72-1030

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August 16, 2004 E-21463

Ms. Mary Jane Ross-Lee
Spent Fuel Project Office, NMSS
U. S. Nuclear Regulatory Commission
11555 Rockville Pike M/S 0-6-F-18
Rockville, MD 20852

Subject: Transmittal of Reference 6, NUHOMS® HD System SAR Section 9.6
Docket 72-1030

Dear Ms. Ross-Lee:

You have brought it to my attention that the subject reference, *Review and Evaluation of B-10 Areal Density Measurements of BORAL Coupons*, Report NET 230-01, is not available to your staff.

Transnuclear hereby transmits a copy of this non-proprietary reference.

Sincerely,

Michael Mason
Chief Engineer

Enclosures: as noted

NMSS01

Report No. : NET 230-01

Review and Evaluation of B_{10} Areal Density Measurements of BORAL Coupons

February 2004

Prepared
for
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under
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Review and Evaluation of ^{10}B Areal Density Measurements of BORAL Coupons

1.0 Introduction

BORAL is the trade name for a neutron absorber manufactured by AAR Corporation of Livonia, Michigan. BORAL is a laminated panel with solid aluminum cladding and a core of blended boron carbide (B_4C) and aluminum powders, compressed by hot rolling. Boral is manufactured according to established processes and procedures.

The purpose of this test program is to provide applicants for dry fuel storage systems supporting data to request NRC approval for credit for 90% of the ^{10}B contained in BORAL used in the system. NRC Standard Review Plans limit the credit for ^{10}B contained in fixed neutron absorbers for dry fuel storage systems to 75%, unless comprehensive tests are performed to verify that the fabrication process for the neutron absorber assures the presence and uniformity of the neutron poison (^{10}B) in the absorber material.

A method has been proposed (Reference 1) for the computation of percent credit for boron-based neutron absorbers. This method specifies that "material for which data is presented to show the measured attenuation for thermal neutrons to be at or above the acceptance attenuation (A_a), is given the full credit of 90 percent." This test program was developed to meet the test requirement for 90% credit. The neutron attenuation tests, combined with the established BORAL manufacturing procedures, provide verification of the presence and uniformity of the ^{10}B in BORAL panels.

The coupons tested used in this program were provided by AAR. AAR selected the coupons from a commercial production run of 3236 BORAL panels. Production required 114 powder batches; each powder batch yields 30 panels. One panel was randomly selected from each group of 30 panels made from each unique powder batch. Two coupons were cut from random locations from each of the 114 BORAL panels selected for the test, for a total of 228 BORAL test coupons.

The coupons were rectangular and approximately 5.5 inches wide by 11.0 inches long. The minimum certified areal density for these coupons is 0.020 gms B-10/cm^2. The areal densities were measured at 4 locations on each coupon providing a total of 912 measurements. The measurements were made via neutron attenuation testing using known calibration standards to determine the areal densities.

This report documents a statistical analysis of the 912 areal density measurements which demonstrates compliance with requirements for 90% boron credit in dry storage casks. The analysis described subsequently serves to demonstrate that this criteria is satisfied for the 912 areal density measurements on BORAL coupons.

2.0 Methodology

The proposed method specifies that it "is to be used to compute the level of credit to be allowed for 1/v neutron absorber materials, such as boron or lithium. The computation of the allowed level of credit uses the results of neutron attenuation measurements performed on samples of the absorber material placed in a beam of thermal neutrons."

The standard specifies the following variables among its definitions:

A = neutron attenuation, a measured value taken on a given absorber material in a beam of thermal neutrons with fixed energy spectrum. A is assumed to be normally distributed with mean μ and standard deviation σ.

A_a = acceptance value of neutron attenuation, based on a qualified homogeneous absorber standard such as ZrB_2, evaluated at 111% (i.e.1/0.90) of the poison density assumed in the criticality computational model.

A_{tl} = attenuation tolerance limit, a statistic of the data

n = number of coupon measures of attenuation A

P = probability

μ = true mean of A

$\bar{x}$ = estimate of μ

σ = true standard deviation of A

S = estimate of σ

C_p = exact number of standard deviations required at probability P

K_p = tolerance coefficient that is substituted for C_p when μ and σ are estimated by $\bar{x}$ and S, respectively

γ = confidence level

The method specifies that, "data taken under the above rules are used to bound the probability P that the value of neutron attenuation A at an arbitrary location on the material is greater than the acceptance attenuation A_a. This is done by computing an attenuation tolerance limit, A_{tl}, such that, with 95 percent confidence, the probability is less than 0.001 that $A < A_{tl}$."

In the current analysis, the areal density has been computed instead of the neutron attenuation. The areal density is directly proportional to the neutron attenuation. The analysis described subsequently demonstrates that with 95 percent confidence the probability is less than 0.001 that the measured areal density will be less than 111% of the minimum certified areal density.

Implicit in the proposed method is the assumption that the data is normally distributed. To satisfy that this requirement has been met, two tests for normality, Kolmogorov-Smirnov and Anderson-Darling, have been applied to the test data. In addition, the cumulative probability versus areal density has been examined as a further test of normality.

3.0 Test Data

3.1 Test Method

Tests have been performed by NETCO in the Beam Hole Laboratory of the Breazeale Reactor Facility at Penn State University. In these tests a collimated thermal beam of neutrons from the reactor is passed through the Boral coupons placed perpendicular to the incident beam. The intensity of the incident and attenuated beams are measured with BF_3 detectors. These attenuation values were then converted to areal density measurements using a curve fit based on attenuation measurements on coupons of known areal density.

Four locations on each coupon were tested in this manner and the resulting data has been compiled into a single data file that was utilized for this analysis.

3.2 Raw Data

The coupon test results are contained in Appendix A. A subset of the data containing only the areal density measurements is constructed for use in the subsequent statistical analyses. The data is structured in four columns with each column representing a different measurement location on each coupon. All of the data points are plotted here to illustrate the distribution of measured areal density values.

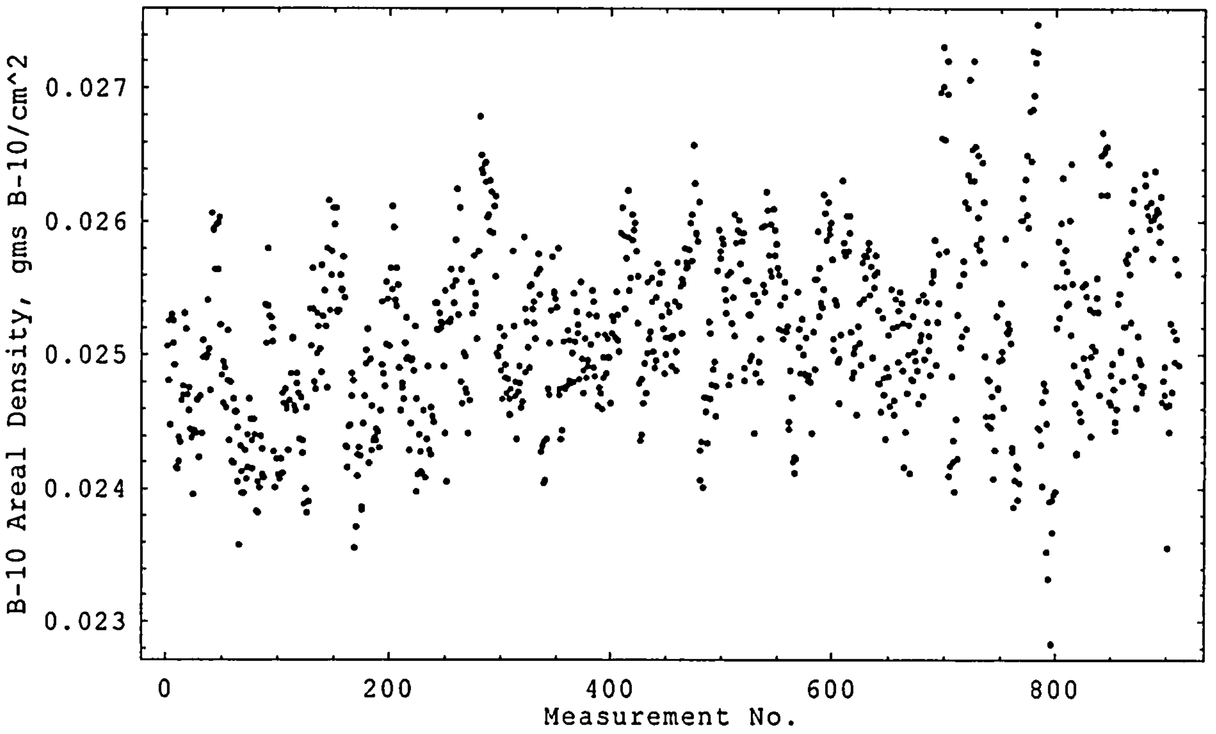


Figure 3-1: Measured Areal Density versus Measurement Number

3.3 One-Sided Tolerance Factor Calculation

The proposed method specifies that a one-sided tolerance factor be calculated to determine, with 95% confidence, the value above which 99.9% of the areal density measurements lie. The tolerance factor itself varies with the degree of confidence, fraction of data in question, and number of samples being tested. Factors have been calculated in tables for several different parameters, however, none of the available tables contain the parameters specified for this test. As such, an approximate formula for the tolerance factor is utilized to provide the necessary value given the parameters of this analysis.

The approximate calculation of a one-sided tolerance factor κ, comes from the following formulas (Reference 2):

$$K = \frac{Z_{1-P} + \sqrt{Z_{1-P}^2 - ab}}{a}$$ **Equation 1**

$$a = 1 - \frac{Z_{1-P}^2}{2(N-1)}; b = Z_{1-P}^2 - \frac{Z_{1-\gamma}^2}{N}$$ **Equation 2**

where:

Z_{1-P} = Standard Normal Score at 1 - P level of significance

N = Number of Samples (912)

These equations are an approximation, however and deviate conservatively from the tabular values in Reference 2 for smaller samples sizes. The difference between the two methods quickly approaches zero after as few as 40 samples. Given that we are working with a sample size of 912, the approximation formula will produce an adequately precise value.

The one-Sided Tolerance factor for P=0.999, α=0.05 & n=912 is calculated to be 3.22572

4.0 Analysis of Areal Density Measurements

4.1 Distributed Properties of the Areal Density Measurements

In order to apply the one sided tolerance factors described in Section 4.1, it must be demonstrated that the areal density data are normally distributed. Figure 4-1 shows the areal density measurements distribution. Table 4-1 contains a summary of the properties of the distributed data. The tests show what appears to be a normally distributed data set with a mean coupon areal density of 0.025 gms B-10/cm^2. There is a slight skewing of the data towards higher areal density values and the kurtosis shows that there is more concentration of data near the mean than in a completely normal distribution. However, these values represent a small deviation from a normal distribution and are conservative with respect to a minimum areal density evaluation.

Figure 4-1: Areal Density Measurements: Distributed Data

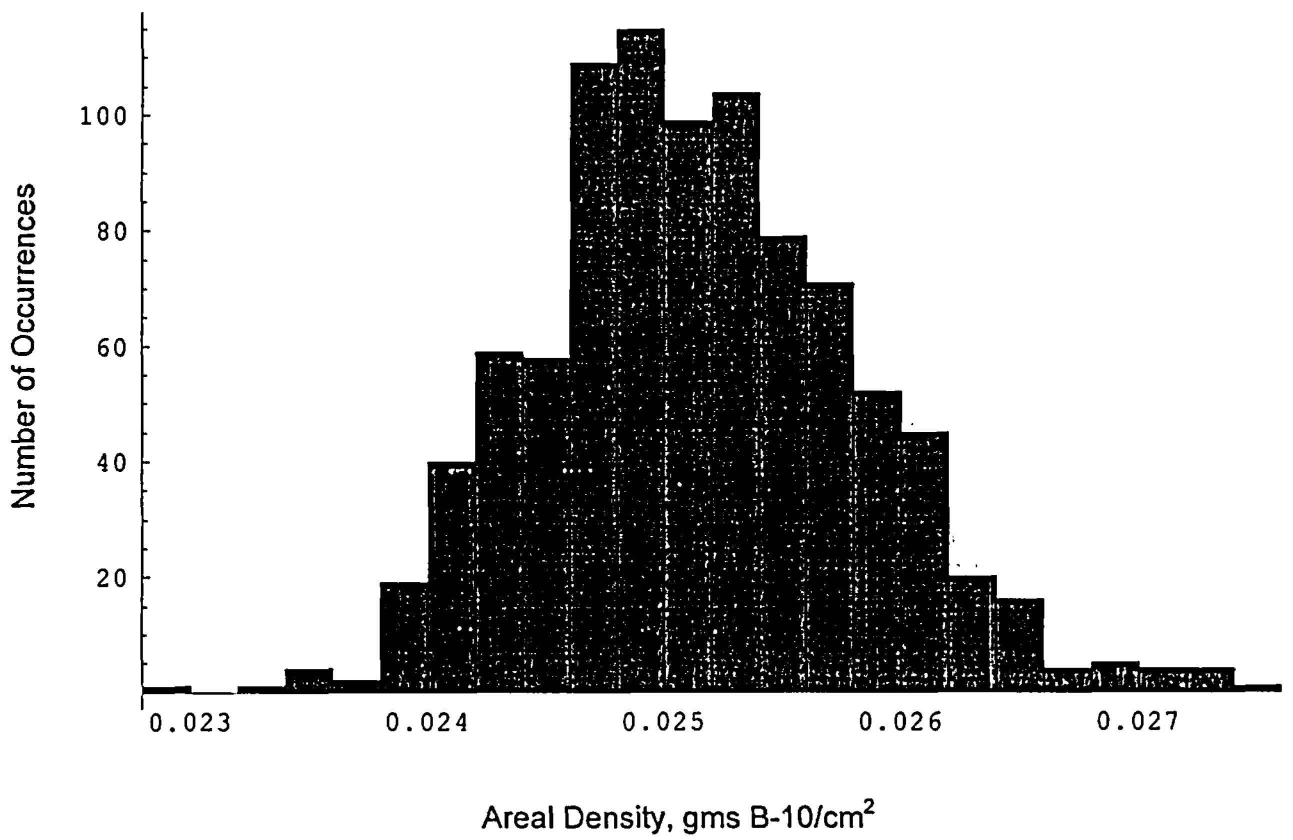


Table 4-1

Properties of the Distributed Data

Location Statistics		Dispersion Statistics		Shape Statistics	
Mean	0.0251432	Variance	4.587×10^{-7}	Skewness	0.309405
Harmonic Mean	0.0251251	Standard Deviation	0.000677	Quartile Skewness	0.056328
Median	0.0251133	Mean Deviation	0.0005399	Kurtosis Excess	0.177064
		Median Deviation	0.000447		

4.2 Test for Normality

The first step in testing for normality is to construct a cumulative probability plot from the data set. This is accomplished by arranging the data set in order of ascending areal density and computing the cumulative frequency for each data point as:

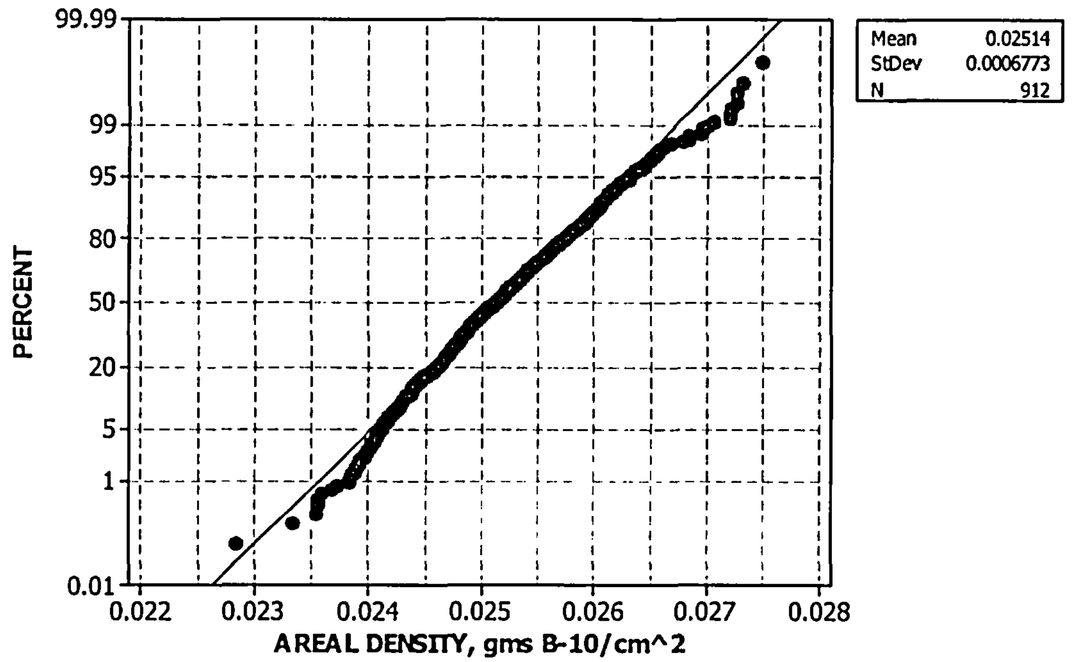
$$\frac{(j-0.05)}{10}$$ **Equation 3**

For j = 1...912

Figure 4-2 is plot of the cumulative probability versus areal density. It is noted that the data appears to be clustered toward the center of the distribution. This is expected based on the Kurtosis excess shown in Table 4-1. It is also noted that with the exception of a few data points at the upper and lower tails of the distribution, the cumulative probability is well approximated by a straight line. This confirms that a normal distribution is an appropriate model.

The Anderson-Darling and Kolmogorov/Smirnoff test statistics are calculated subsequently as further tests of normality.

Figure 4-2: Cumulative Probability versus Areal Density



4.2.1 Kolmogorov-Smirnov Test for Normality

In applying the Kolmogorov/Smirnoff test for normality, a test statistic D is calculated for the data distribution. D is the difference between the ordered areal density values and their predicted cumulative probability under the assumption of a normal distribution. The calculated value for the BORAL areal density data is 0.0329.

Under the Kolmogorov/Smirnoff test, D must be less than a certain critical value. The large sample critical value at a 95% confidence is 0.24. Accordingly, we cannot reject the hypothesis that the density are normal distributed.

4.2.2 Anderson-Darling Test for Normality

The Anderson-Darling test is based on the test statistic, A^2, which examines the differences between the tails of the normal distribution and the tails of the test data. The null hypothesis (that the data is normally distributed) is rejected for measures of the test statistic that exceeds a certain critical value.

The test statistic can be calculated numerically from:

$$A^2 = -\left[\sum_{i=1}^{n}(2i-1)(\ln(u_i)+\ln(1-u_{n+1-i}))\right]/n - n$$ **Equation 4**

where u_i is the value of the theoretical cumulative distribution at the i^{th} largest observation. The test statistic calculated for the Boral areal density values is 1.3018.

The large sample critical value for the Anderson-Darling test is 2.492 at 95% confidence and 3.857 at 99% confidence. Thus we cannot reject the null hypothesis that the data are normally distributed. It is noted that there is some significant deviation in the tails of the data, a situation to which the Anderson-Darling test is very sensitive. This is reflected in the relatively high test statistic value (1.3018) for the test data.

4.3 One-Sided Tolerance Limit and Assessment of 90% Boron Credit

The following equation provides the one sided tolerance limit to the observed coupon areal density:

$$A_{tl} = \bar{x} - K_{912}S$$ **Equation 5**

where the variable definitions are identical to those outlined previously. Given that the data passes the test for normality, the calculation for the above one-sided tolerance limit is applicable.

Thus the lower tolerance areal density limit is 0.0229 gms B-10/cm^2. The minimum certified areal density is 0.020 gms B-10/cm^2 for the Boral samples tested. The areal density at 111% of the minimum certified value of 0.020 is 0.0222 gms B-10/cm^2. Thus 0.0229 gms B-10/cm^2 > 0.0222 gms B-10/cm^2 and $A_{tl} \geq A_a$ and 90% boron credit is demonstrated.

5.0 Summary and Conclusions

Areal density measurement obtained via neutron attenuation testing at 4 locations each on 228 Boral coupons have been evaluated. The data have been demonstrated to be normally distributed. Accordingly, a one sided tolerance factor for normally distributed data can be applied. This has been computed following the method of Natrella and is 3.226 at 99.9% probability and 95% confidence level.

The proposed method of Reference 1 has been applied to the data set. The minimum certified areal density for this Boral is 0.020 gms B-10/cm^2. The mean of the measured data is 0.02514 gms B-10/cm^2. At a 99.9% probability and a 95% confidence level the one sided lower tolerance limit is 0.0229 gms B-10/cm^2 which exceeds 111% of the minimum certified areal density. Accordingly 90% credit for boron-10 is demonstrated.

6.0 References

1) Standard Guide for Thermal Neutron Absorber (Poisons) for Criticality Control in Dry Cask Storage Systems (DCSS) or Transportation Packages Containing Fissile Materials, Proposed by ASTM Subcommittee c26.03, 5/8/2003.

2) Natrella, M.G., Experimental Statistics, National Bureau of Standards Handbook 91, 8/1/63.

Appendix A

BORAL Coupon B-10 Areal Density Test Data

(For each coupon B-10 areal density $\left(\frac{gm}{cm^2}\right)$ is provided for locations A, B, C and D)

Appendix A

Test Data

Coupon ID	A	B	C	D
WN310009-1-1	0.025062784	0.024806101	0.025250876	0.024480108
WN310009-1-2	0.025295658	0.025086125	0.025252807	0.024921785
WN310010-1-1	0.024152418	0.024151064	0.024378336	0.024202582
WN310010-1-2	0.024352811	0.024659791	0.024761737	0.024701446
WN310025-1-1	0.025310048	0.02518946	0.024700361	0.024747781
WN310025-1-2	0.024580798	0.024444167	0.024380079	0.02440745
WN310039-1-1	0.023953087	0.024438754	0.024408661	0.02465363
WN310039-1-2	0.024672659	0.024228369	0.024687562	0.024413707
WN310048-1-1	0.025107024	0.024973144	0.0249895	0.02497466
WN310048-1-2	0.025397755	0.025000009	0.025044618	0.024732663
WN310057-3-1	0.026060044	0.025943994	0.02593695	0.025635984
WN310057-3-2	0.02597623	0.025634738	0.025991252	0.026032276
WN310061-1-1	0.025224999	0.024849114	0.024948213	0.024638632
WN310061-1-2	0.024898957	0.024600053	0.025178941	0.02480407
WN310075-3-1	0.024364684	0.024797911	0.024201101	0.024193524
WN310075-3-2	0.024664107	0.024569897	0.024569525	0.024457774
WN310089-2-1	0.024046765	0.023573319	0.024314851	0.023963183
WN310089-2-2	0.02412745	0.02396863	0.024289791	0.024072452
WN310092-1-1	0.024400776	0.024162693	0.02467133	0.024521085
WN310092-1-2	0.02436154	0.024143137	0.024520822	0.024401198
WN310104-1-1	0.023831937	0.024049098	0.023821381	0.02400616
WN310104-1-2	0.024390186	0.024299037	0.024099889	0.024080493
WN310110-1-1	0.025373166	0.025079003	0.025794203	0.025359912
WN310110-1-2	0.025280417	0.025269293	0.025199859	0.025094384
WN310121-1-1	0.024272875	0.024006694	0.024225933	0.024220253
WN310121-1-2	0.024102052	0.024075745	0.02421622	0.024114638
WN310139-2-1	0.024712177	0.024640813	0.024742599	0.024591163
WN310139-2-2	0.02461095	0.024280069	0.024661688	0.024862879
WN310146-2-1	0.025119246	0.025126485	0.024612966	0.024587419
WN310146-2-2	0.02486097	0.024785377	0.02470586	0.024366957
WN310159-1-1	0.024683577	0.024266206	0.024359331	0.023880987
WN310159-1-2	0.023998171	0.023817214	0.024607315	0.023905208

WN310160-3-1	0.025342119	0.025062351	0.025643139	0.025336303
WN310160-3-2	0.024797053	0.02473757	0.025010589	0.025302956
WN310178-3-1	0.025207332	0.025038543	0.025669036	0.024866697
WN310178-3-2	0.025284033	0.025471761	0.025206727	0.024754864
WN310189-3-1	0.025791584	0.02616027	0.025330142	0.025774087
WN310189-3-2	0.025591125	0.026108237	0.025977552	0.026101363
WN310191-1-1	0.025329923	0.025311747	0.025331261	0.025591665
WN310191-1-2	0.025491384	0.025480582	0.02572866	0.025418951
WN310203-3-1	0.024319779	0.024152398	0.024305606	0.024461341
WN310203-3-2	0.024471521	0.024689251	0.024861995	0.024804559
WN310219-3-1	0.023548182	0.023711944	0.024098474	0.024253562
WN310219-3-2	0.024307312	0.024244783	0.02386301	0.023837085
WN310229-3-1	0.024489568	0.024689865	0.025025203	0.024938471
WN310229-3-2	0.025186076	0.024188899	0.024962587	0.024289017
WN310231-3-1	0.024612605	0.024355676	0.024385391	0.024363196
WN310231-3-2	0.024447336	0.024428654	0.02430794	0.0245779
WN310248-2-1	0.025387475	0.024924922	0.024860293	0.024765164
WN310248-2-2	0.025536062	0.025070611	0.025410071	0.025061323
WN310253-3-1	0.025646942	0.025484394	0.026117152	0.025959746
WN310253-3-2	0.025397081	0.025362524	0.025650442	0.025515734
WN310269-1-1	0.024897995	0.024583602	0.02478124	0.024753167
WN310269-1-2	0.024664961	0.025079898	0.025277477	0.024967961
WN310270-2-1	0.024975498	0.024282817	0.024952272	0.024487692
WN310270-2-2	0.024964347	0.024884132	0.025208686	0.024663578
WN310284-3-1	0.023974464	0.024105729	0.024405032	0.024127656
WN310284-3-2	0.024273225	0.024117766	0.024584294	0.02408033
WN310295-3-1	0.024372285	0.02436898	0.024914282	0.024282916
WN310295-3-2	0.024605536	0.024256535	0.024545289	0.024495201
WN310309-3-1	0.025377409	0.025378078	0.025188766	0.025179848
WN310309-3-2	0.025307682	0.025199705	0.02524281	0.025231378
WN310312-3-1	0.024912399	0.024416244	0.025476981	0.024053059
WN310312-3-2	0.025239974	0.025239084	0.025265478	0.025639317
WN310327-1-1	0.025504648	0.025385105	0.025855037	0.02555185
WN310327-1-2	0.026239722	0.025292016	0.026102825	0.025639398
WN310331-1-1	0.024798475	0.024638805	0.025009472	0.024991368
WN310331-1-2	0.024741325	0.02471565	0.024410207	0.024655964
WN310343-1-1	0.025540763	0.025536554	0.025310426	0.025738992

WN310343-1-2	0.025364315	0.025453822	0.025116241	0.025771357
WN310359-2-1	0.026783062	0.026392283	0.026498241	0.026358498
WN310359-2-2	0.026428689	0.026293496	0.026444899	0.026025109
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WN310367-2-2	0.025909552	0.02610902	0.025577502	0.02618893
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WN310388-3-2	0.024546168	0.024745426	0.025770323	0.025209445
WN310390-3-1	0.02479099	0.02469223	0.024367891	0.024716781
WN310390-3-2	0.024784283	0.024908228	0.024600173	0.024642192
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WN310401-2-2	0.025052215	0.02550945	0.024901818	0.025521616
WN310418-3-1	0.025339326	0.025232267	0.025390233	0.025117152
WN310418-3-2	0.02560807	0.025748131	0.025442231	0.025637384
WN310428-3-1	0.024271066	0.024319813	0.02435357	0.024035317
WN310428-3-2	0.024063883	0.024367709	0.024739131	0.024698693
WN310433-3-1	0.025082176	0.025327353	0.025729351	0.025461976
WN310433-3-2	0.025456227	0.025409627	0.025349646	0.025793764
WN310443-1-1	0.024743934	0.024702981	0.024372821	0.024436573
WN310443-1-2	0.024754107	0.025098629	0.02473717	0.024766014
WN310452-3-1	0.02518011	0.024802825	0.025108593	0.024785904
WN310452-3-2	0.025004612	0.024793911	0.025460044	0.025097562
WN310464-3-1	0.025312942	0.025217135	0.02516141	0.024815393
WN310464-3-2	0.025541755	0.024962146	0.024711228	0.02487988
WN310471-1-1	0.025109669	0.02482858	0.02495189	0.024909421
WN310471-1-2	0.025300498	0.025069008	0.025478954	0.025385999
WN310486-3-1	0.024901833	0.024838183	0.025281738	0.024611482
WN310486-3-2	0.025148373	0.024755141	0.024710614	0.024588301
WN310493-3-1	0.024829724	0.024976731	0.025151142	0.024861691
WN310493-3-2	0.024975819	0.025118687	0.024972047	0.02463536
WN310501-1-1	0.025157272	0.025279835	0.025253202	0.025126509
WN310501-1-2	0.025462926	0.025298829	0.025104468	0.025019828
WN310510-2-1	0.025908263	0.026099029	0.026107352	0.025887887
WN310510-2-2	0.025336303	0.02572533	0.026233009	0.025884894
WN310527-1-1	0.025481268	0.025568707	0.026055574	0.025854099
WN310527-1-2	0.025931636	0.025983497	0.025776582	0.025578602

WN310532-2-1	0.025230941	0.02478146	0.02436056	0.024817718
WN310532-2-2	0.024401762	0.024631024	0.024934355	0.024711376
WN310545-2-1	0.0255409	0.025012667	0.025112927	0.025171974
WN310545-2-2	0.025388614	0.025577035	0.025018442	0.024898188
WN310550-2-1	0.02542234	0.024949884	0.025673425	0.025528334
WN310550-2-2	0.025609758	0.02561872	0.02528044	0.025184991
WN310564-1-1	0.024860678	0.025124858	0.0249959	0.025364587
WN310564-1-2	0.025321788	0.025116591	0.025140268	0.024912686
WN310570-3-1	0.025132215	0.025390106	0.024876752	0.02502303
WN310570-3-2	0.025690245	0.025363542	0.025505345	0.02515642
WN310588-2-1	0.025560333	0.025525504	0.025797359	0.025692725
WN310588-2-2	0.025650119	0.025653986	0.025779399	0.025985878
WN310597-2-1	0.026055311	0.025695887	0.026571999	0.026289661
WN310597-2-2	0.025902261	0.025907078	0.025846972	0.026147002
WN310606-2-1	0.024062615	0.024282215	0.024343733	0.024010414
WN310606-2-2	0.024683882	0.024569179	0.024676478	0.024333554
WN310614-1-1	0.025242764	0.025152711	0.024665262	0.024779327
WN310614-1-2	0.024891686	0.024948751	0.024760994	0.024545099
WN310622-1-1	0.02562412	0.025937174	0.025725776	0.025771429
WN310622-1-2	0.025867963	0.025825565	0.025490722	0.025401633
WN310636-2-1	0.025303872	0.025593779	0.024771754	0.024836724
WN310636-2-2	0.025618324	0.025231276	0.025427714	0.02514052
WN310641-1-1	0.026045256	0.025834679	0.025928522	0.026006486
WN310641-1-2	0.02591236	0.025681345	0.025849059	0.025909118
WN310659-3-1	0.024810211	0.024904006	0.025549148	0.025552879
WN310659-3-2	0.025290864	0.024956939	0.025295604	0.024990644
WN310661-3-1	0.02544206	0.024415477	0.025443774	0.024864616
WN310661-3-2	0.025389151	0.024943107	0.025113668	0.024795219
WN310673-1-1	0.02595298	0.025514257	0.025964729	0.025461431
WN310673-1-2	0.026222721	0.026083706	0.025741865	0.025626861
WN310681-3-1	0.025977647	0.025577403	0.026092906	0.025741408
WN310681-3-2	0.025933166	0.02582296	0.025644319	0.025185094
WN310693-3-1	0.025591089	0.02537274	0.025175017	0.02511485
WN310693-3-2	0.02542702	0.025543833	0.025167034	0.025210573
WN310701-1-1	0.024501274	0.024448863	0.024885668	0.02468246
WN310701-1-2	0.024198248	0.024231005	0.024119184	0.024216958
WN310710-1-1	0.025467378	0.025051779	0.025193495	0.024864528

WN310710-1-2	0.025260051	0.024998043	0.024850422	0.024861822
WN310728-3-1	0.025127696	0.024810021	0.024846345	0.024802291
WN310728-3-2	0.024799985	0.024407892	0.025170221	0.02489289
WN310733-3-1	0.025559264	0.025559608	0.025921588	0.025649635
WN310733-3-2	0.025288257	0.025378526	0.025346304	0.025489753
WN310745-1-1	0.026202934	0.026056797	0.02586212	0.026145506
WN310745-1-2	0.025902687	0.025943795	0.025983518	0.025710089
WN310759-1-1	0.025112095	0.025030996	0.025404133	0.025366216
WN310759-1-2	0.0249411	0.024964823	0.024631391	0.025148673
WN310763-1-1	0.026301315	0.025773783	0.025842904	0.025742988
WN310763-1-2	0.026041929	0.025777342	0.026038304	0.025915963
WN310776-1-1	0.025165627	0.024825168	0.02500519	0.024872873
WN310776-1-2	0.025053279	0.024550734	0.025212468	0.025086737
WN310786-3-1	0.025378184	0.024921798	0.025683668	0.025412133
WN310786-3-2	0.025737209	0.025573234	0.025733904	0.025787788
WN310791-3-1	0.02584014	0.025442477	0.025660619	0.024975916
WN310791-3-2	0.025592207	0.025497983	0.025744519	0.025609594
WN310807-3-1	0.025322167	0.024785026	0.024785919	0.024568568
WN310807-3-2	0.025278884	0.024695299	0.024828751	0.024367554
WN310813-3-1	0.02490395	0.024836401	0.02514519	0.024618467
WN310813-3-2	0.025491691	0.025197242	0.024552158	0.024657685
WN310825-2-1	0.02541107	0.025205095	0.025328842	0.0249446
WN310825-2-2	0.025466841	0.025385065	0.025232287	0.024883781
WN310836-3-1	0.024162393	0.02442615	0.024711995	0.024999296
WN310836-3-2	0.025221841	0.024116583	0.024815298	0.024801459
WN310846-3-1	0.025279596	0.025021011	0.024959364	0.024881907
WN310846-3-2	0.025405526	0.024636274	0.025104153	0.025145653
WN310851-1-1	0.025443351	0.024686542	0.024967928	0.02539637
WN310851-1-2	0.025241852	0.025135294	0.025028236	0.024853993
WN310866-3-1	0.025539447	0.025625909	0.025589767	0.025862206
WN310866-3-2	0.02492544	0.025240426	0.025382668	0.025750327
WN310871-3-1	0.026961002	0.026626005	0.027308424	0.027002474
WN310871-3-2	0.026609806	0.02577504	0.026958406	0.02720173
WN310885-3-1	0.024095254	0.024168342	0.024839255	0.024363037
WN310885-3-2	0.02420533	0.023981384	0.024518909	0.024221127
WN310897-3-1	0.025290828	0.02552143	0.025045637	0.025141162
WN310897-3-2	0.025697439	0.025605473	0.026143261	0.025188571

WN310907-3-1	0.026344906	0.026100927	0.027060588	0.026301247
WN310907-3-2	0.02653737	0.026309943	0.027197811	0.026561292
WN310912-3-1	0.025829769	0.026024011	0.026502411	0.025788299
WN310912-3-2	0.025870462	0.026447015	0.026145357	0.025692452
WN310928-3-1	0.024981785	0.024540925	0.02481346	0.024472949
WN310928-3-2	0.024807789	0.02445237	0.024691669	0.024543779
WN310931-3-1	0.024069098	0.024284694	0.025289389	0.024737283
WN310931-3-2	0.024748683	0.024955737	0.025378319	0.024968369
WN310946-3-1	0.025020172	0.024603974	0.025869272	0.025167781
WN310946-3-2	0.025156528	0.025233171	0.025188455	0.025083087
WN310952-1-1	0.024304976	0.024271267	0.023861064	0.024061947
WN310952-1-2	0.02417239	0.023912524	0.024154305	0.024041451
WN310966-3-1	0.026009042	0.026009858	0.026173751	0.025679621
WN310966-3-2	0.026311714	0.026050909	0.026495584	0.025950786
WN310971-2-1	0.026828762	0.026454073	0.0272698	0.026834928
WN310971-2-2	0.026942264	0.027188124	0.027260417	0.027476265
WN310986-2-1	0.02446054	0.024442969	0.02432269	0.024020344
WN310986-2-2	0.024649469	0.024779945	0.024734018	0.024488035
WN310997-3-1	0.023521666	0.023314106	0.023897216	0.022831721
WN310997-3-2	0.023666809	0.023909867	0.023957032	0.023974017
WN311002-3-1	0.025506813	0.025195715	0.025845998	0.025278931
WN311002-3-2	0.025990362	0.025691342	0.026321948	0.025512048
WN311016-3-1	0.025784427	0.025366324	0.025628456	0.02538139
WN311016-3-2	0.026009691	0.025147917	0.026432893	0.02552978
WN311027-1-1	0.024918312	0.024638023	0.024260028	0.024254805
WN311027-1-2	0.024792061	0.024573407	0.02476535	0.02450682
WN311034-2-1	0.02550881	0.024981448	0.025525401	0.024877124
WN311034-2-2	0.025429175	0.024848053	0.025333782	0.024388988
WN311047-1-1	0.02498632	0.025059344	0.025316043	0.025031688
WN311047-1-2	0.025573643	0.025424281	0.025317077	0.024701745
WN311053-1-1	0.026495456	0.026194857	0.026672636	0.026519733
WN311053-1-2	0.026551271	0.026199289	0.026565494	0.026434853
WN311065-1-1	0.024642446	0.024621218	0.024849719	0.024933374
WN311065-1-2	0.024746579	0.024435316	0.024497935	0.024591602
WN311077-2-1	0.025384107	0.025458075	0.025031535	0.025015043
WN311077-2-2	0.024801187	0.02520689	0.025708875	0.025212974
WN311081-1-1	0.025690483	0.025756339	0.025601634	0.025241545

WN311081-1-2	0.025938463	0.026148243	0.026236717	0.025799113
WN311099-2-1	0.024842107	0.024606005	0.025133383	0.024965113
WN311099-2-2	0.02477038	0.024938619	0.024725744	0.024760487
WN311109-2-1	0.026271628	0.026359608	0.026117825	0.026050723
WN311109-2-2	0.025940697	0.026141315	0.02600297	0.025718767
WN311111-2-1	0.026021941	0.02605259	0.026378062	0.026090108
WN311111-2-2	0.026068011	0.025967582	0.025846989	0.026184472
WN311120-1-1	0.024642737	0.024805468	0.024916453	0.024702933
WN311120-1-2	0.024617647	0.023551083	0.024418997	0.024628727
WN311139-3-1	0.025230235	0.024722828	0.025182761	0.024944969
WN311139-3-2	0.02571714	0.025109932	0.025598794	0.02492805

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