0.546	0.518	0.555
156	0.500	0.533	0.498	0.542	0.538	0.514	0.545
144	0.750	0.758	0.729	0.770	0.766	0.730	0.774
132	0.750	0.764	0.739	0.771	0.764	0.747	0.780
120	0.750	0.769	0.742	0.776	0.773	0.748	0.781
108	0.750	0.769	0.744	0.776	0.774	0.750	0.782
96	0.750	0.769	0.744	0.775	0.775	0.742	0.783
84	0.750	0.769	0.745	0.775	0.773	0.744	0.781
72	0.750	0.767	0.736	0.772	0.769	0.745	0.775
60	0.750	0.760	0.725	0.767	0.763	0.737	0.769
48	0.750	0.757	0.728	0.766	0.758	0.730	0.765
36	0.875	0.911	0.881	0.920	0.911	0.878	0.923
24	0.875	0.910	0.873	0.920	0.909	0.878	0.922
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AW-102 (2010) - Riser 28

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.538	0.491	0.549	0.544	0.502	0.552
408	0.500	0.543	0.509	0.549	0.548	0.508	0.556
396	0.500	0.546	0.512	0.554	0.546	0.513	0.554
384	0.500	0.546	0.502	0.555	0.545	0.512	0.554
372	0.500	0.547	0.514	0.555	0.545	0.515	0.554
360	0.500	0.546	0.517	0.551	0.544	0.513	0.553
348	0.500	0.544	0.504	0.550	0.541	0.508	0.550
336	0.500	0.540	0.493	0.549	0.537	0.503	0.543
324	0.500	0.531	0.495	0.542	0.537	0.500	0.548
312	0.500	0.539	0.513	0.548	0.544	0.513	0.549
300	0.500	0.542	0.508	0.550	0.546	0.517	0.554
288	0.500	0.540	0.511	0.550	0.547	0.516	0.555
276	0.500	0.536	0.504	0.545	0.547	0.516	0.556
264	0.500	0.539	0.511	0.548	0.546	0.509	0.554
252	0.500	0.535	0.504	0.545	0.543	0.516	0.554
240	0.500	0.532	0.508	0.540	0.538	0.509	0.545
234	0.500	0.533	0.501	0.545	0.538	0.510	0.550
228	0.500	0.538	0.506	0.545	0.542	0.510	0.551
216	0.500	0.539	0.513	0.550	0.542	0.515	0.552
204	0.500	0.540	0.512	0.550	0.541	0.515	0.552
192	0.500	0.540	0.515	0.550	0.540	0.514	0.551
180	0.500	0.538	0.504	0.550	0.538	0.509	0.549
168	0.500	0.538	0.507	0.547	0.536	0.503	0.546
156	0.500	0.533	0.504	0.544	0.531	0.501	0.541
144	0.750	0.773	0.740	0.786	0.769	0.732	0.783
132	0.750	0.776	0.746	0.786	0.773	0.741	0.784
120	0.750	0.780	0.754	0.788	0.778	0.748	0.787
108	0.750	0.781	0.759	0.789	0.780	0.755	0.788
96	0.750	0.780	0.751	0.789	0.780	0.748	0.788
84	0.750	0.782	0.749	0.790	0.780	0.753	0.786
72	0.750	0.777	0.752	0.788	0.777	0.753	0.785
60	0.750	0.778	0.754	0.787	0.776	0.749	0.784
48	0.750	0.775	0.751	0.785	0.770	0.741	0.781
36	0.875	0.889	0.862	0.918	0.897	0.855	0.921
24	0.875	0.908	0.873	0.919	0.902	0.859	0.920
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

AW-102 (2010) - Riser 29

		UT Path 1			UT Path 2		
Elevation	Nominal Wall	Ave	Min	Max	Ave	Min	Max
420	0.500	0.538	0.493	0.549	0.535	0.490	0.544
408	0.500	0.543	0.509	0.550	0.541	0.506	0.547
396	0.500	0.544	0.515	0.553	0.544	0.512	0.549
384	0.500	0.544	0.515	0.554	0.544	0.509	0.550
372	0.500	0.543	0.514	0.552	0.544	0.509	0.550
360	0.500	0.542	0.514	0.549	0.544	0.517	0.549
348	0.500	0.540	0.508	0.549	0.543	0.516	0.549
336	0.500	0.538	0.502	0.547	0.540	0.502	0.544
324	0.500	0.528	0.497	0.537	0.531	0.501	0.540
312	0.500	0.532	0.500	0.540	0.533	0.502	0.543
300	0.500	0.534	0.504	0.543	0.536	0.503	0.549
288	0.500	0.534	0.505	0.543	0.535	0.508	0.547
276	0.500	0.534	0.499	0.545	0.535	0.506	0.548
264	0.500	0.534	0.505	0.544	0.535	0.499	0.547
252	0.500	0.534	0.505	0.544	0.533	0.503	0.545
240	0.500	0.529	0.503	0.539	0.525	0.494	0.540
234	0.500	0.542	0.504	0.549	0.543	0.516	0.554
228	0.500	0.544	0.517	0.550	0.547	0.519	0.555
216	0.500	0.547	0.518	0.553	0.547	0.519	0.557
204	0.500	0.548	0.514	0.555	0.547	0.519	0.555
192	0.500	0.548	0.514	0.555	0.547	0.516	0.556
180	0.500	0.547	0.516	0.555	0.546	0.512	0.555
168	0.500	0.548	0.499	0.557	0.542	0.510	0.553
156	0.500	0.545	0.519	0.550	0.533	0.508	0.544
144	0.750	0.774	0.751	0.787	0.767	0.733	0.787
132	0.750	0.777	0.750	0.786	0.775	0.746	0.789
120	0.750	0.780	0.751	0.788	0.785	0.751	0.796
108	0.750	0.782	0.755	0.791	0.789	0.761	0.797
96	0.750	0.778	0.752	0.788	0.785	0.761	0.795
84	0.750	0.778	0.753	0.788	0.782	0.756	0.788
72	0.750	0.775	0.745	0.784	0.783	0.754	0.794
60	0.750	0.774	0.748	0.784	0.777	0.750	0.788
48	0.750	0.774	0.747	0.784	0.773	0.747	0.785
36	0.875	0.888	0.858	0.894	0.887	0.848	0.894
24	0.875	0.886	0.857	0.897	0.884	0.855	0.892
12	0.875	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle	Knuckle

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