72-1015
72-1025

AAR CARGO SYSTEMS
a division of AAR Manufacturing Group, Inc.

February 26, 2004

Mr. Stewart Brown
U.S. Nuclear Regulatory Commission
Mail Stop: 013D13
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Subject: Additional Boral documents

Dear Mr. Brown:

Enclosed are three more documents requested during our recent conference call:

AAR Report # 1649 – BORAL POWDER MIXER QUALIFICATION

AAR-11002QAP – CHEMICAL TESTING OF BORAL TO VERIFY GMS LOADING OF EITHER B4C, B10 OR BORON

AAR-11004QAP – NEUTRON ATTENUATION MEASUREMENT

I have also asked cask/canister suppliers who have performed their own independent tests to qualify Boral for their product specific service conditions to provide a copy of their test reports to you.

Sincerely,

James S. Hobbs
Director Nuclear Programs

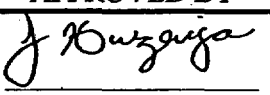
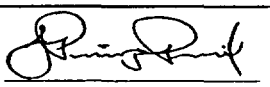
Jh022604

NMSS01

AAR CARGO SYSTEMS  12633 Inkster Rd. Livonia, MI 48150 USA	**NUCLEAR QUALITY ASSURANCE PROGRAM**	QUALITY ASSURANCE PROCEDURE

TITLE

NEUTRON ATTENUATION MEASUREMENT

REV.	REVISED BY	APPROVED BY	ISSUE DATE	REMARKS
13	Joe Koncsol		3/10/99	Revised-Clerical changes
14	Jeff Moore		10/2/03	Revised procedure for a change in Neutron attenuation testing facilities from U of M to Penn State.

Document No.

AAR-11004QAP

NEUTRON ATTENUATION MEASUREMENT

1.0 PURPOSE AND SCOPE

This procedure covers neutron attenuation measurement of Boral coupons (samples), plate, and sheet being manufactured by AAR Cargo Systems.

2.0 INSTRUMENTATION

2.1 Neutron transmission measurements are performed with a collimated thermal neutron beam

2.2 A beamport channels neutrons from a heavy water tank adjacent to the reactor core. The heavy water slows the neutrons and then a graphite thermalizer provides a Maxwell-Boltzman energy distribution. The mean energy of the distribution is .025eV. A schematic is shown in figure 1.

2.3 Diffracted neutrons pass through the beam port and emerge as three beams arranged as shown in figure 2. Boral samples are tested when placed in-between the emerging top and bottom beams and their detectors. Boral samples are positioned to desired height and width in order to take counting rates through pre determined locations on the test sample.

2.6 Background measurements are obtained by placing a cadmium plate over the neutron beam.

3.0 SYSTEM PREPARATION

3.1 Establish and maintain steady reactor power.

3.2 For the determined counting time, measure the unattenuated neutron beam intensity, I_u. Verify that I_u is comparable to previous values. If I_u deviates significantly from previous values, notify the Reactor Manager.

NEUTRON ATTENUATION MEASUREMENT

4.0 TRANSMISSION MEASUREMENT PROCEDURE

(NOTE: Beam intensity and counting time are reference values only. These values factor out in the calculation of transmission and attenuation.)

4.1 Calibrate by using known standard neutron absorbing materials including cadmium plates to determine the count rate for the un-attenuated beams.

4.2 For the determined counting time, measure and record the unattenuated neutron beam intensity, I_u

4.4 Place the calibration standard sample in place, measure and record the transmitted (attenuated) beam intensity, I_a . The calibration standard measurement shall be repeated periodically.

4.5 Place each sample, in turn, in the sample location. The number and location of multiple readings taken on each sample to be determined by the customer or at the discretion of AAR, if customer has no preference.

4.6 Measure and record the transmitted (attenuated) beam intensity, I_a.

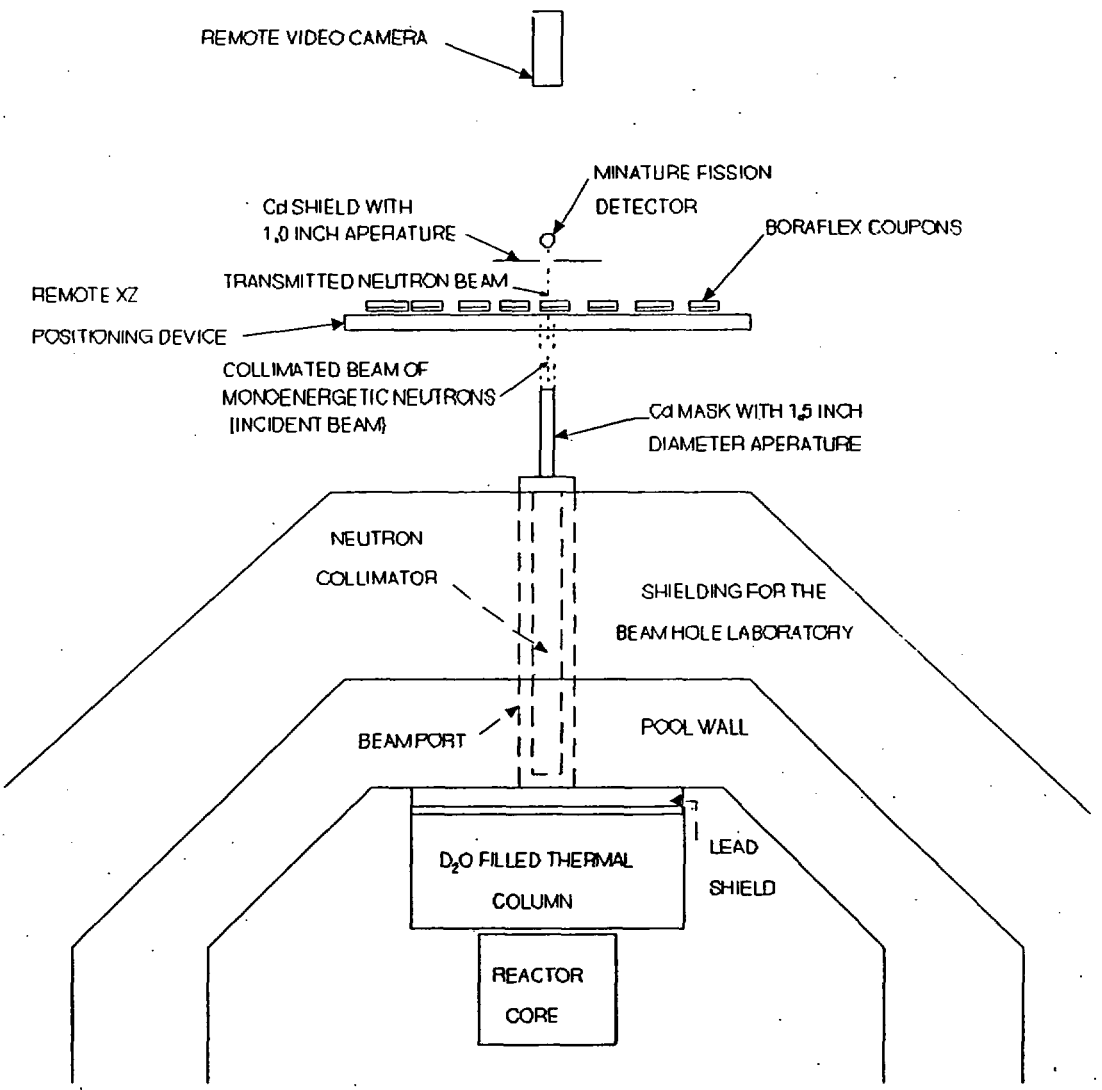
4.7 Calculate and record transmission, attenuation, standard deviation, and confidence interval.

4.8 Readings and calculations will be repeated for transmission variations greater than ten percent on a single sample sheet.

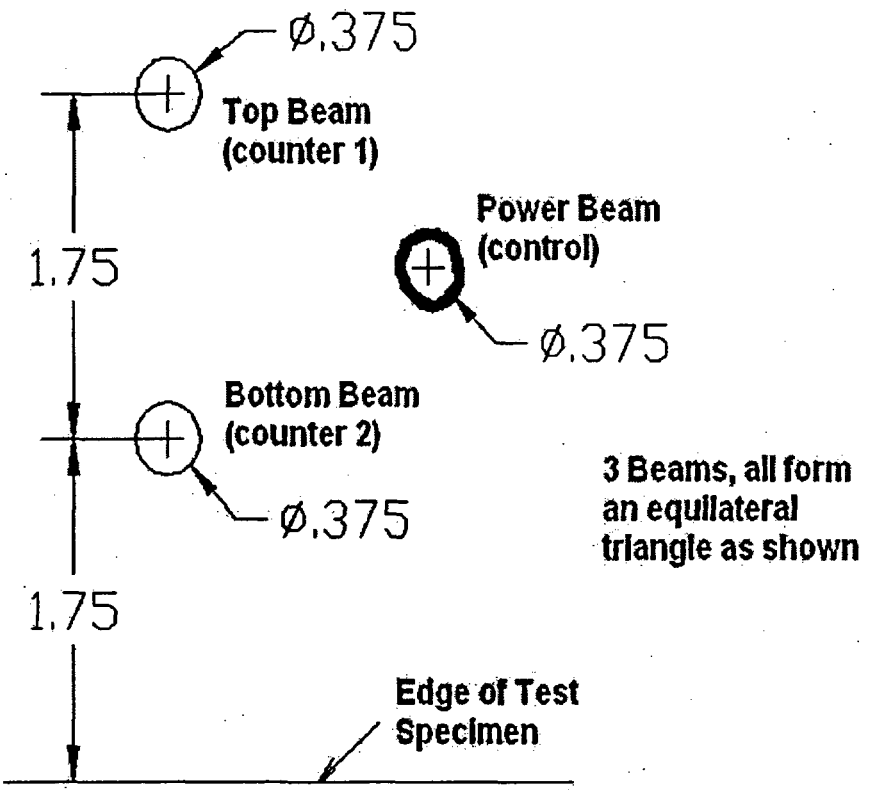
7.0 ATTACHMENTS

Figure 1 Penn State Reactor Beamport Diagram
Figure 2 Beamport Geometry

Penn State research reactor beam-port diagram



Penn State research reactor beam-port geometry



AAR CARGO SYSTEMS 12633 Inkster Rd. Livonia, MI 48150 USA	NUCLEAR QUALITY ASSURANCE PROGRAM	QUALITY ASSURANCE PROCEDURE

TITLE

CHEMICAL TESTING OF BORAL TO VERIFY GMS LOADING OF EITHER B_4C, B^{10} OR BORON

REV.	REVISED BY	APPROVED BY	ISSUE DATE	REMARKS
22	Phill Pusilo	Ross Schmitz	4/17/02	Revised procedure to add attachment of statistical analysis of sec 6.0 of 10012 QAP
23	Jeff Moore		11/7/02	Revised procedure to account for sample size decrease for 1 inch square to 1 cm square. With this change sec. 3.3.5 was changed from 400 ml acid/water mix to 200 ml acid /water mix. Also a provision was added to 3.2.2 for powder mix to call for the use of 3-4 grams of powder in order to justify using 200 ml acid/water mix in sec. 3.2.3
24	Phill Pusilo		10/2/03	Added Attachment-1 Guide to the chemical analysis program.

Document No.

AAR-11002QAP

CHEMICAL TESTING OF BORAL® TO VERIFY GMS LOADING OF EITHER B_4C, B^{10} OR BORON

1.0 SCOPE

This procedure shall be used to qualify Boral® unless otherwise specified in the contract or work order. All testing of Boral will be performed under ambient conditions.

1.1 CALIBRATED EQUIPMENT UTILIZED

200 gram analytical balance
1" micrometers

2.0 REFERENCE DOCUMENTS

BPS 9000-05 "Specification for Boron Carbide for Boral" latest revision
BPS 9000-06 "Specification for Atomized Aluminum Powder for Boral" latest revision
BPS 9000-07 "Specification for Aluminum Extrusion or Plate for Boral" latest revision

3.0 PROCEDURES

3.1 Boron Carbide - Each lot of raw material will be inspected for certification of compliance from the supplier and any additional test required to assure the material conforms to the contract requirements or Paragraph 2.0. For each lot of raw material, ten samples shall be taken from separate containers. They are subjected to the quantitative analysis described in Paragraphs 3.2.1 through 3.2.7. The result yields the percentage of raw material remaining after the analysis. Results shall be recorded on Appendix D. A correction factor shall be calculated per the formula shown on Appendix D for each lot of raw material.

3.2 Boron Carbide/Aluminum Mix Test (In-Process) – Per the sample plan in Appendix A, core ingredients will be tested for quantitative analysis to assure the material conforms to the requirements stated on the purchase order. Each sample will be identified with a serialized batch number. The percentage of boron carbide in the sample will be determined as follows:

3.2.1 Heat sample in oven at 475°F (246°C) for one hour minimum, and cool in a desiccator. 475°F is a reference temperature, the purpose of this is to evaporate the residual liquid.

3.2.2 Record net weight of dry samples (gms), use approximately 3-4 grams.

CHEMICAL TESTING OF BORAL® TO VERIFY GMS LOADING OF EITHER B_4C, B^{10} OR BORON

3.2.3 Place the sample in approximately 200ml hydrochloric acid solution (one part acid, one part water) until the chemical action (bubbling) stops.

3.2.4 Filter the residue out of the solution with 21mm glass microfibre filter circles.

3.2.5 Wash the residue at least three times in hot dilute hydrochloric acid followed by a rinse in deionized water for three times.

3.2.6 Heat the residue in oven at 475°F (246°C) for one hour minimum, and cool in a desiccator. (See 3.2.1 parameter).

3.2.7 Record the net weight of the dry residue (gms.)

3.2.8 Multiply the dry residue weight by the correction factor previously determined for the lot per Section 3.1. The result yields the total B_4C in mix.

3.2.9 Compute the % recovery of the core material by dividing the residue weight from Paragraph 3.2.8 by the net dry weight from Paragraph 3.2.2.

3.2.10 Complete Appendix B, to report data.

3.3 Total Boron Content Per Unit of Area: Two one-inch retain samples from each end will be retained from each sheet of Boral® produced from one ingot. The retain samples will be identified with a unique serial number and shall be retained by the seller for a minimum period of one year. The samples may then be disposed of or turned over to the buyer upon request. An approximate one-centimeter sample having the least thickness shall be cut from either retain strip. The one-centimeter sample shall then be subjected to the following quantitative analysis: (Reference this procedure Appendix A)

(Attachment from AAR-10012 QAP section 6.0)
BORON CARBIDE CONTENT OR NEUTRON SHIELDING PERFORMANCE

CHEMICAL TESTING OF BORAL® TO VERIFY GMS LOADING OF EITHER B_4C, B^{10} OR BORON

The standard procedure for determining the shielding suitability of the Boral material is by chemical analysis. As a customer specified option, AAR Cargo Systems will perform neutron attenuation tests to verify shielding parameters.

Criteria

The shielding suitability inspection by either of the following methods shall be done on a random sampling basis to ensure than 95% of an ingot Lot exceeds the customers minimum requirement with 95% confidence. For this purpose, random samples shall be tested from a population of 100 ingots and the results used to draw a statistical conclusion about the Lot.

Procedure: First 100 Ingots

100% of the first 100 ingots shall be tested at the beginning of a production run or upon the change of a boron carbide lot or upon the change of ingot formulation or process change. The average test result (boron content or neutron attenuation) must exceed the customer specification by at least 2 standard deviations. If it does not, production will stop, Nuclear Engineering will be notified, all material in process will be held and the material will be dispositioned according to AAR-15001 QAP latest revision.

Procedure: Subsequent Ingot Lots

20 Ingots will be chosen at random from the following 100 ingots. The average test result must exceed the customer specification by 2.396 times the standard deviation (see Appendix F). If it does not, additional samples must be chosen so that the criteria enumerated in Appendix F is met.

3.3.1 Measure four remote areas of the retain sample (1cm square in size) and record the high and low thicknesses (cms) Take average of the two measurements.

3.3.2 Heat sample in oven 475°F (246°C) for one hour minimum, and cool in desiccator.

CHEMICAL TESTING OF BORAL® TO VERIFY GMS LOADING OF EITHER B_4C, B^{10} OR BORON

3.3.3 Record the net dry weight (gms) of the sample in air and also in distilled water. The difference is the volume in cubic centimeters. The weight in water must be determined within sixty seconds after placing in water, otherwise sample must be redried per Paragraph 3.3.2. Prior to weighing the sample in water, the water temperature is recorded. A correction factor based on the water temperature is then used for sample volume calculation. NOTE: Water temperature shall be ambient 20°C - 25°C.

3.3.4 Compute the density of the sample by dividing the net dry weight in air by the volume of the sample determined in Paragraph 3.3.3 (gms/cc).

3.3.5 Place the sample in approximately 200ml of hydrochloric acid (1 part acid, 1 part water) until the chemical action (bubbling) stops. Sample may be warmed to aid the filtering process.

3.3.6 Filter the residue out of the solution through a Gooch crucible. Use de-ionized water to aid the filtering process.

3.3.7 Heat the residue in oven at 475°F (246°C) for one hour minimum, and cool in a desiccator.

3.3.8 Divide the volume from Paragraph 3.3.3 by the sample average thickness. This yields the area.

3.3.9 Record the net weight of dry residue (gms).

3.3.10 Multiply the dry residue weight by the correction factor to determine the total B_4C of the composite material.

3.3.11 Compute the boron carbide weight per unit area (gms/sq cm) by dividing the corrected residue weight from Paragraph 3.3.10 by the area from Paragraph 3.3.8.

3.3.12 Compute the total boron per unit area (gms/sq. cm) by multiplying the boron carbide weight per unit area from Paragraph 3.3.11 by the total boron percentage content stated on raw material certification and divide by one hundred.

CHEMICAL TESTING OF BORAL® TO VERIFY GMS LOADING OF EITHER B_4C, B^{10} OR BORON

3.3.13 Compute the total B^{10} per unit area (gms/sq. cm) by multiplying the boron from Paragraph 3.3.12 by the total B^{10} percentage content stated on raw material certification and divide by one hundred.

3.3.14 Complete Appendix C to report data. Certain calculated values may not appear on Appendix C if the calculations have been performed by computer. In these cases, the necessary information will appear on the computer-generated form (Appendix E). Approval signature must be different than the analyst. Additionally, 10 out of every 100 samples will be verified in the computer by some one other than the original approver. This additional step will verify the correct transfer of data from data sheets to the computer.

3.3.15 When all data is complete, an approver will verify that the first 100 serial numbers of each lot are tested 100%. If there is a missing serial number the approver will provide documentation as to why the material was missing (i.e. scrapped, cracked etc.). Approver shall also verify that 20% or higher as applicable of each subsequent 100 serial numbers is also tested. Approver will also review data and make sure there are no loadings lower than specified by the customer, or unusually high loadings.

4.0 ATTACHMENTS

Appendix A	Derivation of Boral Acceptance Criteria (1 page)
Appendix B	Boral Analysis % B_4C Powder Data Sheet (1 page)
Appendix C	Boral Analysis gm/cm^2 Data Sheet (1 page)
Appendix D	Correction Factor (1 page)
Appendix E	Boral Data Sheet Calculation (1 page)
Appendix F	Micrometer checklist (1 page)

DERIVATION OF BORAL® ACCEPTANCE CRITERIA

The mean and standard deviation of a normal population is estimated by measuring the mean and standard deviation of a random sample of pieces from the population. The mean and standard deviation of a normal population is used to identify a value above which 95% of the population exists with 95% confidence. This minimum value is termed the "Lower Tolerance Limit" (LTL) and the statistical basis is called 95/95 confidence.

AAR Cargo Systems (AAR) has defined an acceptance criteria for Boron-10 (B^{10}) "areal" density (gm/cm^2) using the LTL and 95/95 confidence. Specifically, AAR determines the frequency of random sampling necessary to statistically ensure that the LTL for a lot exceeds the customer specified minimum B^{10} areal density with 95/95 confidence. This assertion is based on the following relationship:

$$LTL = SM - sC\_ \quad (1)$$

Where:

LTL = lower tolerance limit
SM = sample mean
C = calculation factor from tabulation below
s= sample standard deviation

Number of samples	Calculation factor C_(2)
5	4.202
10	2.911
15	2.566
20	2.396
25	2.292
30	2.220
40	2.126
60	2.020

For example: Assume that a customer's minimum B^{10} areal density is 0.025 gm/cm^2. For every lot of panels that are produced, AAR will sample 25 if the mean of sample exceeds 0.025gm/cm^2 by 2.292 times the sample standard deviation. If the mean of the samples exceeds 0.025 gm/cm^2 by only 2.020 times the sample standard deviation, AAR must sample 60 panels. If failure occurs, 100% testing of the subject chemical analysis lot (100 ingots) is required.

(1) "Statistical Intervals for a Normal Population" by G.A., Hahn, Vol. 2, No. 3, July 1970, Journal of Quality Technology.

(2) See Table A-7, "Experimental Statistics", Handbook 91, U.S. Dept. of Commerce, Natl. Bureau of Stds.

AAR CARGO SYSTEMS

Boral® Analysis %B_4C Powder Data Sheet

Sales Order # _____ **Customer:** _____ **Date:** _____

Serial#/Batch#	Date received	B_4C Lot #	Total Dry Weight	Dry Weight Residue	Crucible #	Tare Weight	Gross Weight	Total % B_4C

Analyst: _____ **Approval #1:** _____ **Procedure/Rev** AAR 11002 QAP Lat Rev.

FORM 11002-02 APPENDIX B REV 20 **Approval #2:** _____

AAR CARGO SYSTEMS 12633 Inkster Road Livonia, Michigan 48150 USA	NUCLEAR QUALITY ASSURANCE PROGRAM	Procedure Manual Appendix C Rev 21

AAR CARGO SYSTEMS

Boral® Analysis gm/cm² Data Sheet

Sales Order #_____ **Customer:**_____ **Date:**_____

	Gauge										
Serial #	High	Low	Average	H_20 Temp.	Dry Weight	H_20 Weight	Crucible Number	Tare Weight	Gross Weight	Gm/cm² B	Thickness Density

Analyst:_____ **Approval # 1**_____ **Procedure/Rev** AAR 11002 QAP Lat Rev

FORM 11002-03 APPENDIX C REV 21 **Approval # 2**_____

Approved By:	*Original Issue:*	*Supersedes Issue*	*Document Number:*
Ross Schmitz	*3/9/77*	*20*	*AAR-11002QAP*

AAR CARGO SYSTEMS

CORRECTION FACTOR DATA FORM

B_4C Lot # _____

	Original Dried Weight.	Dry Weight Residue	% Recovery
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
8	_____	_____	_____
9	_____	_____	_____
10	_____	_____	_____

Arithmetic Mean = % Recovery Average = _____

Correction Factor = 100/% Recovery Average = _____

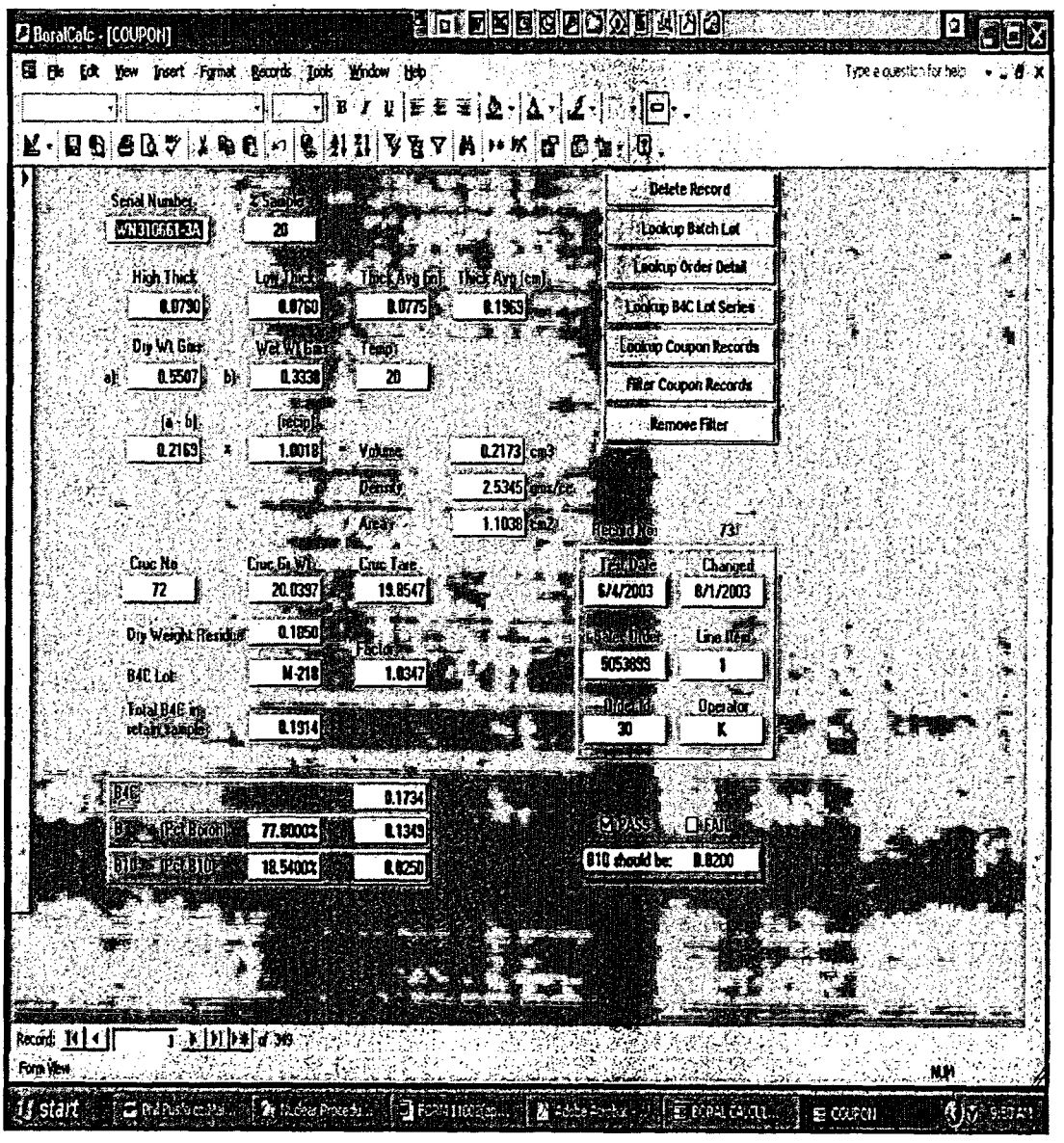
_____ _____

Laboratory Analyst **Date**

_____ _____

Approval **Date**

FORM 11002-04 APPENDIX D REV 20


BoralCalc - [COUPON]
File Edit View Insert Format Records Tools Window Help
Serial Number
WN3106661-3A
Samples
20
High Thick
0.0790
Low Thick
0.0760
Thick Avg (in)
0.0775
Thick Avg (cm)
0.1963
Dry Wt Glass
a) 0.5507
Wet Wt Glass
b) 0.3338
Temp
20
(a - b)
0.2169
(temp)
1.0018
Volume
0.2173 cm3
Density
2.5345 gms/cc
Area
1.1038 cm2
Delete Record
Lookup Batch Lot
Lookup Order Detail
Lookup B4C Lot Series
Lookup Coupon Records
Filter Coupon Records
Remove Filter
Record(s) to
737
Calc No
72
Calc Gs Wt
20.0397
Calc Tare
19.8547
Test Date
6/4/2003
Changed
6/1/2003
Dry Weight Residue
0.1850
Factor
B4C Lot
M-218
1.0347
Order
9053693
Line Item
1
Total B4C in retain Calculo
0.1914
Date In
30
Operator
K
B4C
0.1734
77.8000%
0.1349
18.5400%
0.0250
PASS
FAIL
B10 should be: 0.0200
Record: 1 of 749
Form View
start
COUPON

AAR CARGO SYSTEMS

SERIAL NUMBER RANGE _____

00			30			60			90		
01			31			61			91		
02			32			62			92		
03			33			63			93		
04			34			64			94		
05			35			65			95		
06			36			66			96		
07			37			67			97		
08			38			68			98		
09			39			69			99		

10			40			70		
11			41			71		
12			42			72		
13			43			73		
14			44			74		
15			45			75		
16			46			76		
17			47			77		
18			48			78		
19			49			79		

20			50			80		
21			51			81		
22			52			82		
23			53			83		
24			54			84		
25			55			85		
26			56			86		
27			57			87		
28			58			88		
29			59			89		

Approved By:	*Original Issue:*	*Supersedes Issue*	*Document Number:*
Ross Schmitz	*3/13/02*		*AAR-11002QAP*

Guide to the Boral® Automated Chemical Analysis Program.

1.0 Purpose

The purpose of this guide is to describe the operation and characteristics of the Boral® Automated Chemical Analysis Program.

2.0 Scope

This attachment to the Chemical testing procedure AAR 11002 QAP will provide detailed instructions for the administration and data entry performed by the Quality Assurance Lab (Lab Manager and Lab Technician).

3.0 Responsibility

The Nuclear Q.A. Lab which includes the Lab Manager as well as the Lab Technician will have full responsibility for the administration, maintenance, and upgrade to this program.

4.0 References

This attachment is a detailed instruction guide to the Chemical testing procedure AAR-11002 QAP, Inspection procedure AAR-10012 QAP, Software Qualification of Chemical Testing of Boral® AAR-7016 QAP and is to be used as an aid in the operation of the Boral® Automated Chemical Testing Program.

5.0 Definitions

Boral® Automated Chemical Analysis Program: is an automated calculation program designed to calculate ^{10}B grams aerial density per test sample, log and maintain test data, and print various reports.

6.0 Procedure

6.1 *Boral® Calculations Menu*: This is the first menu that is prompted as the program is started. The Boral® Calculations Menu contains the following seven options:

1. Insert an order
2. Setup B_4C lots
3. Assign bathes
4. Assign series

5. Coupon data
6. Pass report
7. Fail report

6.1.1 *Insert an order:* This is where information is added for each specific order. Acceptance criteria added to the inspection program is linked to the chemical analysis program (only orders added to the inspection program can be added to the chemical analysis program), the only additional information needed is the ^{10}B loading. To add an order, click on "Insert an order", find the specific order in the listing and click on the order. Once selected the ^{10}B loading acceptance criteria can be added. Once the ^{10}B loading has been added and is verified to be correct, click "OK to insert new order".

6.1.2 *Setup B_4C lots:* Each serial number is linked to information related to a specific B_4C lot. Each B_4C lot contains technical information used in the ^{10}B aerial density calculation (percent B_4C, percent boron, percent ^{10}B and B_4C correction factor). For each B_4C lot the above information must be entered, the percentages are obtained from the vendor certifications and the correction factor is obtained from a chemical analysis of the B_4C itself, performed by the lab. To enter the information click on Add New Record, then add the B_4C lot, percent B_4C, percent boron, percent ^{10}B and the B_4C correction factor, once all the information is added press return and the information will be added to the database.

6.1.3 *Assign batches:* Each Boral® order is assigned a sequential order number which is assigned when it is added to the Boral® inspection program. The Boral® inspection program and the chemical analysis program are linked and the order information is translated over to the chemical analysis program which includes the order number. The only information that needs to be added in addition to the order number is the batch letter and the B_4C lot number. To assign a batch click on assign batches, then click on look up order, find the specific Boral® order and find the order number. Once the order number is found click on add new record. There will be three fields: Order number, batch letter and B_4C lot (the batch letter and B_4C lot number are determined by the serial number ranges for that specific order). Input the order number from the look up table then add the batch letter which comes from the assigned B_4C lot, example; M-220 = Y, M-221 = Z, then add the B_4C lot. Once all the information is inputted the batch will be added to the program for that specific order. If there are multiple

B_4C lots used for the specific order, each additional B_4C lot will have to be added to the assign batch table.

6.1.4 *Assign Series:* Assigning a series refers to entering serial number ranges that correspond to B_4C lots. The information for entering a series comes directly from the Ingot data sheets. To enter a series click add record and add the following information: Order I.D., B_4C lot, series, starting serial number, ending serial number and pieces (dash numbers). The order I.D. refers to the number assigned to the order. The B_4C lot is the lot that refers to the serial number range that utilized that specific lot. The series refers to the part of the serial number that includes the B_4C lot letter, the job code, the year number and line item number. The starting and ending serial number is the range that corresponds to the B_4C lot. The pieces refer to how many plates are produced per ingot. After all the information has been inputted the series will be added to the program.

6.1.5 *Coupon Data:* The coupon data table is the information inputted from the Boral® Analysis gm/cm^2 data sheet to calculate the ^{10}B loading. To run the calculations for the ^{10}B loading click on coupon data and enter the following data from the Boral® Analysis gm/cm^2 data sheet: Serial number, percentage of samples tested, High gage, Low gage, Water temperature, Dry weight, Wet weight, Crucible number, Tare weight, Gross weight and operator's initials. Once all the data has been entered the program will calculate the ^{10}B loading, give a pass or fail result and add the results to the database.

6.1.6 *Pass Report:* The pass report generates all the serial numbers within an order I.D. which have passed the chemical analysis per customer requirements. To run a report, click on pass report and enter the following information: Serial number range (beginning serial number and ending serial number), Order I.D., Reviewed by and Title. Once all the information is added the report will be generated and ready to be printed. The report will list all the serial numbers tested along with ^{10}B loadings, and Densities.

6.1.7 *Fail Report:* The fail report generates all the serial numbers within an order I.D. which have failed the chemical analysis per customer requirements. To run the report, click on fail report and enter the same information as would be entered for a pass report.

AAR Report #1649

BORAL POWDER MIXER QUALIFICATION

April 7, 2003

By:

Jeff Moore
Sr. Manager – Nuclear Products
AAR Cargo Systems
1-734-466-8110
jmoore@aarcorp.com

by: J. Moore	date: 04/07/03	AAR CARGO SYSTEMS	SHEET: 2 of 7
chk:	date:		SUBJECT: Rept. # 1649 BORAL POWDER MIXER QUALIFICATION
rev:	date:		

RECORD OF REVISION

LTR.	date	description	page(s)
NONE	04/07/03	Released	All

1. BACKGROUND

Boral manufacturing procedures are prepared for the unique requirements of each new order. One of the process steps is the mixing of B_4C and Aluminum powders. A precise ratio of these must be maintained and assured. For many years the instructions were provided based on the use of two "V" shaped mechanical mixing devices utilized by AAR.

In the spring of 2003 a new mixing machine with double was purchased and set up for production. At this time one of the smaller units was set aside as a back-up.

2. PURPOSE

It is the purpose of this report to document the qualification of the new mixing device for use in standard Boral production. The report also serves as documentation of the changes imposed in the manufacturing instructions based on the use of the new mixer.

3. CURRENT PROCEDURE

The standard "Boral Shop Traveler" which instructs production personnel on how to produce Boral has stated:

```
For each batch of 5 ingots:
Weigh out Aluminum Powder          xxx lbs
Weigh out Boron Carbide Powder     yyy lbs
Load powders into blender
Add #3747 oil                      zzz CC
Mix for 20 minutes
```

Where xxx, yyy and zzz are the respective amounts of material for a five (5) ingot batch of powder.

The powder as noted is mixed for 20 minuets in the "blender". This is monitored with use of an automatic timer which shuts off the mixing device after 10 minuets. Two cycles of 10 minuets are utilized to accomplish the required 20 minuets.

Two similar mixers have been available. A representative picture follows:

Fig. 1 Old Style Mixer

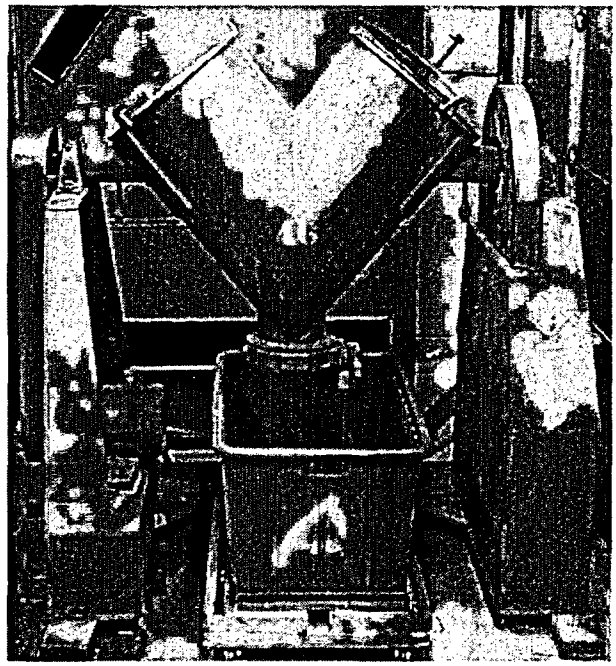
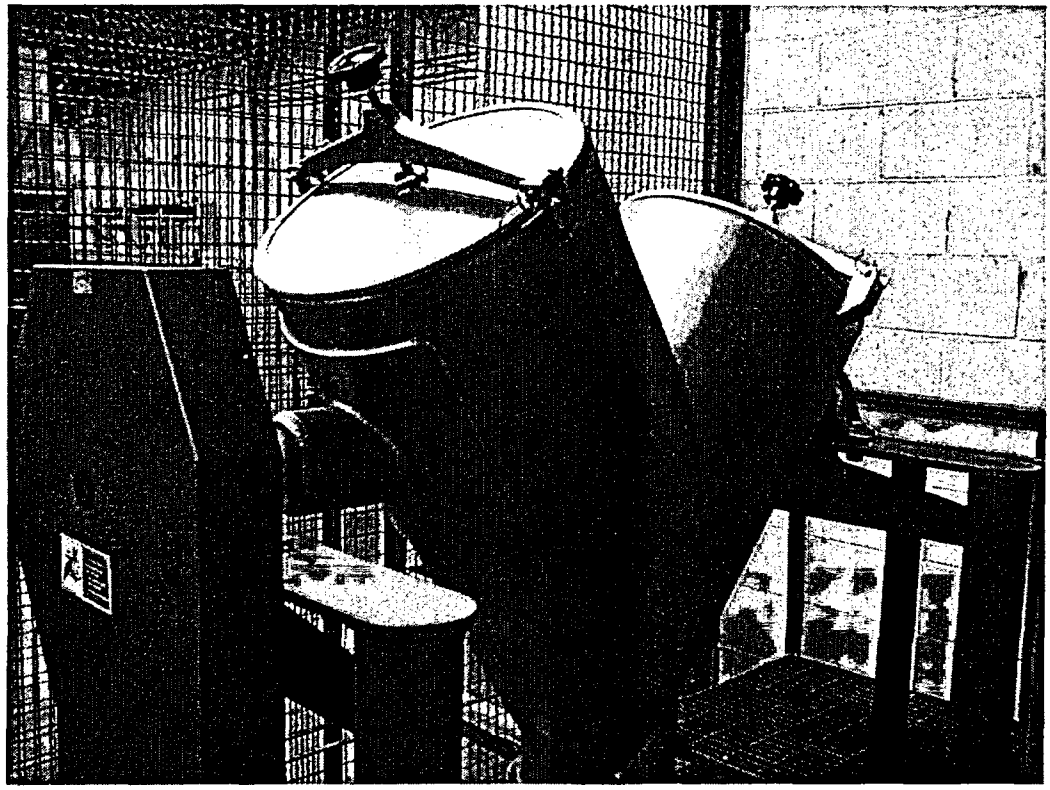


Fig. 2 New Mixer



4. NEW MIXER

The new Mixer is made by Patterson Kelley. (Ref PK print # XF00000283) It has a 5 Cubic Foot capacity. Cross mixing is accomplished with the one "leg" being longer than the other. The shell is made of 316 Stainless Steel. A wafer valve also made of 316 Stainless Steel seals against a White Neoprene liner.

The shell is constructed to be 60% full when loaded with 5 cubic feet of powder. The maximum density of the powder is 240 pounds per cubic foot. The operating manual recommends not "undercharging" by more than 20%. This is equivalent to saying that it is not recommended to load less than four cubic feet of powder.

The density of mixed Boron Carbide and Aluminum powders typical of Boral is roughly 100 pounds per cubic foot. The Mixer is thus ideally suited for batches of between 400 and 500 pounds.

5. TEST HYPOTHESIS

Increased efficiency due to cross mixing allows for a homogeneous mixture to be accomplished in 10 minutes.

6. TEST PLAN

Three batches of mixing tests shall be performed with slightly different methods. All three will utilize the same ratio of B4C to Al powder mix. After each mixing cycle ten (10) random samples will be drawn from different locations within the mixed powder. These will undergo wet chemistry testing per AAR-10012 QAP to determine the percentage of B4C in each sample. The amount of variation within the mix batch will be utilized to evaluate the mixing method.

The three methods will be:

1) A ten ingot batch utilizing double the amounts of raw material specified in the current AAR work instruction package. The NEW mixer will be used and run for 20 minutes.

2) A ten ingot batch utilizing double the amounts of raw material specified in the current AAR work instruction package. The NEW mixer will be used and run for 10 minutes.

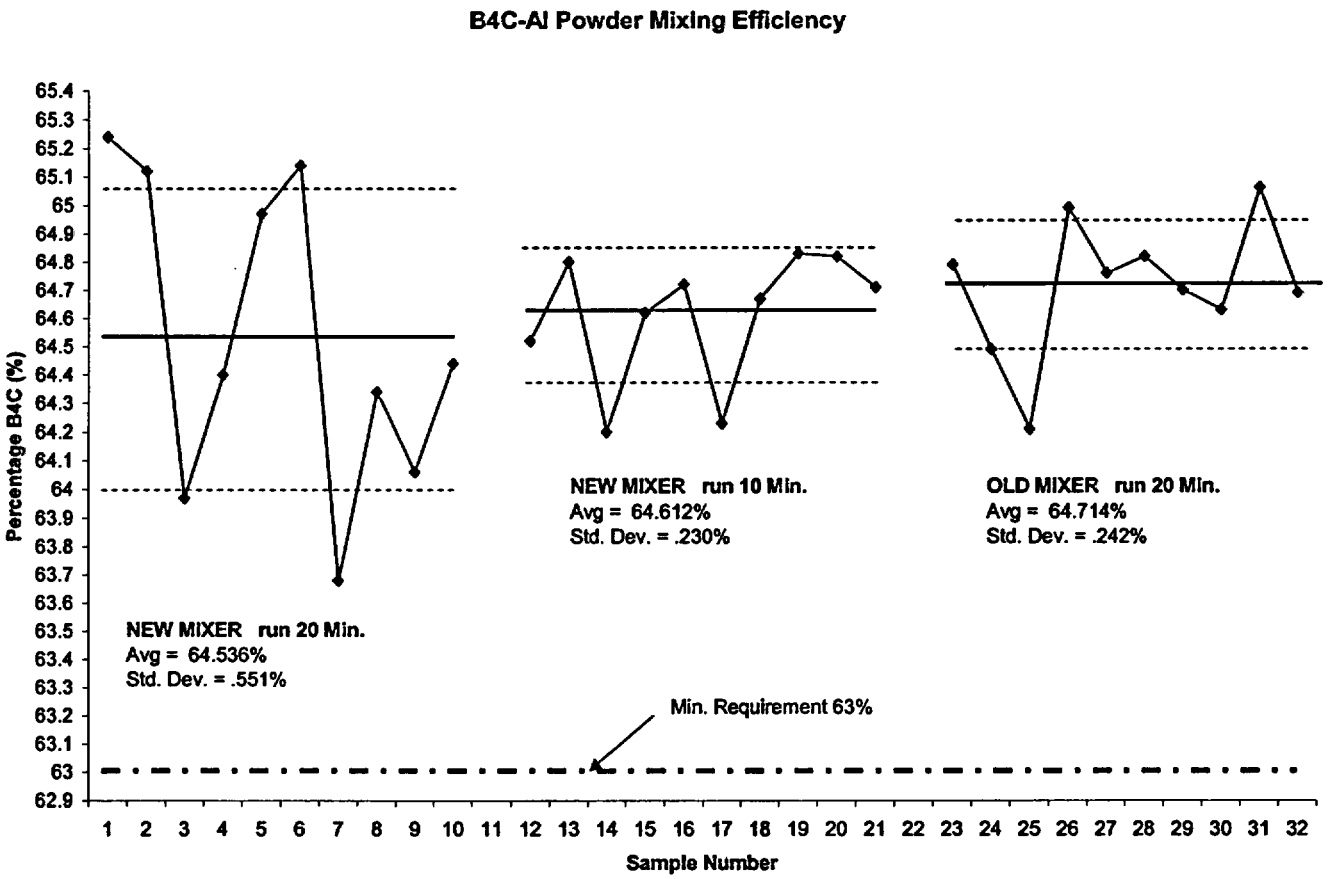
3) A five ingot batch utilizing the current AAR work instruction package. The OLD mixer will be used and run for 20 minutes.

The mixing will be done to the PR-1444 Warranty (sales order 5052543) Work Instructions at revision level A dated 24-Mar-03. This requires a 65% ratio of B4C in the mixture and defines a five ingot lot as 41.79 pounds of Aluminum Powder and 77.61 pounds of Boron Carbide powder in addition to 59.70 Cubic Centimeters of #3747 Oil. The 10 ingot lots in the new mixer will utilize twice of each of these amounts respectively.

7. TEST RESULTS

Results are given in Percentage of B4C present in the sample based on Wet Chemistry Analysis (as outlined in AAR-10012 QAP).

New Mixer 20 minutes	New Mixer 10 minutes	Old Mixer 20 minutes
65.24	64.52	64.79
65.12	64.8	64.49
63.97	64.2	64.21
64.4	64.62	64.99
64.97	64.72	64.76
65.14	64.23	64.82
63.68	64.67	64.7
64.34	64.83	64.63
64.06	64.82	65.06
64.44	64.71	64.69
Average 64.536	Average 64.612	Average 64.714
Standard Deviation 0.561325676	Standard Deviation 0.229724473	Standard Deviation 0.248997385



8. CONCLUSION

It is acceptable to operate the New Patterson Kelly XF00000283 powder blender with double sized loads for a period of ten minutes and attain levels of homogeneity comparable to the older blenders. It is thus recommended that the new blender be incorporated into production and that Work Instructions be revised to include quantities and times consistent with the operation of this new equipment.