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Title: ANALYSIS TO EVALUATE PREDICTORS OF FIBERBOARD AGING TO GUIDE SURVEILLANCE SAMPLING FOR THE 9975 LIFE EXTENSION PROGRAM

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EXECUTIVE SUMMARY

During surveillance of the 9975 shipping package at the Savannah River Site K-Area Complex, several package dimensions are recorded. The analysis described in this report shows that, based on the current data analysis, two of these measurements, Upper Assembly Outer Diameter (UAOD) and Upper Assembly Inside Height (UAIH), do not have statistically significant aging trends regardless of wattage levels. In contrast, this analysis indicates that the measurement of Air Shield Gap (ASGap) does show a significant increase with age. It appears that the increase is greater for high wattage containers, but this result is dominated by two measurements from high-wattage containers. For all three indicators, additional high-wattage, older containers need to be examined before any definitive conclusions can be reached.

In addition, the current analysis indicates that ASGap measurements for low and medium wattage containers are increasing slowly over time. To reduce uncertainties and better capture the aging trend for these containers, additional low and medium wattage older containers should also be examined.

Based on this analysis, surveillance guidance is to augment surveillance containers resulting from 3013 surveillance with 9975-focused sampling that targets older, high wattage containers and also includes some older, low and medium wattage containers. This focused sampling began in 2015 and will continue in 2016.

The UAOD, UAIH and ASGap data are highly variable. It is possible that additional factors such as seasonal variation and packaging site location might reduce variability and be useful for focusing surveillance and predicting aging.

1.0 BACKGROUND

Historically, selection of 9975 containers for surveillance has been based on the selection of 3013 containers for surveillance. That is, when a 3013 container is selected for surveillance, its 9975 container also has a non-destructive examination (NDE). Selection of 3013s for surveillance is described in "Selection of 3013 Containers for Field Surveillance: Fiscal Year 2013 Update" (Kelly et. al 2013). This surveillance scheme provides some randomization for the selection of 9975 containers. However, the goal of the 3013 sampling is to find "potential problem" containers in the 3013 population at the time of surveillance and does not address aging issues in either the 3013 population or the 9975 container population.

The aim of the KAC 9975 surveillance program is to monitor material performance in order to ensure the shipping package maintains the safety functions credited in the Documented Safety Analysis (WSRC 2014). A high priority mission for KAC is to extend the 9975 storage life beyond 15 years. The life extension studies require an understanding of fiberboard aging as well as any other degradation to the package. This analysis of the fiberboard aging looks at two questions:

1.) Do NDE measurements show aging tends?
2.) What 9975-focused surveillance data is needed to understand and predict fiberboard aging?

2.0 FIBERBOARD PROPERTIES AFFECTING AGING

The fiberboard assemblies in the packages considered in this analysis are fabricated from either cane- or softwood-based fiberboard. The behavior of these two materials is very similar, although some minor differences have been noted (Daugherty 2015a and 2015b). For example, cane fiberboard tends to display a wider range of variability in properties although the ranges of baseline properties for both materials show significant overlap. In addition, the rates of dimensional change due to degradation vary slightly between the two materials depending on the specific aging environment. For simplicity, it is assumed that the average aging behavior is the same for both materials. However, there is a bias in package age since no packages were received into storage with softwood-based fiberboard until 2007, while cane-based packages have been in storage since 2002.

Fiberboard dimensions will change as a result of fiberboard degradation or from change in the moisture content. In general, increasing the fiberboard moisture content causes the fiberboard to swell, increasing the dimensions. However, increased moisture content also weakens the material, allowing the lower fiberboard layers (which support the weight of the lead shield, stainless steel containment vessels, and payload) to compress, potentially reducing the overall fiberboard height. Conversely, reducing the moisture content leads to shrinkage and reduced fiberboard dimensions. While this may allow recovery of the fiberboard strength, the previously compacted layers may not rebound upon moisture loss. This means that there is a possibility of a change in dimensions that does not reflect a change in strength.

Fiberboard degradation rates tend to increase with increasing temperature and moisture. Elevated fiberboard temperature will result from the internal heat load, and will increase further during seasonal temperature increases (summertime) and as the package is surrounded by other packages. The overall fiberboard moisture content will not change rapidly, since the drum provides a significant degree of isolation. However, small daily temperature fluctuations can lead to some air exchange through various small gaps (in the drum closure, around the caplugs, etc.),

Moisture can re-distribute within the fiberboard as a result of a thermal gradient. In addition, degradation (thermal breakdown) of the fiberboard will produce water as a byproduct, increasing the amount of water present. The net effect of these various phenomena is that the fiberboard environment is continually changing, and therefore the indicator dimensions are continually changing.

Heat and moisture are key factors affecting aging. There are very few moisture data available. However, wattage levels, which are an indication of heat load, are available for all containers.

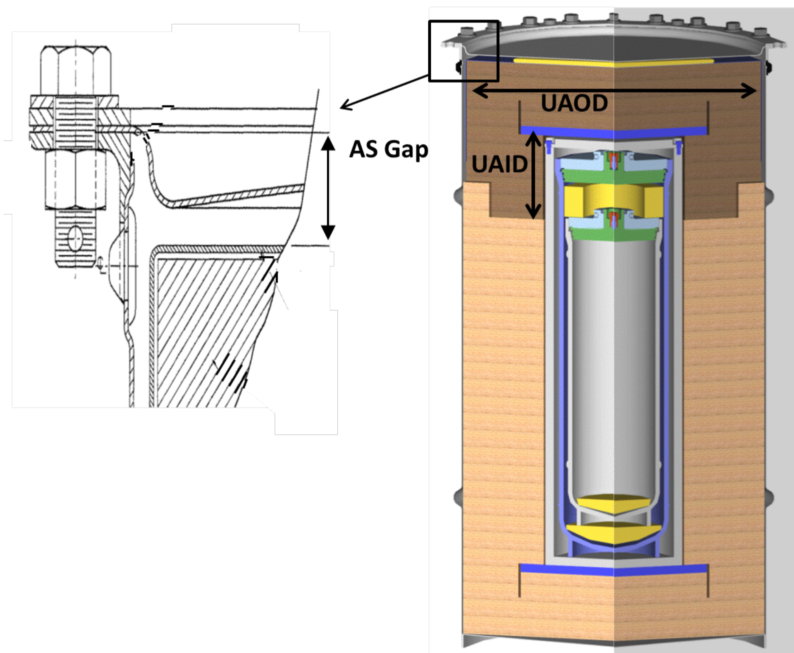
3.0 INDICATORS OF FIBERBOARD AGING

Three NDE measurements have been identified as possibly useful indicators for predicting the life of the fiberboard. The possible indicators are decreasing values of Upper Assembly Outer Diameter (UAOD) and Upper Assembly Inside Height (UAIH), and increasing values of Air Shield Gap (ASGap). Each of these three indicator dimensions is illustrated in Figure 1.

It is desirable to focus on dimensions that are expected to change the most over time. This would typically be the height and diameter of the lower fiberboard assembly (shaded light brown in Figure 1). However, the shield and lower fiberboard assembly are not removed during NDE, or during most other facility activities, so very few data are available on lower fiberboard assembly dimensions. Of the available data, dimensions UAOD and UAIH from the upper fiberboard assembly offer the best chance to identify a trend over time. Larger changes would typically be expected in the axial direction compared to the radial direction due to the layered fabrication of the fiberboard assemblies, since the glue joints provide a degree of reinforcement against radial movement.

The 9975 drum is dimensionally stable, so that any change in height of either the lower or upper fiberboard assembly will be reflected in the ASGap dimension. Shrinkage of the fiberboard will result in an increased ASGap. For a new package, the nominal ASGap value is 0.8 inches, although the actual dimension can be higher (up to 1 inch) or lower (down to 0.502 +/- 0.06 inch to avoid interference with the lid). If the ASGap is greater than one inch, this is considered to be an ASGap failure. However, it is not clear that this limit is an indication of significant degradation.

Figure 1. Cross section of 9975 shipping package showing the three indicator dimensions.



4.0 DATA ANALYSIS

To date (March, 2016), UAOD, UAIH (inches) measurements have been made on two hundred and forty-five 9975 containers. Of these, 235 are from 3013-based NDE and DE surveillance and 10 are from 9975-specific surveillance conducted in August 2015 (6 containers) and February 2016 (4 containers). The 9975-specific surveillance targeted older containers with higher wattages. ASGap measurements (inches) are available on 194 9975-type containers. Of these, 184 are from 3013 NDE and DE surveillance and 10 are from the 9975-specific surveillance. These data are documented in Appendix A. The following analysis examines these data to determine if there are statistically significant aging trends for these indicator variables and to assess the interaction between age and wattage.

4.1 UAOD

A regression analysis was used to determine if there is a trend in UAOD over time. The model used was to consider UAOD as a function of Age and Wattage with a possible interaction term. The lm package in the R software was used for this regression analysis (R Core Team 2012). The results showed that there was not a significant interaction, so the regression model with Age and Wattage only was used. The analysis showed no trend with age and no differences between wattages.

To illustrate this result wattage levels are grouped into High, Medium and Low wattages. These groups were initially defined as (Grouping 1):

- *High*: ≥ 11 (13 containers with UAOD and UAIH; 12 with ASGap)
- *Medium*: 8 ≥ and < 11 (71 containers with UAOD and UAIH; 47 with ASGap)
- *Low*: < 8 (156 containers with UAOD and UAIH; 130 with ASGap)

Figure 1 shows the three regression fits for the three different wattage groups versus age. The shaded areas are 95% confidence intervals for the fits. The overlapping confidence intervals indicate that there are not significant differences between the fits. This graphic was generated using ggplot2 (Wickham, H. 2009).

4.2 UAIH

The same approach was used to look at possible aging trends of UAIH over time. Again, there were no significant interactions and no significant aging trends. The plots of UAIH versus wattage for the three groups (Figure 2) show overlapping confidence intervals for the three groups.

4.3 ASGap

In contrast to UAOH and UAIH, the ASGap analysis indicates significant interactions between age and wattage and a significant increasing aging trend. As can be seen in Figure 3, the aging trend with high wattage containers is significantly greater than that with low or medium wattage containers. However, the trend for high wattage containers is highly dependent on only two observations with high ASGap measurements.

In addition to Grouping 1, a second grouping (Grouping 2) is defined as

- "high" >= 14 watts,
- “medium" > 11 watts and <14 watts, and
- “low” < = 11 watts (Grouping 2)

Figure 4 contains the plots of ASGap versus Age for this grouping of wattages. Although the data is very limited for high wattage containers and there is considerable variability for medium and low wattage containers, this plot again shows that ASGap appears to be increasing dramatically for high wattage containers and that the increase is much less for the low and medium wattage containers.

Figure 1. UAOD: Comparison of aging trends for different wattage groups (Grouping 1)

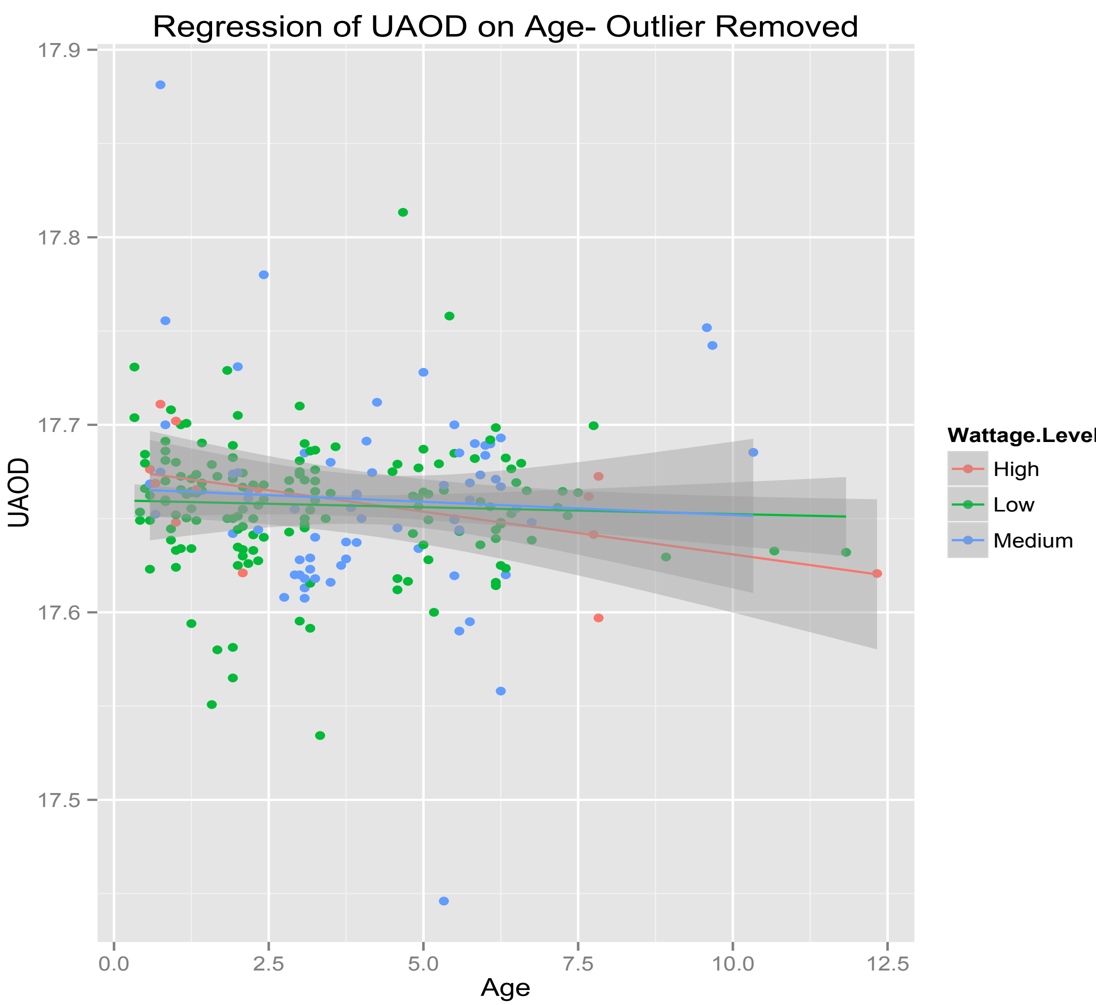


Figure 2. UAIH: Comparison of regressions for different wattage groups (Grouping 1)

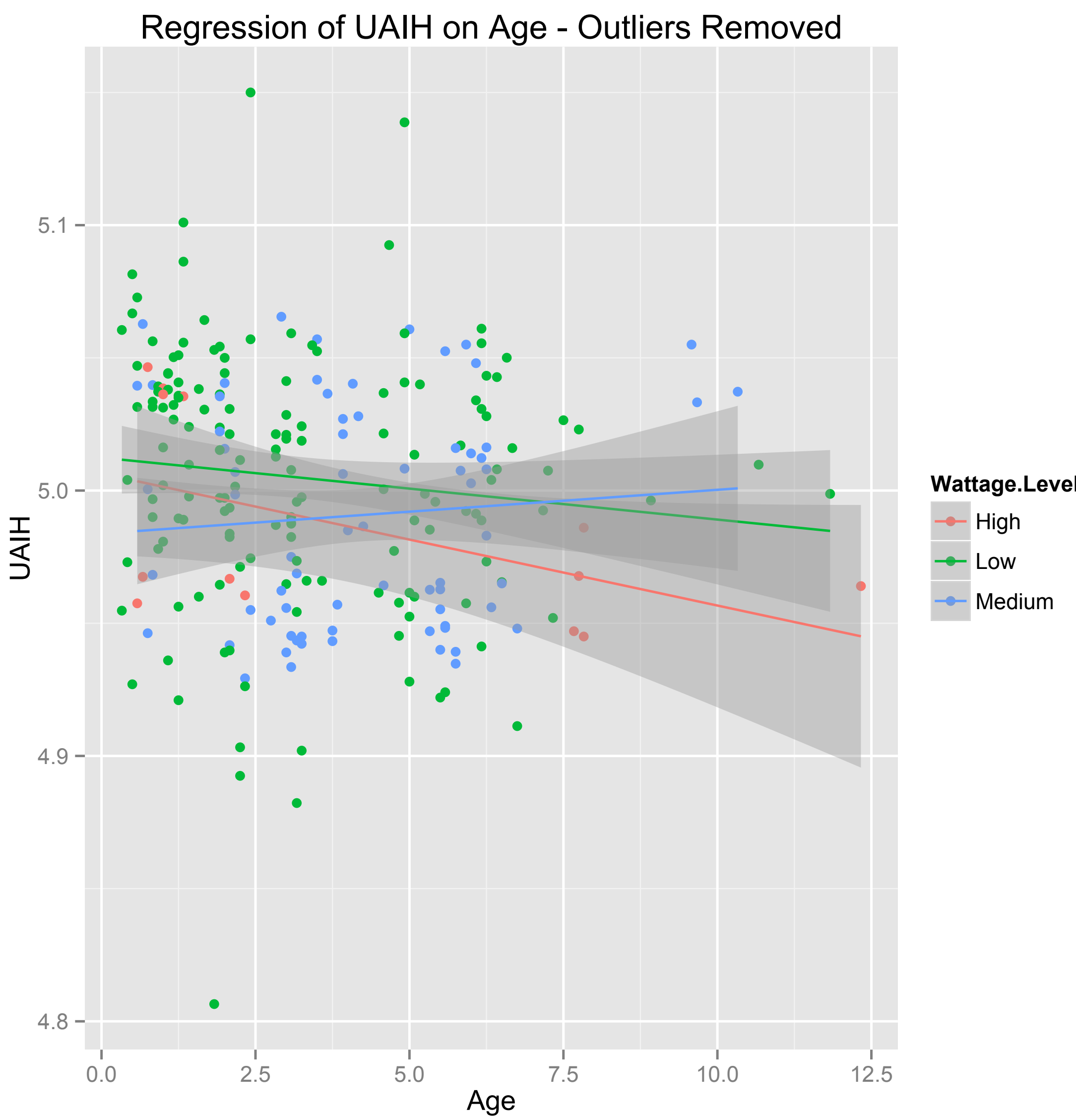


Figure 3. ASGap: Comparison of regressions for different wattage levels (Grouping 1)

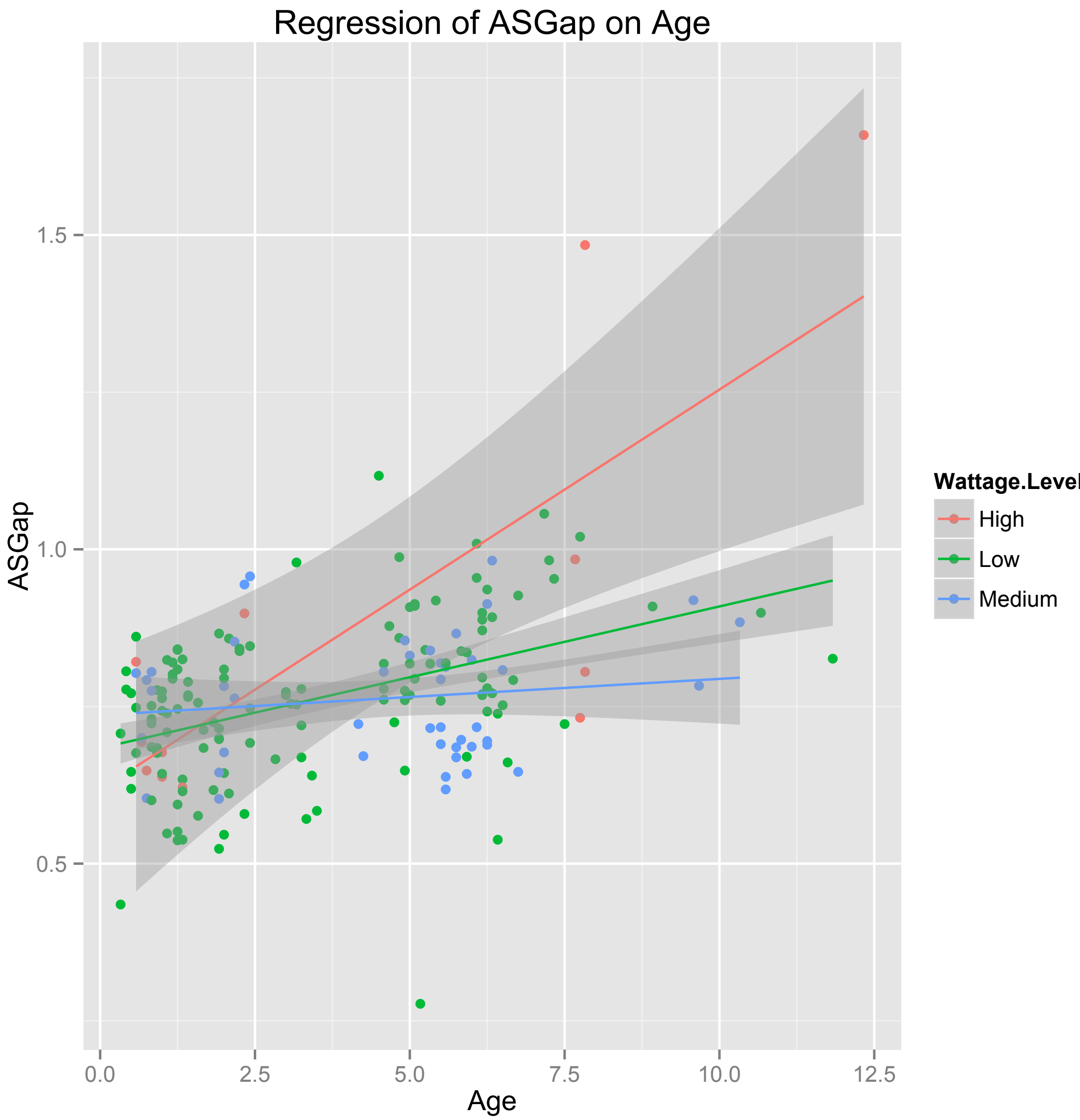
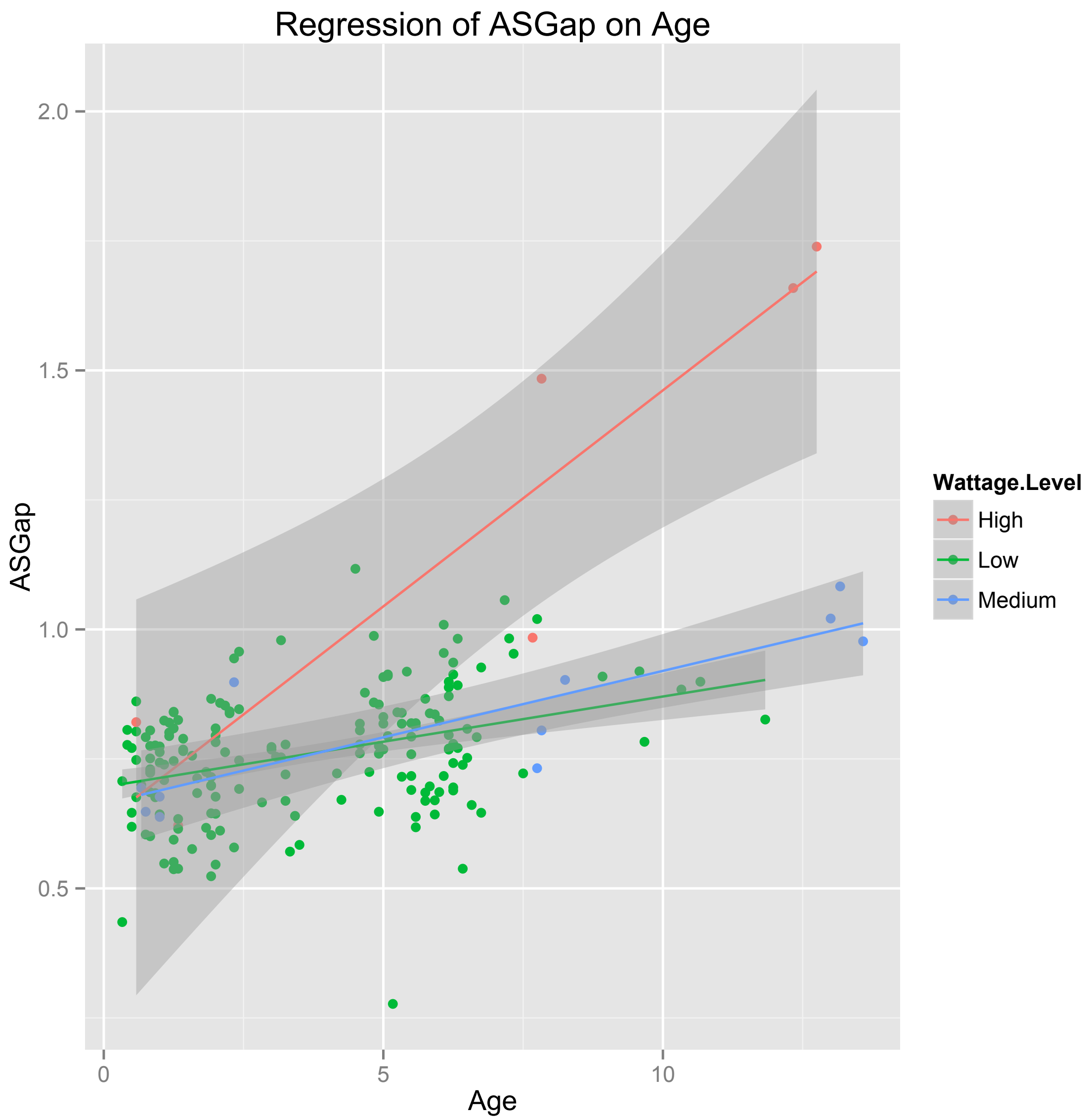


Figure 4. ASGap: Comparison of regressions for different wattage levels (Grouping 2)



5.0 IMPLICATIONS of DATA ANALYSIS for SURVEILLANCE

There is considerable variability in these data for medium and low wattage groups and very limited data for the high wattage group. A question that is currently under investigation is, "can variability be reduced by including other factors besides age and wattage (prediction variables) in the analysis." The immediate task is to use the current analysis to determine the surveillance approach for 2016.

5.1 Reducing Variability by Including Additional Predictive Variables

Given that there is significant scatter in the data and fiberboard dimensions are constantly changing, two additional variables could be considered to help understand the sources of the scatter. These are seasonal temperature variation (based on seasonal changes in the K-Area Complex ambient temperature) and the packaging site.

Future analyses will add seasonal variation and packing site data to the regression model. Seasonal variation will be evaluated by adding a "Season" variable. Season will be defined as: winter (Dec 1 – Feb 28), spring/fall (Mar 1 – May 31 or Sep 1 – Nov 30), and summer (Jun 1 – Aug 31). Additionally, packaging site impacts will be evaluated by adding a variable that takes the values RFETS, Hanford, and SRS.

Another variable that could be important for understanding the variability in the data is the fiberboard production batch. Efforts are underway to acquire this information.

5.2 Surveillance Guidance for 2016

This surveillance guidance is based on the goals of (1) determining aging trends (based on the indicator variable ASGap) and interactions between wattage and age and (2) investigating the hypothesis that lower wattage containers will not be an aging problem in the next five or ten years (again based on the indicator ASGap).

The analysis of the current data shows a possible trend of increasing ASGap over time for high wattage containers (Figures 3 and 4). However, there are very limited high wattage / high age data. Therefore, 2016 surveillance focuses on collecting data for high wattage, older containers. It is also important to get older containers for the low and medium wattage groups to confirm that there is not a significant aging trend for these containers. To meet these goals, constrained by the logistical limit of 10 containers for focused surveillance in 2016, the following focused surveillance plan is recommended for 2016 (Table 1).

As noted above, as the data and analyses become available for other possible predictive variables (e.g., season, packaging site, batch), surveillance guidance will incorporate these findings.

5.3 Questions Requiring Discussion for Future Surveillance

To guide future surveillance (2017 and beyond), the following questions need to be addressed.

1) What conditions constitute a potential problem for 9975s?
2) What are the surveillance indicators related to those conditions that can be used to predict a potential problem?
3) Is there a ranking of the severity of surveillance conditions for the 9975 such as what is done for the 3013 containers?

4) How do ASGap measurements (and/or other aging indicators) correlate with the rankings?

Table 1. Suggested surveillance containers for 2016

Wattage/Age*	3013 Container ID	9975 Container ID	9975 Leak Test Date	Watts	~Age (in 2015)
High /Low	A000650	06238	20-Jul-10	14	5
High / Med	H004270	04820	20-Nov-07	16	8
High /Med	L000329	04506	20-Nov-07	18	8
High / Old	R610750	02019	26-Mar-03	15	12
Med / Med	H002920	05060	09-Aug-07	13	8
Med / Med	R610767	02738	16-May-05	12	10
Med / Old	H000937	02075	01-Apr-03	13	12
Med / Old	S000648	02510	17-Jun-03	12	12
Lower / Old	R600265	00799	12-Jul-02	11	13
Lower / Old	S000244	01658	23-Jan-03	18	12

* Grouping 2 for wattage levels. Age groups are Low = < 8 years;
Med = >=8, <12; Old = >12.

REFERENCES

Daugherty, W. L. 2015a. Status Report – Cane Fiberboard Properties and Degradation Rates for Storage of the 9975 Shipping Package in KAC. Savannah River National Laboratory Report SRNL-STI-2015-00610. December 2015.

Daugherty, W. L. 2015b. Status Report – Softwood Fiberboard Properties and Degradation Rates for Storage of the 9975 Shipping Package in KAC. Savannah River National Laboratory Report SRNL-STI-2015-00611. December 2015.

Kelly, E., L. Worl, J. Berg, J. McClard, J. Cheadle, D. Riley, and T. Venetz. 2013. Selection of 3013 Containers for Field Surveillance: 2013 Update. Los Alamos National Laboratory report LA-UR-13-21195, February 2013.

R Core Team (2012). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/

Wickham, H. 2009. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York, 2009.

Westinghouse Savannah River Company (WSRC). 2014. K-Area Complex Documented Safety Analysis. WSRC-SA-2002-00005 , Rev 10. June 2014.

Appendix A. SURVEILLANCE DATA USED IN ANALYSIS

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
N	999	12/7/01	2/27/05	3.17	17.623	4.969	9.4	
N	2234	4/23/03	3/3/05	1.92	17.565	4.965	3.1	
N	1091	1/17/02	3/14/05	3.17	17.629	4.944	8.7	
N	874	9/21/01	3/16/05	3.5	17.680	5.042	9	
N	851	9/14/01	3/18/05	3.5	17.616	5.057	9.7	
N	1900	3/10/03	3/23/05	2	17.625	4.939	6.4	
N	362	6/3/02	3/28/05	2.75	17.608	4.951	8.8	
N	1261	4/11/02	3/30/05	2.92	17.655	4.962	9.3	
N	1230	4/16/02	4/1/05	3	17.628	4.956	9.3	
N	1137	3/19/02	4/11/05	3.08	17.618	4.945	9.7	
N	331	5/30/02	4/13/05	2.92	17.620	5.066	8.6	
N	1133	3/19/02	4/18/05	3.08	17.613	4.934	9.4	
N	1067	1/22/02	4/20/05	3.25	17.640	4.945	9.5	
N	1078	1/29/02	4/22/05	3.25	17.618	4.942	9.4	
N	1206	4/12/02	4/25/05	3	17.620	4.939	9.6	
N	875	9/21/01	5/2/05	3.67	17.625	5.037	8.6	
N	1854	3/3/03	5/9/05	2.17	17.626	5.002	5.5	
N	2156	4/11/03	5/11/05	2.08	17.655	4.983	4.7	
N	2256	4/30/03	5/13/05	2.08	17.635	4.942	9.6	
N	2152	4/9/03	5/16/05	2.08	17.621	4.967	11.6	
N	1769	2/14/03	5/23/05	2.25	17.633	4.971	1.3	
N	2078	4/2/03	5/25/05	2.08	17.646	4.940	6	
N	1995	3/24/03	6/1/05	2.25	17.641	4.903	6.7	
N	1827	2/25/03	6/3/05	2.33	17.628	4.926	7.1	
N	369	5/30/02	6/6/05	3.08	17.608	4.988	9.6	
N	2330	5/9/03	6/8/05	2.08	17.630	4.994	5.9	
N	2297	5/6/03	6/13/05	2.08	17.634	4.984	5.5	
N	826	9/5/01	10/10/05	4.08	17.691	5.040	9.6	
N	912	11/14/01	10/12/05	3.92	17.663	5.021	9.1	
N	964	11/29/01	10/19/05	3.92	17.637	5.027	9.7	
N	1044	1/18/02	10/21/05	3.75	17.638	4.943	9.3	
N	917	11/16/01	10/24/05	3.92	17.663	5.006	9.6	
N	1049	1/22/02	10/31/05	3.75	17.629	4.947	9.6	
N	1297	4/17/02	11/2/05	3.58	17.688	4.966	3.1	
N	1323	11/19/02	11/4/05	3	17.681	5.021	1.4	

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
N	1630	1/21/03	11/9/05	2.83	17.664	5.021	0.5	
N	1577	1/10/03	11/10/05	2.83	17.643	5.016	3.8	
N	910	11/14/01	11/11/05	4	17.650	4.985	8.9	
N	1015	1/16/02	11/14/05	3.83	17.656	4.957	9.7	
N	2037	3/27/03	3/9/06	3	17.595	4.965	0.9	
N	2346	5/12/03	3/10/06	2.83	17.664	5.013	1	
N	1881	3/6/03	5/23/06	3.17	17.616	4.882	0.3	
N	1737	2/11/03	5/23/06	3.25	17.660	4.902	1.6	
N	2299	5/5/03	5/24/06	3	17.675	5.020	3.8	
N	1903	3/10/03	5/26/06	3.17	17.686	4.996	6.9	
N	2172	4/15/03	5/30/06	3.08	17.690	4.990	4.4	
N	2103	4/5/03	5/31/06	3.08	17.647	5.008	5.6	
N	1893	3/10/03	6/1/06	3.25	17.670	4.998	1.1	
N	2358	5/14/03	6/2/06	3.08	17.650	4.988	7.4	
N	2371	5/14/03	6/5/06	3.08	17.645	4.983	4.9	
N	2322	5/8/03	6/6/06	3.08	17.685	4.975	9.9	
N	944	11/21/01	6/12/07	5.58	17.590	5.053	9.6	0.638
D	2514	1/14/05	6/14/07	2.42	17.780	4.955	9.4	0.957
N	600	6/19/01	6/27/07	6	17.689	5.014	10.3	0.824
N	1051	1/29/02	7/12/07	5.5	17.700	4.940	9.4	0.69
N	1127	3/19/02	7/13/07	5.33	17.446	4.947	8.4	0.839
D	871	9/21/01	7/16/07	5.83	17.690	5.008	8.4	0.697
D	1163	3/13/02	7/25/07	5.33	17.668	4.963	9.3	0.7155
N	1553	1/6/03	8/3/07	4.58	17.612	5.037	3.3	0.7607
D	1689	3/3/05	8/3/07	2.42	17.640	5.150	3.1	0.692
D	2476	4/1/05	8/6/07	2.33	17.644	4.929	9.3	0.944
N	1510	12/30/02	8/10/07	4.67	17.813	5.093	0.3	0.8778
D	2741	5/11/05	8/13/07	2.25	17.650	4.893	4.7	0.842
N	1368	11/25/02	8/20/07	4.75	17.617	4.977	0.8	0.72475
N	1571	1/10/03	8/20/07	4.58	17.679	5.022	0.9	0.818
N	506	5/22/01	8/21/07	6.25	17.693	5.008	9.3	0.689
N	1710	2/5/03	8/22/07	4.5	17.675	4.962	4.8	1.117
N	1581	1/13/03	8/22/07	4.58	17.645	4.964	8.8	0.805
N	2270	5/1/03	8/23/07	4.25	17.712	4.987	9	0.671
D	1002	1/31/02	8/27/07	5.58	17.644	4.949	10.5	0.618
N	1785	2/15/03	9/4/07	4.58	17.618	5.001	0.9	0.778
N	3776	9/13/04	9/4/07	3	17.710	5.029	6.7	0.768
N	1220	4/22/02	10/17/07	5.5	17.649	4.955	9.1	0.793

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
N	1237	4/19/02	10/18/07	5.5	17.650	4.965	9.4	0.819
N	1149	3/19/02	10/22/07	5.58	17.685	4.948	9.7	0.813
N	1276	4/15/02	10/23/07	5.5	17.620	4.963	9.8	0.717
N	857	9/18/01	10/25/07	6.08	17.690	5.048	9.2	0.717
N	962	11/29/01	10/29/07	5.92	17.673	5.055	9.2	0.6427
N	1074	1/22/02	10/30/07	5.75	17.660	4.935	9.4	0.669
N	1072	1/23/02	10/30/07	5.75	17.595	4.939	9.3	0.685
N	490	5/18/01	10/31/07	6.42	17.653	5.008	6.2	0.7385
N	3245	6/16/04	11/1/07	3.42	17.650	5.055	7.8	0.64
D	1317	11/15/02	11/12/07	5	17.664	4.962	4.7	0.7683
D	3226	4/10/07	11/27/07	0.58	17.669	5.040	8.4	0.803
N	4016	6/21/04	12/4/07	3.5	17.664	5.053	7.9	0.584
D	1627	1/21/03	12/10/07	4.92	17.634	5.008	8.2	0.855
N	4150	9/14/04	12/18/07	3.25	17.687	5.019	1.6	0.669
N	3813	8/6/05	12/18/07	2.33	17.657	5.421	1.4	0.579
D	1997	3/24/03	1/8/08	4.83	17.642	4.945	1.3	0.859
D	1509	12/30/02	1/28/08	5.08	17.663	5.014	6.1	0.794
D	1823	2/25/03	2/11/08	5	17.636	4.928	5.3	0.908
N	5009	8/6/07	2/21/08	0.5	17.684	5.082	1.4	0.646
D	5034	8/1/07	2/25/08	0.5	17.666	5.067	4.7	0.619
N	4898	8/6/07	3/10/08	0.58	17.623	5.047	1	0.748
D	5128	8/1/07	3/11/08	0.58	17.676	4.958	14.5	0.821
N	4927	8/6/07	4/1/08	0.67	17.652	5.063	8.9	0.7
D	1966	3/19/03	4/3/08	5.08	17.649	4.989	6.4	0.91
D	2023	3/26/03	4/15/08	5.08	17.628	4.960	5.9	0.913
N	4761	8/6/07	4/23/08	0.67	17.669	4.968	11.7	0.694
D	5055	7/31/07	5/5/08	0.83	17.686	4.990	1.7	0.751
D	4791	8/1/07	5/16/08	0.75	17.711	5.047	11.4	0.648
N	4825	8/9/07	5/30/08	0.75	17.881	4.946	10.1	0.604
D	5080	8/3/07	6/2/08	0.83	17.659	5.032	4.5	0.7265
N	4782	8/6/07	6/30/08	0.83	17.700	5.040	8.4	0.775
D	4801	8/3/07	7/7/08	0.92	17.639	5.037	4.4	0.684
D	4872	8/1/07	7/21/08	0.92	17.645	5.039	4.3	0.676
D	1968	3/19/03	8/4/08	5.42	17.758	4.996	7	0.9185
N	4698	8/7/07	8/12/08	1	17.624	5.031	0.4	0.763
N	4934	8/7/07	8/13/08	1	17.633	5.002	7.9	0.743
N	4956	8/7/07	8/14/08	1	17.648	5.036	12.3	0.677
D	4804	8/2/07	8/18/08	1	17.652	4.981	5.8	0.774

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
N	4700	8/7/07	8/22/08	1	17.680	5.016	5.1	0.643
N	2430	6/8/05	8/26/08	3.17	17.592	4.974	5.9	0.979
N	4751	8/7/07	8/26/08	1	17.702	5.039	12.5	0.638
N	468	9/16/02	8/27/08	5.92	17.659	4.958	7.1	0.67
N	1834	2/27/03	9/8/08	5.58	17.643	4.924	0.7	0.819
N	1154	3/27/02	9/8/08	6.5	17.655	4.965	9.1	0.808
D	5125	8/2/07	9/9/08	1.08	17.700	5.044	7.5	0.709
D	4744	8/1/07	9/29/08	1.08	17.634	5.038	4.3	0.548
N	1332	11/20/02	10/6/08	5.92	17.636	4.992	3.1	0.836
N	1423	12/16/02	10/6/08	5.83	17.682	5.017	0.7	0.838
N	1059	1/21/02	10/25/08	6.75	17.648	4.948	9.5	0.646
D	4797	8/3/07	11/3/08	1.25	17.594	5.041	4.3	0.594
D	5041	8/1/07	11/17/08	1.25	17.664	5.036	5.5	0.551
N	5054	8/9/07	12/2/08	1.33	17.666	5.036	14.7	0.6215
D	4637	8/5/08	12/8/08	0.33	17.731	4.955	7.1	0.435
D	6004	9/15/08	1/5/09	0.33	17.704	5.061	4.3	0.707
D	6775	9/29/08	2/2/09	0.42	17.649	5.004	4.3	0.777
D	6015	9/18/08	2/16/09	0.42	17.654	4.973	4.6	0.806
D	5007	8/5/08	3/9/09	0.58	17.649	5.032	5.9	0.861
N	1729	2/10/03	3/16/09	6.08	17.692	4.991	2.3	0.9545
N	5085	8/8/07	3/17/09	1.58	17.679	4.960	3.7	0.756
D	5124	8/2/07	3/23/09	1.58	17.551	5.038	7.7	0.576
D	6014	9/17/08	4/5/09	0.58	17.662	5.073	4.1	0.676
N	1779	2/12/03	4/13/09	6.17	17.639	5.031	3.3	0.796
N	1879	3/6/03	4/14/09	6.08	17.656	5.034	0.6	1.009
D	6841	10/15/08	4/20/09	0.5	17.680	4.927	4.3	0.771
D	1970	3/19/03	5/4/09	6.17	17.614	4.941	7.5	0.871
D	1911	3/12/03	5/21/09	6.17	17.699	4.989	3.1	0.899
D	2001	3/25/03	6/8/09	6.25	17.647	5.043	4.5	0.742
N	4777	8/2/07	6/30/09	1.83	17.729	4.807	1.8	0.725
N	2298	5/5/03	7/1/09	6.17	17.644	5.056	2.7	0.888
D	2028	3/27/03	7/6/09	6.33	17.620	4.956	8.5	0.982
N	4988	8/8/07	7/14/09	1.92	17.689	5.036	6.7	0.698
N	4837	8/8/07	7/15/09	1.92	17.642	5.036	9	0.603
N	2339	5/9/03	7/15/09	6.17	17.616	5.061	1.4	0.768
D	2072	4/1/03	7/20/09	6.25	17.667	4.983	8.2	0.913
N	4697	8/8/07	7/28/09	1.92	17.674	5.022	9.2	0.645
N	5155	8/8/07	7/28/09	1.92	17.650	5.054	4.6	0.699

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
D	4996	8/3/07	8/3/09	2	17.635	5.044	5.5	0.546
N	5008	8/8/07	8/11/09	2	17.705	5.050	4.8	0.644
N	6715	10/8/08	8/12/09	0.83	17.670	5.056	5.2	0.723
D	5093	8/2/07	8/17/09	2	17.675	5.016	8.8	0.677
N	4925	8/9/07	8/25/09	2	17.644	4.992	7.2	0.795
N	5102	8/8/07	8/26/09	2	17.731	5.041	8.8	0.78225
N	4134	9/1/04	8/26/09	4.92	17.661	5.139	1.2	0.775
N	3577	6/17/04	8/27/09	5.17	17.600	5.040	1.5	0.277
N	3087	9/27/04	8/28/09	4.92	17.677	5.059	6.2	0.76
N	4135	9/1/04	8/31/09	4.92	17.657	5.041	2.4	0.648
N	4900	8/8/07	9/1/09	2.08	17.674	5.021	5.3	0.6115
N	4229	9/1/04	9/1/09	5	17.728	5.061	9.1	0.831
D	6839	10/20/08	9/21/09	0.92	17.708	4.978	3.7	0.776
N	2691	10/17/07	9/29/09	1.92	17.581	4.997	3.6	0.866
N	4671	6/19/08	9/30/09	1.25	17.655	4.921	2.9	0.84
D	4822	7/18/08	10/5/09	1.25	17.664	5.051	2.5	0.537
N	6171	12/22/08	10/13/09	0.83	17.660	4.997	3.9	0.6855
N	6897	1/27/09	10/22/09	0.75	17.675	5.001	9.7	0.792
D	6044	9/17/08	10/26/09	1.08	17.673	5.044	4.5	0.739
N	6949	1/27/09	11/3/09	0.83	17.756	4.968	8.9	0.805
D	6682	9/16/08	11/9/09	1.17	17.650	5.050	4.5	0.82
D	6881	11/11/08	12/1/09	1.08	17.666	4.936	4.8	0.824
N	4288	2/25/08	12/8/09	1.83	17.650	5.053	4	0.617
N	6355	2/12/09	12/9/09	0.83	17.691	5.034	0.4	0.6007
N	6704	9/16/08	12/10/09	1.25	17.665	4.956	4.5	0.746
N	6322	2/2/09	12/14/09	0.83	17.681	4.625	3.4	0.73
N	6823	9/30/08	12/21/09	1.25	17.671	4.990	4.8	0.841
D	2210	4/22/03	1/4/10	6.75	17.639	4.911	4.4	0.9265
N	4848	11/14/07	1/11/10	2.17	17.661	5.007	9.3	0.763
N	4938	11/14/07	1/13/10	2.17	17.665	4.999	9.1	0.853
D	6709	10/6/08	1/19/10	1.25	17.634	5.035	3.7	0.809
D	6674	9/25/08	2/1/10	1.42	17.690	5.024	4.6	0.765
D	4865	10/6/08	2/16/10	1.33	17.649	4.989	1.2	0.615
D	6742	10/29/08	3/8/10	1.42	17.665	4.998	4.3	0.768
N	4353	11/25/07	3/16/10	2.33	17.666	4.961	11.8	0.898
N	6275	1/13/09	3/17/10	1.17	17.701	5.032	4.9	0.801
N	6769	11/6/08	3/18/10	1.33	17.664	5.086	2.3	0.825
N	6908	1/7/09	3/22/10	1.17	17.663	5.027	2.9	0.794
D	6084	12/15/08	4/8/10	1.33	17.674	5.056	4.3	0.538

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
D	6866	11/12/08	4/21/10	1.42	17.669	5.010	6.9	0.789
D	6135	1/6/09	5/5/10	1.33	17.674	5.101	2.7	0.634
D	6049	10/14/08	6/2/10	1.67	17.673	5.031	4.4	0.684
D	2130	4/9/03	6/14/10	7.17	17.656	4.993	4.7	1.0565
D	2168	4/14/03	7/7/10	7.25	17.665	5.008	4.7	0.9825
D	1918	3/13/03	7/20/10	7.33	17.652	4.952	7.2	0.953
D	3863	5/13/04	8/4/10	6.25	17.558	5.016	8.3	0.695
D	6069	12/16/08	8/25/10	1.67	17.580	5.064	4.2	0.7127
D	4189	9/8/04	9/20/10	6	17.684	5.003	9.6	0.686
D	6723	10/20/08	9/29/10	1.92	17.683	5.024	1.8	0.5235
D	6860	10/27/08	10/14/10	2	17.651	4.997	3.3	0.809
D	4190	9/2/04	11/3/10	6.17	17.671	5.012	9.7	0.77
D	6088	12/22/08	11/29/10	1.92	17.671	5.015	3.6	0.715
D	6027	12/17/08	1/3/11	2.08	17.667	5.031	3	0.858
D	6858	10/16/08	1/24/11	2.25	17.668	5.012	4.3	0.838
D	6824	9/29/08	2/2/11	2.42	17.668	4.975	4.6	0.846
D	2274	5/1/03	2/28/11	7.75	17.700	5.023	7	1.02
D	6046	10/13/08	3/5/11	2.42	17.660	5.057	4.6	0.747
D	309	2/3/08	6/13/11	3.33	17.534	4.966	3	0.571
D	4678	6/24/08	9/19/11	3.25	17.665	5.750	1.1	0.7777
D	6192	12/30/08	10/10/11	2.83	17.670	4.987	2.4	0.666
D	6548	8/27/08	11/1/11	3.25	17.676	5.024	1.2	0.72
D	6052	12/29/08	12/5/11	3	17.674	5.041	4.7	0.773
D	3431	11/28/07	1/5/12	4.17	17.675	5.028	9.8	0.722
D	6205	12/22/08	1/26/12	3.08	17.671	5.059	3.8	0.7542
D	6168	12/30/08	2/29/12	3.17	17.655	4.954	3.3	0.753
D	3982	9/13/04	3/13/12	7.5	17.664	5.027	6.7	0.722
D	2283	5/2/03	4/30/12	8.92	17.630	4.996	4.6	0.909
D	4488	6/24/08	4/15/13	4.83	17.662	4.958	0.8	0.9875
D	6921	11/5/08	11/4/13	5	17.687	4.953	3.4	0.818
D	2305	5/6/03	1/13/14	10.67	17.633	5.010	5.4	0.899
D	4894	7/26/07	2/3/14	6.58	17.680	5.050	4.1	0.661
D	6754	10/27/08	2/19/14	5.33	17.665	4.985	3.7	0.818
D	6732	12/3/08	3/25/14	5.25	17.679	4.999	4.2	0.84
D	4971	10/30/08	4/7/14	5.5	17.685	4.922	4	0.759
D	3373	9/2/04	4/22/14	9.58	17.752	5.055	9.6	0.919
D	3160	9/14/04	5/6/14	9.67	17.742	5.033	9.5	0.783
D	6604	8/26/08	5/29/14	5.75	17.669	5.016	9.5	0.866
D	1654	1/23/03	11/12/14	11.8	17.632	4.999	1.5	0.826

Surv Type *	9975 Container ID	9975Leak TestDate	Surveillance Date	Age (yrs)	UAOD _Ave (inch)	UAIH Ave (inch)	Heat Load (Watts)	ASGap _Ave (inch)
D	4142	8/17/04	12/1/14	10.3	17.685	5.037	9.6	0.884
D	6787	10/7/08	1/7/15	6.25	17.648	5.028	4.2	0.779
D	6037	9/9/08	1/21/15	6.33	17.624	6.555	1.7	0.771
D	3383	11/24/08	2/11/15	6.25	17.625	4.973	4.8	0.936
D	6861	12/3/08	4/13/15	6.33	17.682	5.004	4.3	0.892
D	6677	9/22/08	5/4/15	6.67	17.665	5.016	4.3	0.792
D	6133	1/5/09	6/1/15	6.42	17.677	5.043	3.9	0.538
D	6826	12/2/08	6/16/15	6.5	17.669	4.966	4.2	0.752
S	2713	10/10/07	8/15/15	7.83	17.597	4.945	16.8	1.484
S	4397	12/20/07	8/15/15	7.67	17.662	4.947	16.1	0.984
S	2101	4/5/03	8/15/15	12.3	17.621	4.964	14.5	1.659
S	5020	11/1/07	8/15/15	7.75	17.642	4.968	13.6	0.732
S	5088	10/29/07	8/15/15	7.83	17.673	4.986	13.8	0.805
S	2403		8/16/15	12.7	17.600	4.880	14.4	1.739
S	2675		1/14/16	8.25	17.665	4.952	11.1	0.9025
S	1173		2/22/16	13	17.620	4.969	12.9	1.021
S	1478		2/23/16	13.1	17.660	4.949	11.3	1.083
S	693		2/24/16	13.5	17.662	5.049	11	0.977

*N = Surveillance based on 3013 NDE Samples
D = Surveillance based on 3013 DE Samples
S = Focused surveillance for assessing fiberboard aging over time