

# SOUTHWEST RESEARCH INSTITUTE®

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION  
DEPARTMENT OF ANALYTICAL AND ENVIRONMENTAL CHEMISTRY

June 29, 2016

Los Alamos National Laboratory  
TA-3 SM-271 Drop Point 02U  
Los Alamos, New Mexico 87545

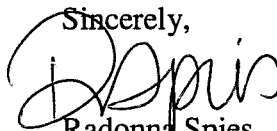
Attn: Victor Garde

Subject:	SwRI Project Number:	21592.01.00X
	SDG:	599959
	SwRI Task Order Number:	160627-5
	SwRI Sample Receipt Number:	57871
	Samples Received:	06.24.2016
	Analysis:	UNS Blends 19 and 20

Dear Mr. Garde,

Please find the enclosed results for the two overall samples received on the above referenced date. Should you have any questions, please feel free to contact me at 210-522-3242, or at [radonna.spies@swri.org](mailto:radonna.spies@swri.org).

Sincerely,



Radonna Spies  
Group Leader – R&D

APPROVED:



Michael J. Dammann  
Director

RPS: jz

Cc: Anya Gonzales, Los Alamos National Laboratory

Encl



Benefiting government, industry and the public through innovative science and technology

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

# **Chain-of-Custody & Sample Receipt Paperwork**

Total Page Count: 010001-  
Fraction: WWS Pages: 010110  
Blends 19 & 20

**Douglas, Steven M.**

---

**From:** Moken, James A.  
**Sent:** Friday, June 24, 2016 10:08 AM  
**To:** Douglas, Steven M.  
**Subject:** Two more sample ID's and SRR

Steven,

I have two more sample ID's that will go under the Los Alamos project # 21592.01.006.

Client ID	Matrix
UNS Blend 19	Solid
UNS Blend 20	Solid

If you have any questions let me know. Thanks.

Jamie



Client: Los Alamos National Laboratory  
SRR # 57871  
Project # 21592.01.00X  
Case: J. Moken  
VTSR: 06/24/2016  
Sample(s) Received: Intact  
Temperature: N/A °C/ SN #: N/A

Southwest Research Institute

**Laboratory Task Order**

TO #: 160627-5 Revision: 0

Project(s): 21592.01.00X  
 Manager(s): SPIES, RADONNA  
 To Client: 06/28/16

SDG: 599959

SRR #'s: 57871

Client(s): Los Alamos National Laboratory

**Instructions**

Documents Related to this task order: 202308[COC for SRR 57871], 202309[SRR Paperwork for SRR 57871]

Deliverables --&gt; Hard Copy: -YES- EDD: no PDF: no

Test: COMB\_1050  
 Section: WETCHEM

Holding: 180 days from CED

**SW846 1050 Test A & C Spontaneous Combustion**

Cnt: 2

System ID	Type	Cont	Matrix	Customer ID	CED	Method Date
599959		1	Solid	UNS Blend 19	NO DATA	NO DATA
599960		1	Solid	UNS Blend 20	NO DATA	NO DATA

Test: IGNIT\_1030  
 Section: WETCHEM

Holding: 180 days from CED

**SW 846 Method 1030 Ignitability of solids**

Cnt: 2

System ID	Type	Cont	Matrix	Customer ID	CED	Method Date
599959		1	Solid	UNS Blend 19	NO DATA	NO DATA
599960		1	Solid	UNS Blend 20	NO DATA	NO DATA

Test: Oxidizer\_UN  
 Section: WETCHEM

Holding: 180 days from CED

**United Nations (UN) "Recommendations on the Transport of Dangerous Goods", Section 34, Classification Procedures, Test Methods and Criteria Relating to Oxidizing Substances of Division 5.1.**

Cnt: 2

System ID	Type	Cont	Matrix	Customer ID	CED	Method Date
599959		1	Solid	UNS Blend 19	NO DATA	NO DATA
599960		1	Solid	UNS Blend 20	NO DATA	NO DATA

Test: PAINT\_9095  
 Section: WETCHEM

Holding: 180 days from CED

**SW846 9095 Paint Filter Liquids Test**

Cnt: 2

System ID	Type	Cont	Matrix	Customer ID	CED	Method Date
599959		1	Solid	UNS Blend 19	NO DATA	NO DATA
599960		1	Solid	UNS Blend 20	NO DATA	NO DATA



## Sample Receipt

Southwest Research Institute

Sample Receipt Number: 57871

VTSR: 06/24/16

Time: 11:40:00

Project: 21592.01.00X

Case #: J. Moken

Client: Los Alamos National Laboratory

Manager: SPIES, RADONNA

Logged in by: SDOUGLAS

Creation Date: 06/24/16

## Notes

Email was received to create an SRR for the following.

Parameters: Analysis/located on Task Order

FRM-070 (J. Moken)

See chain of custody as part of the work order system for more information.

System ID	Customer ID	CED	Matrix	Containers	Special Reqs.
599959	UNS Blend 19		Solid	1	
599960	UNS Blend 20		Solid	1	

Containers: 2

Samples: 2

These documents are associated with this receipt: 202308[COC for SRR 57871], 202309[SRR Paperwork for SRR 57871]

Thermometer: N/A

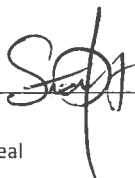
Temperature: N/A

57871 Los Alamos National Laboratory

## Southwest Research Institute

Traffic Report

Sample Custodian Signature: \_\_\_\_\_



- |                     |                        |
|---------------------|------------------------|
| 1. Custody Seal     | Not Present or Damaged |
| 2. Chain of Custody | Present                |
| 3. Sample Tags      | Not Present            |
| Sample Tag Numbers  | Not on COC             |
| 4. SMO Forms        | Not Present            |

Client: Los Alamos National Laboratory

Project: 21592.01.00X

Case: J. Moken / SDG: \_\_\_\_\_

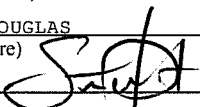
Sample Receipt: 57871

Airbill: Email

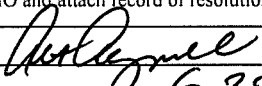
Custody Seal #(s): N/A

Date Received	Time Received	COC Record	SMO Sample #	Corresponding		Traffic Rpt, Tags, COC Agree	Sample Condition
				Sample Tag #	SwRI #		
06/24/16	11:40:00	Email	UNS Blend 19	N/A	599959	YES	Intact
06/24/16	11:40:00	Email	UNS Blend 20	N/A	599960	YES	Intact

## SAMPLE LOG-IN SHEET

Lab Name Southwest Research Institute			Page 1 of 1	
Received By (Print Name) STEVEN DOUGLAS			Log-in Date 06/24/2016	
Received By (Signature) 				
Case Number J. Moken		Sample Delivery Group No. NA		SAS Number NA
Remarks: 21592.01.00X		Corresponding		
		EPA Sample #	Sample Tag #	Assigned Lab #
1. Custody Seal(s) Present <input checked="" type="radio"/> Absent*		UNS Blend 19	N/A	599959
Intact/Broken				
2. Custody Seal Nos. N/A		UNS Blend 20	N/A	599960
3. Chain-of Custody Records <input checked="" type="radio"/> Absent*				
4. Traffic Reports or Packing Lists Present <input checked="" type="radio"/> Absent*				
5. Airbill Airbill/Sticker <input checked="" type="radio"/> Absent*				
6. Airbill No. Email				
7. Sample Tags Present <input checked="" type="radio"/> Absent*				
Sample Tag Numbers Listed <input checked="" type="radio"/> Not listed on Chain of Custody				
8. Sample Condition <input checked="" type="radio"/> Intact <input checked="" type="radio"/> Broken*/Leaking				
9. Cooler Temperature N/AC				
10. Does Information on custody records, traffic reports, and sample tags agree? <input checked="" type="radio"/> Yes <input type="radio"/> No*				
11. Date Received at Lab 06/24/2016				
12. Time Received 11:40:00				
Sample Transfer				
Fraction	Fraction			
Area #	Area #			
By	By			
On	On			

\* Contact SMO and attach record of resolution

Reviewed By 	Logbook No.	Sample Receipt (57871)
Date 6.24.16	Logbook Page No.	9496 800 4 of 5

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

## **Case Narrative**



**Client: Los Alamos National Laboratory**  
**SwRI Project Number: 21592.01.00X**  
**SwRI Task Order Number(s): 160627-5**

## WETCHEM ANALYSIS

### Initial sample preparation

This report encompasses the preparation and analysis of UNS blends 19 and 20 which are the citric acid and PIG base neutralized UNS blends. Samples are presented in Table 1 which contains the sample ID's and the methods requested on each of the blends. To prep the samples, the UNS solution was first neutralized to pH of around 5 using a 1:1.5 ratio of UNS to Splifyter<sup>®</sup> Kolorsafe<sup>®</sup> liquid acid neutralizer. PIG base neutralizer or Citric acid was then added at the same volume as the Splifyter<sup>®</sup> Kolorsafe<sup>®</sup> liquid acid neutralizer. This mixture was then added to swheat and allowed to set for 24 hours before adding it to water and finally to zeolite in the designated ratios. The zeolite concoction was allowed to set for an additional 24 hours prior to analysis.

Table 1. Surrogate creation and analysis table

Surrogate ID	Times made	Methods			
		1030	1050	UN Ox solid (DOT 0.1)	Paint filter
UNS Blend 19	1	1	1	1	1
UNS Blend 20	1	1	1	1	1

### SW-846 9095B: Paint Filter

For this method 100g of each blend was placed into a Gerson 260um paint filter (PN010714R, Lot# B5140428JF8) that was suspended over a 250 mL beaker for 5 minutes to collect any free liquids. During this 5-min period if any of the sample material drips into the cylinder, the material is deemed to contain free liquids for purposes of 40 CFR 264.314 and 265.314. Under the laboratory conditions both UNS blends were not deemed to contain free liquids.

### SW-846 1030: Ignitability of Solids

An ignition source is applied to one end of the test material to determine whether combustion will propagate along 200 mm of the strip within 2 minutes. If the material combustion propagates, the burning time was measured over a distance of 100 mm and the rate of burning would be determined. The surrogate material was formed into an unbroken powder train, 250 mm in length atop a ceramic tile with marks at the 80 and 180 mm in from the end of the train. The ceramic tile was placed about 8 inches in a hood with the sash lowered to give airflow of about 0.7 m/sec. One end of the train was exposed to the end of an acetylene torch with a temperature greater than 1000°C. The torch was held there for 2 minutes and if the sample began to burn down the train the time taken to get from the 80 to 180 mm mark was measured to determine the burn rate.

All two UNS samples acted in a similar fashion during the 1030 analysis. The sample would dry at the burn region and begin to char after a little time had passed (Image 1). The only major difference was that UNS Blend 20 crackled and popped kicking little portions of zeolite out of the burn zone (Image 2). Since none of the blends even burned into the 100mm zone, all of them are considered non-flammable under the test conditions and criteria outlined in Method 1030.

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**SwRI Project Number: 21592.01.00X**  
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Fine Excelsior (natural hardwood shavings) were used as a positive control each day testing was performed.

### **SW-846 1050: Spontaneous combustion and self heating**

The surrogates for this analysis were first sprinkled several times onto a ceramic tile to observe if they smoked or flamed and could be considered pyrophoric solids by test Method A. Since none of the samples exhibited these characteristics, they were tested by Method C. In this test, a 100-mm sample cube is exposed to a test temperature of  $140^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for a minimum of 24 hours to determine whether it undergoes spontaneous ignition or a rise in sample temperature to over  $200^{\circ}\text{C}$  within the 24 hours. If the results of the preliminary test are positive, a second test using a 25-mm sample cube is conducted to further classify the waste as specified in Table 2.

**Table 2. Method 1050 Waste Classification**

Results of Self-Heating Test	DOT Packing Group
Negative for the 100-mm cube test	Not a Self-Heating Waste
Positive for the 100-mm , but negative for the 25-mm cube test	III
Positive for both the 100-mm and 25-mm cube tests or positive for the 25-mm test, if tested alone	II

The filled cube was placed into an oven with two thermocouples measuring the oven temp and up to four thermocouples inserted into each sample to measure its temperature during the analysis. Lids were placed onto the top of the test cubes and tungsten weights were placed on top of those sample believed to have event in order to keep the thermocouples and lids from coming off the sample. Also up to two thermocouples were placed in a tray below the sample in case any sample pushed out of the cube and onto the tray. Once the thermocouples were in place, the oven was ramped to  $140^{\circ}\text{C} \pm 2^{\circ}\text{C}$  and held for 24-48 hours depending on when the sample reached a stable temperature. Although the method states testing to be conducted for 24 hours, many of the samples did not reach  $140^{\circ}\text{C} \pm 2^{\circ}\text{C}$  during the initial 24 hour period, therefore the testing was extended to a minimum of 12 hours after the sample had reached a stable temperature. Temperatures of the oven and sample were collected every 10 seconds and plotted to determine if the sample temperature exceeded  $200^{\circ}\text{C}$  during the time of testing. At the conclusion of the test, the oven was turned off and allowed to cool before removing the sample. The oven and sample temperature graphs are located in Attachment A.

UNS Blend 19 was removed from the oven and found that the outer lower portion of the sample had become brown and formed large clumps (Image 3). UNS Blend 20 had one of the thermocouples record several dips in temperature in the 5-8 hour region and several once temperature had been reached. The early dips may be attributed to sample moisture or possibly a small endothermic reaction in the region. It may also be attributed to issues with the thermocouple since it has been used in numerous 1050 testing's and thermocouple 1 did not show any of these dips. Blend 20 had a faint brown tint to it on the extremities of the sample but very few clumps were seen within the cube. Since none of these blends exceeded  $200^{\circ}\text{C}$  during the analysis all of them are classified as "Not a Self-Heating Waste" as defined by Method 1050 under laboratory conditions.

Client: Los Alamos National Laboratory  
 SwRI Project Number: 21592.01.00X  
 SwRI Task Order Number(s): 160627-5

### DOT UN Oxidation testing

The UNS blends were tested in accordance with the United Nations (UN) “Recommendations on the Transport of Dangerous Goods”, Section 34, *Classification Procedures, Test Methods and Criteria Relating to Oxidizing Substances of Division 5.1*. The UN procedure assesses the relative hazard of oxidizing substances so that an appropriate classification for transport can be made. Tests are conducted on the samples mixed with dry fibrous cellulose in mixing ratios of 1:1 and 4:1, by mass, of sample to cellulose. The burning characteristics of the mixtures are compared with the standard 3:7 mixture, by mass, of potassium bromate to cellulose. If the burning time is less than the standard mixture, the burning times should be compared with those from packing group I or II or category I or II oxidizer, reference standards 3:2 and 2:3, by mass, of potassium bromate to cellulose, respectively. See Table 3 for classification. Table 4 presents the results for the reference standards. Tables 5 and 6 lists the comments the analyst noted for each of the two sample to cellulose ratio burns. All UNS blends were classified as “Not Division 5.1” under laboratory conditions.

**Table 3. Oxidizer Classifications**

The test criteria for determining oxidizing properties of the substance are:	UN Classification
Any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose.	Packing group I
Any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 2:3 mixture (by mass) of potassium bromate and cellulose; and which does not meet the criteria for packing group I	Packing group II
Any substance which, in the 4:1 or 1:1 sample-to-cellulose ration (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose; and which does not meet the criteria for packing group I and II.	Packing group III
Any substance which, in both the 4:1 and 1:1 sample-to-cellulose ration (by mass) tested, does not ignite and burn, or exhibit mean burning times greater than that of a 3:7 mixture (by mass) of potassium bromate and cellulose.	Not Division 5.1

**Table 4. Potassium Bromate and Cellulose Reference Mixtures**

Mean Burn Time, sec 3:7	Mean Burn Time, sec 2:3	Mean Burn Time, sec 3:2
KBrO <sub>3</sub> :Cellulose Ratio	KBrO <sub>3</sub> :Cellulose Ratio	KBrO <sub>3</sub> :Cellulose Ratio
135.32	52.44	19.54

**Table 5. Comments for Sample to Cellulose ratio of 4:1**

Sample ID	Comment 4:1
UNS Blend 19	Charring around wire, smoke, no flames
UNS Blend 20	Charring around wire, smoke, no flames

Client: Los Alamos National Laboratory  
SwRI Project Number: 21592.01.00X  
SwRI Task Order Number(s): 160627-5

**Table 6 Comments for Sample to Cellulose ratio of 1:1**

Sample ID	Comment 1:1
UNS Blend 19	Small flames at wire leads, charring and smoke.
UNS Blend 20	small flames at wire leads, smoke and charring



Image 1: Appearance of UNS Blend 19 after two minute burn during 1030 analysis.

Client: Los Alamos National Laboratory  
SwRI Project Number: 21592.01.00X  
SwRI Task Order Number(s): 160627-5



Image 2: Appearance of UNS Blend 20 after the 2 minute burn period after 1030 analysis. Portions of the zeolite were thrown a little distance away from the main sample train.



Image 3: Browning and clumping formed in the lower portion of the cube of UNS Blend 19 during the 1050 analysis.

Client: Los Alamos National Laboratory  
SwRI Project Number: 21592.01.00X  
SwRI Task Order Number(s): 160627-5

**“I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the laboratory manager or his/her designee, as verified by the following signature. This report shall not be reproduced except in full without the written approval of SwRI.”**



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**Group Leader**

**6/28/16**

---

**Date**

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

**Attachment A**  
**Method 1050 Graphs**

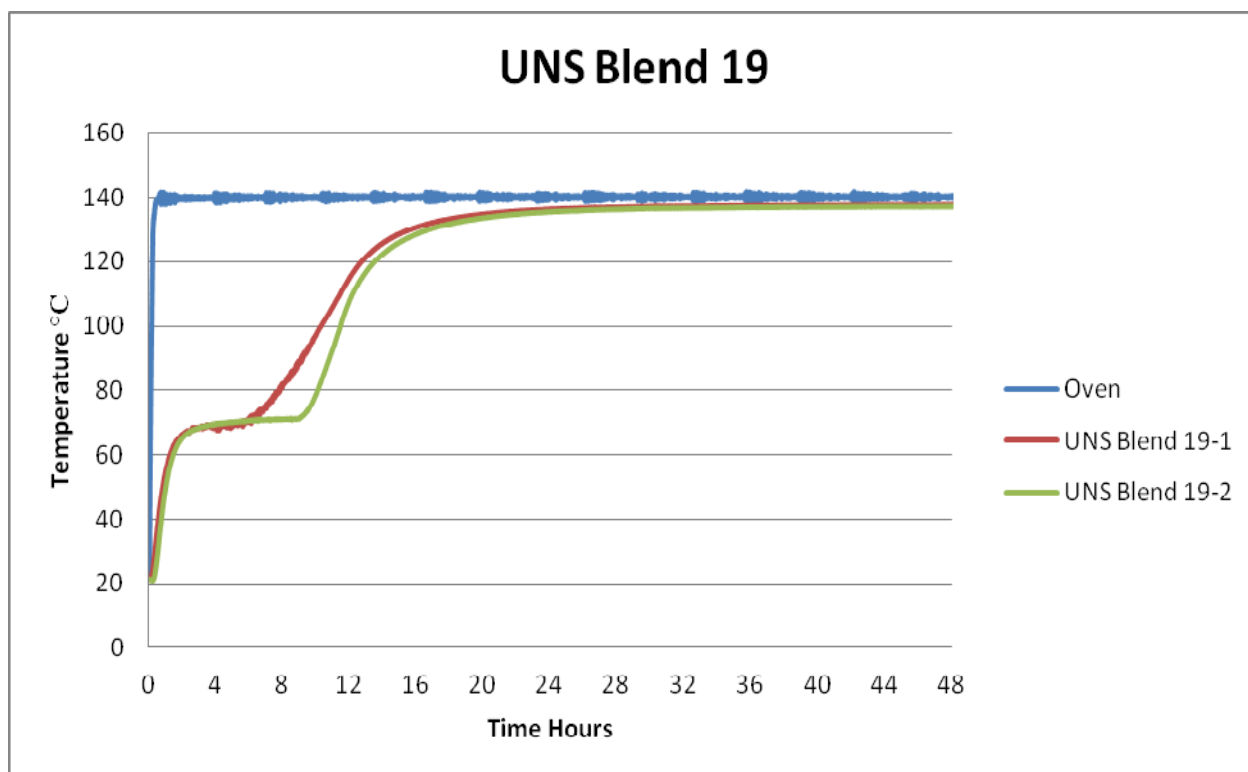


Figure 1. Method 1050 – UNS Blend 19 (100mm cube) full run.

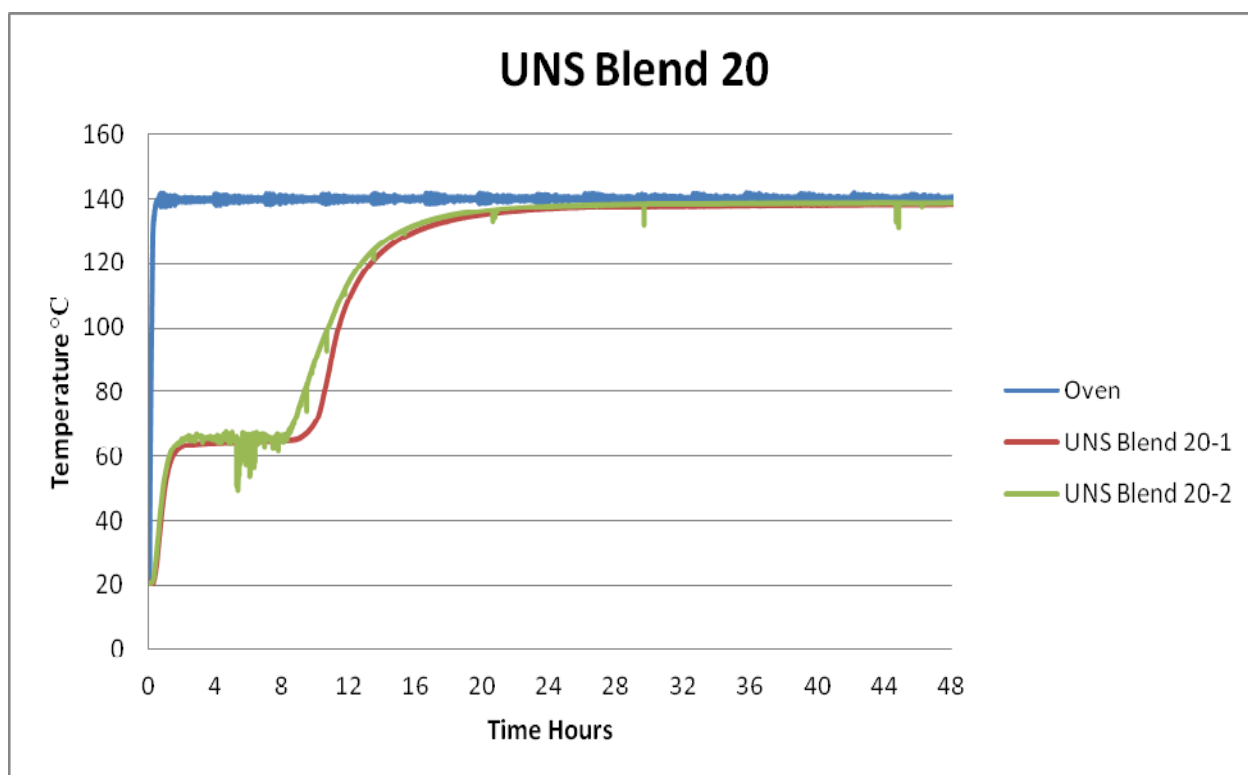


Figure 2. Method 1050 – UNS Blend 20 (100mm cube) full run. Thermocouple 2 had several dips throughout the analysis. These may either be attributed to moisture, small endothermic reactions, or the thermocouple issues.



**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

## **Wetchem Analyses**

### **Sample Results**

# SOUTHWEST RESEARCH INSTITUTE

## UN OXIDIZER TEST

### SAMPLE DATA SHEET

Lab Name: Southwest Research Institute

Client: Los Alamos National Laboratory

Lab Code: SwRI

Project No.: 21592.01.00X

Matrix: Solid

Date Made: 6/22/16

SRR #: 57871

Task Order #: 160627-5

#### Potassium Bromate and Cellulose Reference Mixtures

Mean Burn Time, sec 3:7 KBrO <sub>3</sub> :Cellulose Ratio	Mean Burn Time, sec 2:3 KBrO <sub>3</sub> :Cellulose Ratio	Mean Burn Time, sec 3:2 KBrO <sub>3</sub> :Cellulose Ratio
135.32	52.44	19.45

#### Test Substance

Sample ID	SwRI System ID	Mean Burn Time, sec 4:1 Sample:Cellulose Ratio	Mean Burn Time, sec 1:1 Sample:Cellulose Ratio	Classification	Date Analyzed
UNS Blend 19	599959	no reaction	> 180	Not Division 5.1	06/27/16
UNS Blend 20	599960	no reaction	> 180	Not Division 5.1	06/27/16

The test criteria for determining oxidizing properties of the substance are:	Classification
Any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose.	Packing group I
Any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 2:3 mixture (by mass) of potassium bromate and cellulose; and which does not meet the criteria for packing group I	Packing group II
Any substance which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose; and which does not meet the criteria for packing groups I and II.	Packing group III
Any substance which, in both the 4:1 and 1:1 sample-to-cellulose ratio (by mass) tested, does not ignite and burn, or exhibit mean burning times greater than that of a 3:7 mixture (by mass) of potassium bromate and cellulose.	Not Division 5.1

# ***SOUTHWEST RESEARCH INSTITUTE***

## ***UN OXIDIZER TEST***

### **LABORATORY CONTROL SAMPLE DATA SHEET**

Lab Name: Southwest Research Institute

Client: Los Alamos National Laboratory

Lab Code: SwRI

Project No.: 21592.01.00X

Matrix: Solid

Date Made: 6/22/16

SRR #: 57871

Task Order #: 160627-5

#### **Acceptance Criteria for Daily Laboratory Control Samples**

Mean Burn Time, sec 3:7	Mean Burn Time, sec 2:3	Mean Burn Time, sec 3:2
KBrO <sub>3</sub> :Cellulose Ratio	KBrO <sub>3</sub> :Cellulose Ratio	KBrO <sub>3</sub> :Cellulose Ratio
108-162 sec	42-63 sec	15-23 sec

Sample ID	Mean Burn Time, sec 3:7 KBrO <sub>3</sub> :Cellulose Ratio	Mean Burn Time, sec 2:3 KBrO <sub>3</sub> :Cellulose Ratio	Mean Burn Time, sec 3:2 KBrO <sub>3</sub> :Cellulose Ratio	Data Analyzed
LCS	119.97	52.87	19.65	06/27/16

***SOUTHWEST RESEARCH INSTITUTE******SW 846 Method 1030***  
**SAMPLE DATA SHEET**

Lab Name: Southwest Research Institute

Client: Los Alamos National Laboratory

Lab Code: SwRI

Project No.: 21592.01.00X

Matrix: Solid

Date Made: 6/22/16

SRR #: 57871

Task Order #: 160627-5

Sample ID	SwRI System ID	Method 1030 <i>Ignitability of Solids</i> <i>Results</i>	Date Analyzed
UNS Blend 19	599959	Nonflammable	06/24/16
UNS Blend 19 Dup	599959	Nonflammable	06/24/16
UNS Blend 20	599960	Nonflammable	06/24/16

\* Note: The Ignitability designation is based on the criteria and conditions of the test

***SOUTHWEST RESEARCH INSTITUTE******SW 846 Method 1050***  
**SAMPLE DATA SHEET**

Lab Name: Southwest Research Institute

Client: Los Alamos National Laboratory

Lab Code: SwRI

Project No.: 21592.01.00X

Matrix: Solid

Date Made: 6/22/16

SRR #: 57871

Task Order #: 160627-5

Sample ID	SwRI System ID	SW 846 Method 1050 <i>Test Method to Determine Substances Likey to Spontaneously Combust</i> (Method C) Results	Date Analyzed
UNS Blend 19	599959	Not a self-heating waste	06/24/16
UNS Blend 20	599960	Not a self-heating waste	06/24/16

***SOUTHWEST RESEARCH INSTITUTE******SW846 9095 Paint Filter Liquids Test*****SAMPLE DATA SHEET**

Lab Name: Southwest Research Institute

Client: Los Alamos National Laboratory

Lab Code: SwRI

Project No.: 21592.01.00X

Matrix: Solid

Date Made: 6/22/16

SRR #: 57871

Task Order #: 160627-5

Sample ID	SwRI System ID	Method 9095 <i>Paint Filter Results</i>	Date Analyzed
UNS Blend 19	599959	No free liquids	06/24/16
UNS Blend 19 Dup	599959	No free liquids	06/24/16
UNS Blend 20	599960	No free liquids	06/24/16

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

**UN Oxidizer**

**Raw Data**

## Southwest Research Institute

Method: UN- Oxidizer  
 Project #: 21592. 01.006  
 Client: Los Alamos (LANL)  
 TO# 1100627-5

## Reference Substance

KBrO <sub>3</sub> :Cellulose	Wt KBrO <sub>3</sub> , g	Wt Cellulose, g
3:7	9	21
2:3	12	18
3:2	18	12

Ratio	Rep	Actual KBrO <sub>3</sub> Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
3:7	1	9.0215	21.0060	119.97	
3:7	2				
3:7	3				
3:7	4				
3:7	5				
3:7	Avg				
Ratio	Rep	Actual KBrO <sub>3</sub> Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
2:3	1	12.0135	18.0002	52.87	
2:3	2				
2:3	3				
2:3	4				
2:3	5				
2:3	Avg				
Ratio	Rep	Actual KBrO <sub>3</sub> Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
3:2	1	18.0053	12.0621	19.65	
3:2	2				
3:2	3				
3:2	4				
3:2	5				
3:2	Avg				

Weighted Samples: Monica Gabaldon Balance#: 135 Date: 6/27/16  
 Tested Samples: Monica Gabaldon Timer ID: 022921 Date: 6/27/16  
 Potassium Bromate: Inorg# \_\_\_\_\_ Dried: >12hrs @ 65°C  
 Cellulose: Inorg# 71755-71759 Dried: 74hrs. @ 105°C  
 Variac Setting: 150 ± 7 W



## Southwest Research Institute

Method: UN Oxidizer  
 Project #: 21592.01.006  
 Client: Los Alamos  
 TO# 140627-5

## Sample Analysis

System ID:

UNS Blend #20 [Red]

Sample:Cellulose	Wt Sample, g	Wt Cellulose, g
4:1	24	6
1:1	15	15

Ratio	Rep	Actual Sample Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
4:1	1	24.0222	6.0148	180.78 ①	charring around wire, smoke, no flames
4:1	2	24.0061	6.0040	180.19 ①	
4:1	3	24.0078	6.0124	180.40 ①	
4:1	4	24.0045	6.0071	180.37 ①	
4:1	5	24.0143	6.0274	180.29 ①	
4:1	Avg			7180	① time power turned off. RE 6/27/16 mg
Ratio	Rep	Actual Sample Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
1:1	1	15.0161	15.0102	183.03 ②	Small flames at wire leads, charring + smoke
1:1	2	15.0233	15.0054	183.50 ②	
1:1	3	15.0089	15.0050	184.40 ②	
1:1	4	15.0054	15.0157	187.07 ②	
1:1	5	15.0174	15.0084	184.76 ②	
1:1	Avg			7180	② Time when flames extinguished. Power turned off at 180sec.

Weighted Samples: Monica Gabaldon Balance#: 135 Date: 6/24/16  
 Tested Samples: Monica Gabaldon Timer ID: 022921 Date: 6/27/16  
 Sample Dried? YES (NO) Dried: NA  
 Cellulose: Inorg# 71755-71759 Dried: >4hrs. @105C  
 Variac Setting: 150 ± 7 Watts

Classification:

Not Division 5.1

## Southwest Research Institute

Method: UN Oxidizer  
 Project #: 21592.01.006  
 Client: Los Alamos  
 TO# 140627-5

## Sample Analysis

System ID:

UNS Blend #19 [Blue]

Sample:Cellulose	Wt Sample, g	Wt Cellulose, g
4:1	24	6
1:1	15	15

Ratio	Rep	Actual Sample Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
4:1	1	24.0016	6.0032	180.31 ①	charring around wire, smoke, no flames
4:1	2	24.0140	6.0043	180.56 ①	
4:1	3	24.0031	6.0035	180.29 ①	
4:1	4	24.0076	6.0076	180.72 ①	
4:1	5	24.0084	6.0013	180.31 ①	↓
4:1	Avg			7180	① Time power turned off. No reaction
Ratio	Rep	Actual Sample Wt, g	Actual Cellulose Wt, g	Burning Time, sec	Comment
1:1	1	15.0120	15.0285	181.31 ②	Small flames at wire leads, smoke & charring
1:1	2	15.0160	15.0072	183.03 ②	
1:1	3	15.0079	15.0081	184.00 ②	
1:1	4	15.0069	15.0092	187.94 ②	
1:1	5	15.0282	15.0129	188.97 ②	↓
1:1	Avg			7180	② Time flames extinguished. Power turned off at 180 sec.

Weighted Samples:

Monica GabaldonBalance#: 135Date: 6/24/14

Tested Samples:

Monica GabaldonTimer ID: 022921Date: 6/27/14

Sample Dried ?

YES (NO)Dried: NA

Cellulose:

Inorg# 71755-71759Dried: >4hrs. @105C

Variat Setting:

150 ± 7 Watts

Classification:

Not Division 5.1

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

## **Method 1050**

**Raw Data**

**Southwest Research Institute®**  
**Logbook: Miscellaneous**

010027

Book I.D. # 15-0406-048

Analysis / Method: 1050 Project# 21592.01.006  
 TAP# (if applicable): \_\_\_\_\_  
 Client: Los Alamos TO# 160627-5

Balance # NA  
 LCS Info: 1/A TV: NA  
 Notes: UNS Blend #19 : #20  
start: 6/24/16 14:57  
stop: 6/26/16 16:57

Sample ID				
UNS Blend #19				
<p>Sample took some time getting to temperature due to the moisture content. Sample reach temperature around 26 hours. Upon removal of the sample after analysis it had formed large chunks and the outer portions were browned. No reaction appeared to have cause the temperature to exceed <sup>700°C</sup> 440°C. <sup>700°C</sup> 200°C. The sample is considered to be not self heating.</p>				
UNS Blend #20				
<p>Sample took some time to get to temperature due to the moisture content. Around 5-8 hours the second thermocouple had dips in temp from 65-55°C. This may be attributed to moisture or possible electrical issues in the thermocouple. After analysis the sample was removed and the external portions of the sample had a faint brown tint to it. Since no excess temperature increase of 200°C was noted the sample is considered to be not self heating.</p>				
Calculation:				

Analyst Signature: James Gu Date: 6/24/16  
 Reviewed by: M. Orskold Date: 6/28/16

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

**Method 9095**  
**Paint Filter**  
**Raw Data**

**Southwest Research Institute®**  
**Logbook: Miscellaneous**

Book I.D. # 15-0406-048

Analysis / Method: Point filter 9095

Project# 21592.01.006

**TAP# (if applicable):**

**Client:**

## Lab Alkarnas

TO# 160627-5

Balance # 135

LCS Info: Water

TV: fzu1

Notes: sample fails if any liquid or sample passes the filter  
into the beaker below.

Sample ID	sample wgt (g)	Pass/fail
LCS	101.2791	fail
UNs Blend 19	100.3428	pass
UNs Blend 19 D	100.9572	pass
UNs Blend 20	108.2814	pass

Calculation:

**Analyst Signature:**

Date: 6/24/14

Reviewed by:

Date: 6/28/12

Logbook #/ Page # 017 0063

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

## **Method 1030**

**Raw Data**

**Southwest Research Institute®**  
**Logbook: Miscellaneous**

Book I.D. # 15-0406-048

Analysis / Method: 1030 Project# 21592.01'006

TAP# (if applicable): \_\_\_\_\_

Client: Los Alamos TO# 1606235

Balance # NA

LCS Info: explosive # 61753 TV: burn rate 72.2 mm/sec

Notes: \_\_\_\_\_

Sample ID	burn time across 100mm	burn rate mm/sec			
LCS	12.03 sec	8.31			
UN5 Blend 19	did not burn	Sample dried and charred	did not form a flame		
UN5 Blend 19D	did not burn	"		"	
UN5 Blend 20	did not burn	Sample cracked & popped occasionally but did not form a flame and propagate.			
JAM 6/24/16					
Calculation:					

Analyst Signature: [Signature] Date: 6/24/16

Reviewed by: /M. Graham Date: 6/28/14

Logbook #/ Page # 017 0062



**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

# **Surrogate Preparation**

## **Logbook Pages**

Work continued from Page

**SWRI**128-01-WCS12 Nit B Zoo-1

600 mL (124-04-WCS12) to 1200 mL zeolite

128-02-WCS12 Nit B Zoo-2

600 mL (124-04-WCS12) to 1800 mL zeolite

let sit for 24 hr prior  
to analysis5/15/16  
10:10128-03-WCS12 UNB solution

8322.851

840.695

61.562

595.084

40008.600

~~Sodium nitrate~~ 5/16/16

493.562

596.525

2373.849

2.340

63.727

6550.17

g aluminum nitrate nonahydrate (#64597-64592, 64593-64594, 64591-64596)

g calcium nitrate (#69606, 69607) +

g chromium nitrate (#66141, 63851) +

g Iron(III) nitrate (#63601, 63582) +

g magnesium nitrate (#69603, 69604) +

g sodium nitrate (#69611) +

g lead nitrate (#65951, 69629, 69623) +

g oxalic acid (#69684) +

g nickel nitrate (#65593) +

g nitric acid (#67843)

g DI H<sub>2</sub>O

balance #89

SIGNATURE

DATE

5/15/16

DISCLOSED TO AND UNDERSTOOD BY

DATE

WITNESS

DATE

5/25/14

Mr. Grubbs

Work continued from Page

SWRI

Blend #19 172-01-WCS12

100ml UNS solution to 150ml spility neutralized pH ~5,  
150ml citric acid (#36116) added and then 400ml  
of this was added to 400ml suheat and let sit  
for 24 hours. Take 600ml of this and add 1200ml DI  
H<sub>2</sub>O. Then add 1800ml of this to 5100ml zeolite

Blend #20 172-02-WCS12

100ml UNS solution to 150ml spilityger <sup>Room 612216</sup> (#36116) + 150ml PIG Base neutralizer  
(#21804). 400ml of this was added to 400ml suheat, and let  
set for 24 hours.  
took 200ml of the suheat mixture and added 400ml DI H<sub>2</sub>O.  
then after mixing added this to 1800ml zeolite.

JAM 6126116

Work continued to Page

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

WITNESS

DATE

DATE

*[Signature]*  
M. Gub...

6/22/16  
6/28/16

**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

## **Balances and DI Water Verification Logs**

Balance Number	Asset Number	Manufacturer	Serial Number	Location	Number of Places	Maximum Weight
135	020014	Mettler Toledo	B338797310	Lab 47	4 <sup>th</sup> 5 <sup>th</sup>	220 g 81 g

Date	Operator	Std Wt. 200 g AN # 011988 Tolerance: 199.9800-200.0200 g Recorded Wt. (mg)	Std Wt. 2 g AN # 020641 Tolerance: 1.99980-2.00020 g Recorded Wt. (mg)	Std Wt. 0.02 g AN # 012685 Tolerance: 0.01995-0.02005 g Recorded Wt. (mg)
6/10/16	JAM	199.9998	2.00003	0.01995
6/13/16	SAM	199.9996	1.99996	0.02001
6/14/16	SAM	199.9998	1.99999	0.02003
6/15/16	SAM	199.9996	1.99997	0.01999
6/16/16	KE	199.9998	2.00013	0.02002
6-17-16	KE	199.9998	2.00000	0.02001
6-19-16	SAM	199.9997	1.99998	0.02000
6-20-16	KE	199.9994	2.00005	0.01998
6/21/16	SAM	199.9997	1.99998	0.01997
6-22-16	KE	199.9997	1.99996	0.01996
6-23-16	KE	199.9996	1.99995	0.01998
6-24-16	KE	199.9996	1.99996	0.01997
6/27/16	SAM	199.9997	2.00004	0.02000
6-28-16	KE	199.9998	2.00000	0.02002

Comments:

Book I.D.# 11-0406-062

Balance Number	Asset Number	Manufacturer	Model Number	Location	Number of Places	Maximum Weight
89	014982	Mettler Toledo	XP5003S	Lab 24	2 <sup>nd</sup> 3 <sup>rd</sup>	5100 g 1000 g

[illegible]

**Comments:**

**D.I. WATER SYSTEM NOTEBOOK**  
**SOUTHWEST RESEARCH INSTITUTE**  
**BUILDING 70**

Contact Enviroqua Water Technologies (1-800-466-7873) for repairs/exchanges. (Make sure to have a P.O.)

**HIGH PURITY SYSTEM (HP)**

DATE / TIME	INITIALS	RESISTIVITY MONITOR		QC LIGHTS		USAGE (GALS)	COMMENTS
		(M OHMS)	QC LT.	QC 1	QC 2		
5/9/16 1735	Dkmz	17.93	✓	✓	✓	n/a	✓
5/10/16 1801	Dkmz	17.94	✓	✓	✓	n/a	✓
5/13/16 1810	Dkmz	17.94	✓	✓	✓	n/a	✓
5/16/16 1715	Dkmz	17.93	✓	✓	✓	n/a	✓
5/17/16 1930	Dkmz	17.94	✓	✓	✓	n/a	✓
5/18/16 1801	Dkmz	17.94	✓	✓	✓	n/a	✓
5/19/16 1805	Dkmz	17.94	✓	✓	✓	n/a	✓
5/20/16 1650	Dkmz	17.94	✓	✓	✓	n/a	✓
5/21/16 1807	Dkmz	17.93	✓	✓	✓	n/a	✓
5/24/16 1811	Dkmz	17.93	✓	✓	✓	n/a	✓
5/25/16 1747	Dkmz	17.93	✓	✓	✓	n/a	✓
5/26/16 1800	Dkmz	17.93	✓	✓	✓	n/a	✓
5/27/16 1547	Dkmz	17.93	✓	✓	✓	n/a	✓
5/31/16 1651	Dkmz	17.94	✓	✓	✓	n/a	✓
6/1/16 1801	Dkmz	17.93	✓	X	✓	n/a	X-change needed??
6/2/16 1710	Dkmz	17.93	✓	X	✓	n/a	-tank exchange needed

Legend: Check = Green (OK); X = Red (call for service)

**LOW PURITY SYSTEM (LP)**

DATE / TIME	INITIALS	QC LIGHTS		USAGE (GALS)	COMMENTS
		QC 1	QC 2		
5/9/16 1736	Dkmz	✓	18.0	37407.4	✓
5/10/16 1802	Dkmz	✓	18.0	37408.1	✓
5/13/16 1812	Dkmz	✓	18.0	37411.6	✓
5/16/16 1716	Dkmz	✓	18.0	37426.5	✓
5/17/16 1931	Dkmz	✓	18.0	37427.6	✓
5/18/16 1803	Dkmz	✓	18.0	37435.3	✓
5/19/16 1806	Dkmz	✓	18.0	37446.7	✓
5/20/16 1651	Dkmz	✓	18.0	37448.4	✓
5/22/16 1808	Dkmz	✓	18.0	37462.1	✓
5/24/16 1812	Dkmz	✓	18.0	37463.5	✓
5/25/16 1748	Dkmz	✓	18.0	37464.6	✓
5/26/16 1821	Dkmz	✓	18.0	37472.5	✓
5/27/16 1548	Dkmz	✓	18.0	37473.0	✓
5/31/16 1657	Dkmz	✓	18.0	37473.9	✓
6/1/16 1802	Dkmz	✓	18.0	37476.7	✓
6/2/16 1711	Dkmz	✓	18.0	37480.1	✓

Legend: Check = Green (OK); X = Red (call for service)

**D.I. WATER SYSTEM NOTEBOOK**  
**SOUTHWEST RESEARCH INSTITUTE**  
**BUILDING 70**

Contact Enviroqua Water Technologies (1-800-466-7873) for repairs/exchanges. (Make sure to have a P.O.)

**HIGH PURITY SYSTEM (HP)**

DATE / TIME	INITIALS	RESISTIVITY MONITOR		QC LIGHTS		USAGE (GALS)	COMMENTS
		(M OHMS)	QC LT.	QC 1	QC 2		
6/3/16 1757	DRMZ	17.94	✓	X	✓	n/a	Call placed
6/6/16 1804	DRMZ	17.94	✓	X	✓	n/a	pending
6/7/16 1700	DRMZ	17.93	✓	X	✓	n/a	pending
6/8/16 1702	DRMZ	17.93	✓	X	✓	n/a	still pending
6/9/16 1728	DRMZ	17.93	✓	X	✓	n/a	pending
6/10/16 1630	DRMZ	17.93	✓	X	✓	n/a	PENDING EXCHANGE
6/13/16 1655	DRMZ	17.93	✓	✓	✓	n/a	MOVED RED TANK V-1 change. All OK
6/14/16 1815	DRMZ	17.93	✓	✓	✓	n/a	✓
6/15/16 1817	DRMZ	17.93	✓	✓	✓	n/a	✓
6/16/16 1750	DRMZ	17.93	✓	✓	✓	n/a	✓
6/17/16 1950	DRMZ	17.93	✓	✓	✓	n/a	✓
6/20/16 1755	DRMZ	17.94	✓	✓	✓	n/a	✓
6/21/16 1735	DRMZ	17.92	✓	✓	✓	n/a	✓
6/22/16 1800	DRMZ	17.93	✓	✓	✓	n/a	✓
6/23/16 1751	DRMZ	17.92	✓	✓	✓	n/a	✓
6/24/16 1729	DRMZ	17.92	✓	✓	✓	n/a	✓

Legend: Check = Green (OK); X = Red (call for service)

**LOW PURITY SYSTEM (LP)**

DATE / TIME	INITIALS	QC LIGHTS		USAGE (GALS)	COMMENTS
		QC 1	QC 2		
6/3/16 1758	DRMZ	✓	✓ 18.0	37482.2	✓
6/6/16 1857	DRMZ	✓	✓ 18.0	37484.3	✓
6/7/16 1701	DRMZ	✓	✓ 18.0	37489.2	✓
6/8/16 1703	DRMZ	✓	✓ 18.0	37491.8	✓
6/9/16 1729	DRMZ	✓	✓ 18.0	37492.6	✓
6/10/16 1631	DRMZ	✓	✓ 18.0	37499.3	✓
6/13/16 1656	DRMZ	✓	✓ 18.0	37501.4	✓
6/14/16 1816	DRMZ	✓	✓ 18.0	37520.5	✓
6/15/16 1818	DRMZ	✓	✓ 18.0	37521.3	✓
6/16/16 1751	DRMZ	✓	✓ 18.0	37522.6	✓
6/17/16 1951	DRMZ	✓	✓ 18.0	37527.3	✓
6/20/16 1757	DRMZ	✓	✓ 18.0	37530.8	✓
6/21/16 1736	DRMZ	✓	✓ 18.0	37538.4	✓
6/22/16 1801	DRMZ	✓	✓ 18.0	37540.1	✓
6/23/16 1752	DRMZ	✓	✓ 18.0	37541.4	✓
6/24/16 1730	DRMZ	✓	✓ 18.0	37546.3	✓

Legend: Check = Green (OK); X = Red (call for service)



**SOUTHWEST RESEARCH INSTITUTE**  
**CLIENT: Los Alamos National Laboratory**  
**SwRI PROJECT#: 21592.01.00X**  
**SwRI TASK ORDER: 160627-5**  
**SwRI SRR: 57871**  
**SDG: 599959**  
**VTSR: 06.24.2016**

## **Certificates of Calibration**



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	46011
Asset Number:	018344	Calibrated:	2/1/2016
Description:	OVEN	Calibration Due:	2/1/2017
Manufacturer:	THERMO SCIENTIFIC	Data Type:	FOUND / LEFT
Model Number:	HERATHERM OMS60	Temp./RH:	70 °F / 42 %
Serial Number:	41241291	Work Order #	403137157
Calibration Procedure:	OVENS, CHAMBERS, INCUBA		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

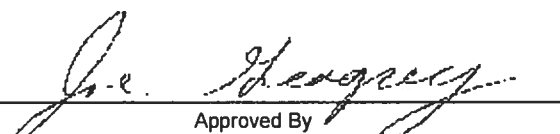
Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

Remarks:

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
015454	HART SCIENTIFIC	5627A	THERMOMETER PRT	2/18/2016
018495	FLUKE	1523	TEMPERATURE METER	2/18/2016

  
Approved By

Calibrated By: RRV  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403137157	Mfr:	Thermo Scientific	Technician:	RRV
Asset No:	018344	Model:	Heratherm OMS60	Type Data:	Found-left
Serial No:	41241291	Type:	Oven Chamber	Cal Date:	1-Feb-16

Remarks: Calibration limits per customer request. Chamber exceeds 70% of limit at the 200 °C test point.  
Customer to determine if the result found meets their requirements. Temperature uniformity not calibrated

Function/Range	Test Point	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
50 °C	50.4	50.0	-0.4	2.0	0.18	Pass	20%
100 °C	101.0	100.0	-1.0			Pass	50%
150 °C	152.1	150.0	-2.1	3.0		Pass	70%
200 °C	203.2	200.0	-3.2	4.0		Pass	80%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	36974
Asset Number:	022396	Calibrated:	8/19/2015
Description:	THERMOCOUPLE, TYPE K	Calibration Due:	8/19/2016
Manufacturer:	DIGI-SENSE	Data Type:	AS LEFT
Model Number:	93631-11	Temp./RH:	73.6°F / 58 %
Serial Number:	22396	Work Order #	403133757
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

### Remarks:

CAL -80 °C TO 1000 °C. See Measurement Report for values and limits applied.

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009137	HART SCIENTIFIC	1575	SUPER THERMOMETER	1/13/2016
010281	HART SCIENTIFIC	5628	SPRT	2/19/2016
010814	HART SCIENTIFIC	1529	TEMPERATURE METER	11/21/2015
013617	HART SCIENTIFIC	5650	THERMOCOUPLE PROBE TYPE S	5/8/2016
013908	HART SCIENTIFIC	5628	SPRT	2/18/2016
015240	HART SCIENTIFIC	2566	THERMOCOUPLE SCANNER, 12-1	11/20/2015

  
Approved By

Calibrated By: MAR  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403133757	Mfr.	Digi-Sense	Technician:	Mark Romero
Asset No.	022396	Model	93631-11	Type Data:	As-found
Serial No.	22396	Type.	Thermocouple, Type K	Cal Date:	18-Aug-15
Remarks:					

Function/Range	Test Point	TI Reading	Difference	+/- Limit	+/- Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-79.6	-76.1	3.5	2.2	0.5	Fail	159%
	99.7	99.3	-0.4	2.2	0.5	Pass	20%
	398.4	401.4	3.0	3.0	1.3	Fail?	100%
	699.3	702.6	3.3	5.2	1.3	Pass	63%
	1002.6	1002.4	-0.2	7.5	1.3	Pass	3%

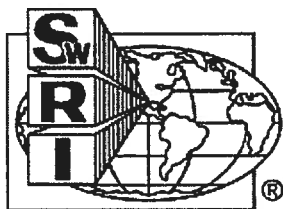
END OF REPORT

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403133757	Mfr.	Digi-Sense	Technician:	Mark Romero
Asset No.	022396	Model	93631-11	Type Data:	As-left
Serial No.	22396	Type.	Thermocouple, Type K	Cal Date:	19-Aug-15
Remarks: limits set to $\pm 5\%$ of reading for test point at -80 °C and 400 °C and above, per customer. Remainder of test points calibrated to standard Type K limits.					

Function/Range	Test Point	TI Reading	Difference	+/- Limit	+/- Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-79.6	-76.1	3.5	4.0	0.5	Pass	88%
	-44.4	-42.8	1.6	2.2	0.5	Pass	73%
	-0.1	0.3	0.4	2.2	0.5	Pass	18%
	99.7	99.3	-0.4	2.2	0.5	Pass	20%
	398.4	401.4	3.0	20.0	1.3	Pass	15%
	699.3	702.6	3.3	35.0	1.3	Pass	9%
	1002.6	1002.4	-0.2	50.0	1.3	Pass	0%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	47205
Asset Number:	022923	Calibrated:	2/22/2016
Description:	THERMOCOUPLE TYPE K	Calibration Due:	2/22/2017
Manufacturer:	DIGI-SENSE	Data Type:	AS LEFT
Model Number:	08516-96	Temp./RH:	74.7°F / 38 %
Serial Number:	22923	Work Order #	403137431
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

### Remarks:

CAL -45 °C TO 1100 °C. Limits at -45 °C  $\pm 3$  °C, rest of range meets normal type K specifications.

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009414	HART SCIENTIFIC	1502A	TEMPERATURE METER W/PROB	6/22/2016
010814	HART SCIENTIFIC	1529	TEMPERATURE METER	11/3/2016
013617	HART SCIENTIFIC	5650	THERMOCOUPLE PROBE TYPE S	5/8/2016
015240	HART SCIENTIFIC	2566	THERMOCOUPLE SCANNER, 12-1	11/3/2016
015895	HART SCIENTIFIC	5618B	RTD	6/22/2016

  
Approved By

Calibrated By: MAR  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403137431	Mfr:	Digi-Sense	Technician:	Mark Romero
Asset No.:	022923	Model:	08516-96	Type Data:	As-found
Serial No.:	22923	Type:	Thermocouple Type K	Cal Date:	18-Feb-16
Remarks:					

Function/Range	Test Point	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-79.1	-76.3	2.8	2.2	0.5	Fail	127%
	0.2	0.0	-0.2	2.2	0.5	Pass	9%
	396.7	396.0	-0.7	3.0	1.3	Pass	24%
	698.9	698.0	-0.9	5.2	1.3	Pass	17%
	1101.6	1094.9	-6.7	8.3	1.3	Pass	81%

END OF REPORT



Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403137431	Mfr:	Digi-Sense	Technician:	Mark Romero
Asset No.:	022923	Model:	08516-96	Type Data:	As-left
Serial No.:	22923	Type:	Thermocouple Type K	Cal Date:	22-Feb-16
Remarks: customer requested limits for test point -45 °C be $\pm 3$ °C. A reading exceeded 70% of limits. Customer to determine if readings meet their requirements.					

Function/Range	Test Point	TI Reading	Difference	$\pm$ Limit	$\pm$ Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-44.9	-43.0	1.9	3.0	0.5	Pass	63%
	0.2	0.0	-0.2	2.2	0.5	Pass	9%
	396.7	396.5	-0.2	3.0	1.3	Pass	7%
	698.9	698.0	-0.9	5.2	1.3	Pass	17%
	1101.6	1094.9	-6.7	8.3	1.3	Pass	81%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	38184
Asset Number:	022488	Calibrated:	9/10/2015
Description:	THERMOCOUPLE PROBE TYPE K	Calibration Due:	9/10/2016
Manufacturer:	DIGI-SENSE	Data Type:	FOUND / LEFT
Model Number:	08516-96	Temp./RH:	73.2°F / 62 %
Serial Number:	22488	Work Order #	403134274
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCCL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

### Remarks:

CAL -40 °C TO 1000 °C

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009137	HART SCIENTIFIC	1575	SUPER THERMOMETER	1/13/2016
010281	HART SCIENTIFIC	5628	SPRT	2/19/2016
010814	HART SCIENTIFIC	1529	TEMPERATURE METER	11/21/2015
013617	HART SCIENTIFIC	5650	THERMOCOUPLE PROBE TYPE S	5/8/2016
013908	HART SCIENTIFIC	5628	SPRT	2/18/2016
015240	HART SCIENTIFIC	2566	THERMOCOUPLE SCANNER, 12-1	11/20/2015

  
Approved By

Calibrated By: MAR  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134274	Mfr.	Digi-Sense	Technician:	Mark Romero
Asset No.	022488	Model	08516-96	Type Data:	Found-left
Serial No.	22488	Type.	Thermocouple Probe, Type K	Cal Date:	10-Sep-15
Remarks: a reading exceeded 70% of limits. No adjustment possible. Customer to determine if readings meet their requirements.					

Function/Range	Test Point	TI Reading	Difference	+/- Limit	+/- Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-39.8	-37.9	1.9	2.2	0.5	Pass	86%
	99.7	99.2	-0.5	2.2	0.5	Pass	24%
	498.0	498.3	0.4	3.7	1.3	Pass	9%
	750.3	749.9	-0.4	5.6	1.3	Pass	7%
	1002.9	1000.5	-2.4	7.5	1.3	Pass	32%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	38121
Asset Number:	022476	Calibrated:	9/9/2015
Description:	THERMOCOUPLE PROBE TYPE K	Calibration Due:	9/9/2016
Manufacturer:	DIGI-SENSE	Data Type:	FOUND / LEFT
Model Number:	08516-96	Temp./RH:	74.3°F / 56 %
Serial Number:	22476	Work Order #	403134199
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

### Remarks:

CAL -40 °C TO 1000 °C

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009137	HART SCIENTIFIC	1575	SUPER THERMOMETER	1/13/2016
010281	HART SCIENTIFIC	5628	SPRT	2/19/2016
010814	HART SCIENTIFIC	1529	TEMPERATURE METER	11/21/2015
013617	HART SCIENTIFIC	5650	THERMOCOUPLE PROBE TYPE S	5/8/2016
013908	HART SCIENTIFIC	5628	SPRT	2/18/2016
015240	HART SCIENTIFIC	2566	THERMOCOUPLE SCANNER, 12-1	11/20/2015

  
Approved By

Calibrated By: MAR  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134199	Mfr.	Digi-Sense	Technician:	Mark Romero
Asset No.	022476	Model	08516-96	Type Data:	Found-left
Serial No.	22476	Type.	Thermocouple Probe, Type K	Cal Date:	9-Sep-15
Remarks: a reading exceeded 70% of limits. No adjustment possible. Customer to determine if readings meet their requirements.					

Function/Range	Test Point	TI Reading	Difference	+/- Limit	+/- Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-39.8	-37.9	1.9	2.2	0.5	Pass	86%
	99.7	99.0	-0.7	2.2	0.5	Pass	33%
	498.0	497.7	-0.3	3.7	1.3	Pass	7%
	750.3	749.6	-0.7	5.6	1.3	Pass	12%
	1002.9	999.9	-3.0	7.5	1.3	Pass	40%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	53401
Asset Number:	023174	Calibrated:	5/25/2016
Description:	THERMOCOUPLE TYPE K	Calibration Due:	5/25/2017
Manufacturer:	DIGI-SENSE	Data Type:	FOUND / LEFT
Model Number:	08516-96	Temp./RH:	75.4°F / 57 %
Serial Number:	23174	Work Order #	403139870
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

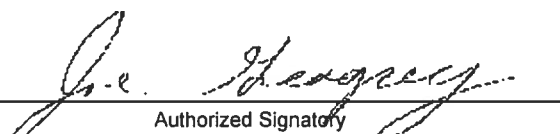
Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

Remarks:  
CAL -45 °C TO 200 °C.

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009137	HART SCIENTIFIC	1575	SUPER THERMOMETER	12/9/2016
010281	HART SCIENTIFIC	5628	SPRT	4/29/2017
013908	HART SCIENTIFIC	5628	SPRT	2/24/2017
015240	HART SCIENTIFIC	2566	THERMOCOUPLE SCANNER, 12-1	11/3/2016

  
Authorized Signatory

Calibrated By: MAR  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403139870	Mfr:	Digi-Sense	Technician:	Mark Romero
Asset No.:	023174	Model:	08516-96	Type Data:	Found-left
Serial No.:	23174	Type:	Thermocouple Type K	Cal Date:	25-May-16
Remarks: a reading exceeded 70% of limits. No adjustment possible. Customer to determine if reading meets their requirements.					

Function/Range	Test Point	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-44.9	-43.0	1.9	2.2	0.5	Pass	86%
	0.0	0.3	0.3	2.2	0.5	Pass	14%
	99.7	99.4	-0.3	2.2	0.5	Pass	14%
	200.5	200.8	0.3	2.2	0.5	Pass	14%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	38118
Asset Number:	022473	Calibrated:	9/9/2015
Description:	THERMOCOUPLE PROBE TYPE K	Calibration Due:	9/9/2016
Manufacturer:	DIGI-SENSE	Data Type:	FOUND / LEFT
Model Number:	08516-96	Temp./RH:	74.3°F / 56 %
Serial Number:	22473	Work Order #	403134196
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

### Remarks:

CAL -40 °C TO 1000 °C

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009137	HART SCIENTIFIC	1575	SUPER THERMOMETER	1/13/2016
010281	HART SCIENTIFIC	5628	SPRT	2/19/2016
010814	HART SCIENTIFIC	1529	TEMPERATURE METER	11/21/2015
013617	HART SCIENTIFIC	5650	THERMOCOUPLE PROBE TYPE E	5/8/2016
013908	HART SCIENTIFIC	5628	SPRT	2/18/2016

  
Approved By

Calibrated By: MAR  
Metrology Technician

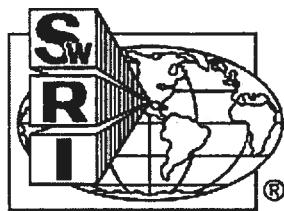


Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134196	Mfr.	Digi-Sense	Technician:	Mark Romero
Asset No.	022473	Model	08516-96	Type Data:	Found-left
Serial No.	22473	Type.	Thermocouple Probe, Type K	Cal Date:	9-Sep-15
Remarks: a reading exceeded 70% of limits. No adjustment possible. Customer to determine if readings meet their requirements.					

Function/Range	Test Point	TI Reading	Difference	+/- Limit	+/- Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-39.8	-38.2	1.6	2.2	0.5	Pass	72%
	99.7	99.2	-0.5	2.2	0.5	Pass	24%
	498.0	498.7	0.8	3.7	1.3	Pass	20%
	750.3	750.9	0.6	5.6	1.3	Pass	11%
	1002.9	1001.5	-1.4	7.5	1.3	Pass	19%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	47207
Asset Number:	022925	Calibrated:	2/22/2016
Description:	THERMOCOUPLE TYPE K	Calibration Due:	2/22/2017
Manufacturer:	DIGI-SENSE	Data Type:	AS LEFT
Model Number:	08516-96	Temp./RH:	74.7°F / 38 %
Serial Number:	22925	Work Order #	403137433
Calibration Procedure:	TEMPERATURE PROBES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

### Remarks:

CAL -45 °C TO 1100 °C. Limits at -45 °C  $\pm 3$  °C, rest of range meets normal type K specifications.

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
009414	HART SCIENTIFIC	1502A	TEMPERATURE METER W/PROB	6/22/2016
010814	HART SCIENTIFIC	1529	TEMPERATURE METER	11/3/2016
013617	HART SCIENTIFIC	5650	THERMOCOUPLE PROBE TYPE S	5/8/2016
015240	HART SCIENTIFIC	2566	THERMOCOUPLE SCANNER, 12-1	11/3/2016
015895	HART SCIENTIFIC	5618B	RTD	6/22/2016

  
Approved By

Calibrated By: MAR  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403137433	Mfr:	Digi-Sense	Technician:	Mark Romero
Asset No.:	022925	Model:	08516-96	Type Data:	As-found
Serial No.:	22925	Type:	Thermocouple Type K	Cal Date:	18-Feb-16
Remarks:					

Function/Range	Test Point	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-79.1	-75.9	3.2	2.2	0.5	Fail	145%
	0.2	0.2	0.0	2.2	0.5	Pass	0%
	396.7	396.4	-0.3	3.0	1.3	Pass	10%
	698.9	698.5	-0.4	5.2	1.3	Pass	8%
	1101.6	1095.9	-5.7	8.3	1.3	Pass	69%

END OF REPORT

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403137433	Mfr:	Digi-Sense	Technician:	Mark Romero
Asset No.:	022925	Model:	08516-96	Type Data:	As-left
Serial No.:	22925	Type:	Thermocouple Type K	Cal Date:	22-Feb-16
Remarks: customer requested limits for test point -45 °C be $\pm 3$ °C. A reading exceeded 70% of limits. Customer to determine if readings meet their requirements.					

Function/Range	Test Point	TI Reading	Difference	$\pm$ Limit	$\pm$ Uncertainty	Result	% Limit
Temperature	°C	°C	°C	°C	°C		
	-44.9	-42.5	2.4	3.0	0.5	Pass	80%
	0.2	0.2	0.0	2.2	0.5	Pass	0%
	396.7	396.4	-0.3	3.0	1.3	Pass	10%
	698.9	698.5	-0.4	5.2	1.3	Pass	8%
	1101.6	1095.9	-5.7	8.3	1.3	Pass	69%

END OF REPORT



# Southwest Research Institute

## Calibration Certificate



Cost Center:	01 CHEMISTRY & CHEMICAL ENGINEERING	Certificate Number:	39984
Asset Number:	020014	Calibrated:	10/7/2015
Description:	BALANCE	Calibration Due:	10/7/2016
Manufacturer:	METTLER	Data Type:	FOUND / LEFT
Model Number:	XS205DU	Temp./RH:	72 °F / 49 %
Serial Number:	B338797310	Work Order #	403134943
Calibration Procedure:	BALANCES & SCALES		

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

Remarks:

### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
001704	TROEMNER	1 G	WEIGHT CLASS 1	12/10/2015
001705	TROEMNER	2 G	WEIGHT CLASS 1	7/2/2016
001706	RICE LAKE	2 G	WEIGHT CLASS 1	7/8/2016
001707	TROEMNER	5 G	WEIGHT CLASS 1	7/29/2016
001708	RICE LAKE	10 G	WEIGHT CLASS 1	7/2/2016
001709	TROEMNER	20 G	WEIGHT CLASS 1	8/5/2016
001710	TROEMNER	20 G	WEIGHT CLASS 1	8/5/2016

Approved By

Calibrated By: RRV  
Metrology Technician



# Southwest Research Institute

## Calibration Certificate



Calibration Laboratory  
Certificate # 3759.01

001711	TROEMNER	50 G	WEIGHT CLASS 1	7/2/2016
001712	TROEMNER	100 G	WEIGHT CLASS 1	7/29/2016
001713	RICE LAKE	200 G	WEIGHT CLASS 1	9/30/2016

Approved By

Calibrated By: RRV  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134943	Mfr:	Mettler	Technician:	RRV
Asset No.:	020014	Model:	XS205DU	Type Data:	Found-left
Serial No.:	B338797310	Type:	Balance	Cal Date:	7-Oct-15
Remarks:					

Function/Range	Applied	TI Reading	Difference	± Limit		Result	% Limit
Corner Load	grams	grams	grams	grams			
Reference	100						
Left Front		100.0002	0.0002	0.0006		Pass	33%
Left Rear		100.0003	0.0003			Pass	50%
Right Rear		100.0001	0.0001			Pass	17%
Right Front		100.0002	0.0002			Pass	33%
Repeatability							
< 81 g Range							
1	80	80.00001					
2		80.00002					
3		80.00001					
4		80.00002					
5		80.00001					
6		80.00002					
7		80.00002					
8		80.00002					
9		80.00002					
10		80.00002					
Std Deviation		0.000005		0.00008		Pass	6%
< 220 g Range							
1	200	200.0001					
2		200.0000					
3		200.0002					
4		200.0001					
5		200.0002					
6		200.0001					
7		200.0002					
8		200.0002					
9		200.0002					
10		200.0002					
Std Deviation		0.00007		0.00020		Pass	35%
Function/Range	Applied	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Direct Weighing	grams	grams	milligrams	milligrams	milligrams		
< 81 g Range	0.00000	0.00000	0.00	0.40	0.06	Pass	0%
	8.00001	8.00002	0.01			Pass	3%
	15.99996	15.99995	-0.01			Pass	3%
	24.00005	24.00010	0.05			Pass	13%
	32.00000	32.00006	0.06			Pass	15%
	40.00002	40.00007	0.05			Pass	13%
	48.00003	48.00006	0.03			Pass	8%

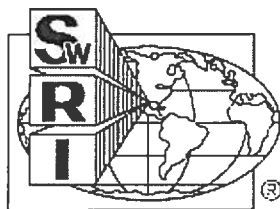
Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134943	Mfr:	Mettler	Technician:	RRV
Asset No.:	020014	Model:	XS205DU	Type Data:	Found-left
Serial No.:	B338797310	Type:	Balance	Cal Date:	7-Oct-15

Function/Range	Applied	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Direct Weighing (Cont)	grams	grams	milligrams	milligrams	milligrams		
< 81 g Range	55.99998	56.00006	0.08	0.40	0.06	Pass	20%
	63.99999	64.00014	0.15			Pass	38%
	72.00002	72.00018	0.16			Pass	40%
	79.99998	80.00009	0.11			Pass	28%
Direct Weighing	0.0000	0.0000	0.0	0.4	0.18	Pass	0%
< 220 g Range	20.0000	20.0001	0.1			Pass	25%
	40.0000	40.0000	0.0			Pass	0%
	60.0000	60.0001	0.1			Pass	25%
	80.0000	80.0001	0.1			Pass	25%
	100.0001	100.0000	-0.1			Pass	25%
	120.0001	120.0001	0.0			Pass	0%
	140.0001	140.0002	0.1			Pass	25%
	160.0001	160.0002	0.1			Pass	25%
	180.0001	180.0002	0.1			Pass	25%
	199.9999	200.0002	0.3			Pass	75%

END OF REPORT





# Southwest Research Institute

## Calibration Certificate



Calibration Laboratory  
Certificate # 3759.01

Cost Center: 01 CHEMISTRY & CHEMICAL ENGINEERING  
Asset Number: 014982  
Description: BALANCE  
Manufacturer: METTLER  
Model Number: XP5003SDR  
Serial Number: 1129300727  
Calibration Procedure: BALANCES & SCALES

Certificate Number: 39314  
Calibrated: 9/25/2015  
Calibration Due: 9/25/2016  
Data Type: FOUND / LEFT  
Temp./RH: 73 °F / 48 %  
Work Order # 403134658

This certificate documents traceability to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or other national metrology institute. The laboratory quality system is compliant to ISO/IEC 17025 2005, ANSI/NCSL Z540-1-1994 and relevant requirements of ISO 9001-2008. This certificate shall not be reproduced, except in full, without written approval of Southwest Research Institute Calibration Laboratory and shall not be used to claim product endorsement by SwRI® or any agency of the U.S. Government.

Results of this calibration relate only to the instrument described above at the time of calibration and does not imply any long term stability. Date due for recalibration is determined by the customer and does not imply the instrument will remain within limits, as any number of factors may cause an out of tolerance condition before this date.

Data type shall be interpreted as follows: Found-left - data recorded and no adjustment or repair was performed. As-left - data recorded after adjustment or repair was performed. As-found data are reviewed and the customer notified when the as-found results are other than pass and/or greater than 70 percent of the test limit. Pass? or Fail? indicate the measured value, plus or minus the expanded uncertainty, overlap the test limit and it is not possible to state Pass or Fail with a 95% confidence level. No statement of compliance with manufacturer or other specification is made or implied by this certificate. The customer has sole responsibility for determination of in/out-of-tolerance or compliance/noncompliance for the intended use of the instrument.

Measurement uncertainties are calculated in accordance with the methods described in the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM) as an expanded uncertainty with a coverage factor of  $k = 2$  to approximately a 95% level of confidence. See Remarks or attached Measurement Report with the same Work Order number for data.

Remarks:

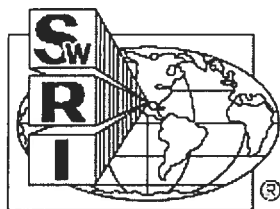
### Standards Used To Calibrate Equipment

Asset	Manufacturer	Model	Description	Cal. Due Date
001712	TROEMNER	100 G	WEIGHT CLASS 1	7/29/2016
001713	RICE LAKE	200 G	WEIGHT CLASS 1	10/1/2015
001714	TROEMNER	200 G	WEIGHT CLASS 1	1/12/2016
001715	RICE LAKE	500 G	WEIGHT CLASS S	7/8/2016
001716	RICE LAKE	1 KG	WEIGHT CLASS 1	4/7/2016
001717	RICE LAKE	2 KG	WEIGHT CLASS 1	4/7/2016
001718	RICE LAKE	2 KG	WEIGHT CLASS 1	4/7/2016

Approved By

Calibrated By RRV  
Metrology Technician

010065



# Southwest Research Institute Calibration Certificate



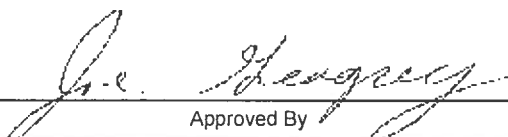
Calibration Laboratory  
Certificate # 3759.01  
4/7/2016

001719

RICE LAKE

5 KG

WEIGHT CLASS 1

  
Approved By

Calibrated By: RRV  
Metrology Technician

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134658	Mfr:	Mettler	Technician:	RRV
Asset No.:	014982	Model:	XP5003SDR	Type Data:	Found-left
Serial No.:	1129300727	Type:	Balance	Cal Date:	25-Sep-15
Remarks:					

Function/Range	Applied	TI Reading	Difference	± Limit		Result	% Limit
Corner Load	grams	grams	grams	grams			
Left Front	1000	1000.000	0.000	0.010		Pass	0%
Left Rear		999.999	-0.001			Pass	10%
Right Rear		1000.000	0.000			Pass	0%
Right Front		1000.001	0.001			Pass	10%
Repeatability							
1000 g Range							
1	500	500.002					
2		500.000					
3		500.001					
4		500.002					
5		500.000					
6		500.000					
7		500.001					
8		500.001					
9		500.001					
10		500.000					
Std Deviation		0.0008		0.0020		Pass	40%
5100 g Range							
1	2000	199.99					
2		200.00					
3		199.99					
4		199.99					
5		200.00					
6		200.00					
7		199.99					
8		199.99					
9		199.99					
10		199.99					
Std Deviation		0.005		0.012		Pass	42%
Function/Range	Applied	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Direct Weighing	grams	grams	grams	grams	grams		
1000 g Range	0.000	0.000	0.000	0.012	0.003	Pass	0%
	100.000	100.001	0.001			Pass	8%
	200.000	200.001	0.001			Pass	8%
	300.000	300.001	0.001			Pass	8%
	400.000	400.001	0.001			Pass	8%
	500.000	500.002	0.002			Pass	17%
	600.000	600.003	0.003			Pass	25%
	700.000	700.002	0.002			Pass	17%

Southwest Research Institute  
Calibration Laboratory  
Measurement Report

Work Order:	403134658	Mfr:	Mettler	Technician:	RRV
Asset No.:	014982	Model:	XP5003SDR	Type Data:	Found-left
Serial No.:	1129300727	Type:	Balance	Cal Date:	25-Sep-15

Function/Range	Applied	TI Reading	Difference	± Limit	± Uncertainty	Result	% Limit
Direct Weighing (Cont)	grams	grams	grams	grams	grams		
1000 g Range	800.000	800.002	0.002	0.012	0.003	Pass	17%
	900.000	900.001	0.001			Pass	8%
	1000.000	1000.000	0.000			Pass	0%
5100 g Range	0.000	0.000	0.000	0.012	0.003	Pass	0%
	500.000	500.001	0.001			Pass	8%
	1000.000	999.999	-0.001			Pass	8%
	1500.00	1500.00	0.00	0.02	0.01	Pass	0%
	2000.00	2000.00	0.00			Pass	0%
	2500.00	2500.00	0.00			Pass	0%
	3000.00	3000.00	0.00			Pass	0%
	3500.00	3500.00	0.00			Pass	0%
	4000.00	4000.00	0.00			Pass	0%
	4500.00	4500.00	0.00			Pass	0%
	5000.00	5000.00	0.00			Pass	0%

END OF REPORT

**SOUTHWEST RESEARCH INSTITUTE  
CLIENT: Los Alamos National Laboratory  
SwRI PROJECT#: 21592.01.00X  
SwRI TASK ORDER: 160627-5  
SwRI SRR: 57871  
SDG: 599959  
VTSR: 06.24.2016**

**Certificates of Analysis  
for Chemicals**



1 Reagent Lane  
Fair Lawn, NJ 07410  
201.796.7100 tel  
201.796.1329 fax

## Certificate of Analysis

Fisher Scientific's Quality System has been found to conform to Quality Management System Standard ISO9001:2008 standard by SAI Global Certificate Number CERT - 0064970

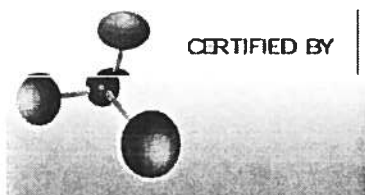
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69597

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69597



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701.

\*Based on suggested storage condition.

SwRI Chem ID: 69597



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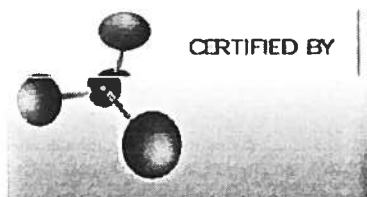
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69596

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69596



*Edgar E. Hane*

Lab Manager Fair Lawn

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\*Based on suggested storage condition.

SwRI Chem ID: 69596



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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SWRI Chem ID: 69595

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLORESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SWRI Chem ID: 69595



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701.  
\*Based on suggested storage condition.

SWRI Chem ID: 69595





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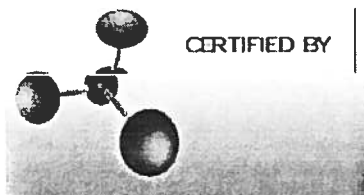
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69594

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69594



*Edgar E. Hane*

Lab Manager Fair Lawn

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\*Based on suggested storage condition.

SwRI Chem ID: 69594



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201.796.1329 fax

## Certificate of Analysis

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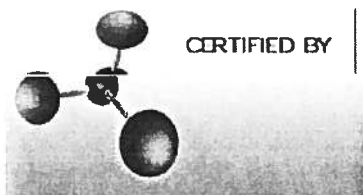
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69593

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69593



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701.  
\*Based on suggested storage condition.

SwRI Chem ID: 69593



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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69592

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69592



*Edgar E. Hane*

Lab Manager Fair Lawn

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SwRI Chem ID: 69592



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Catalog Number	A586	Quality Test / Release Date	3/25/2015
Lot Number	151702		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69573

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	Colorless crystals
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	0.002
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	<0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0015
SODIUM (Na)	%	<= 0.005	0.0024
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69573



*Edgar E. Hane*

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SwRI Chem ID: 69573



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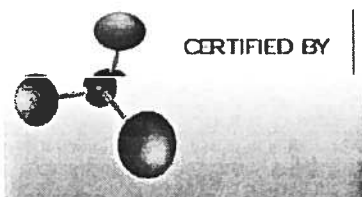
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SWRI Chem ID: 69574

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SWRI Chem ID: 69574



*Edgar E. Hane*

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SWRI Chem ID: 69574



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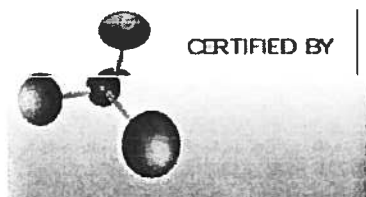
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69575

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG.C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69575



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SwRI Chem ID: 69575



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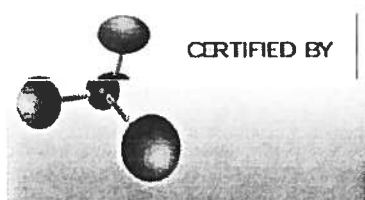
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69576

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69576



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SwRI Chem ID: 69576



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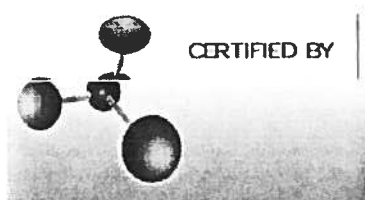
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69577

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69577



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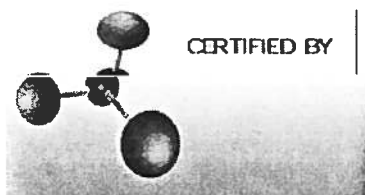
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69578

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69578



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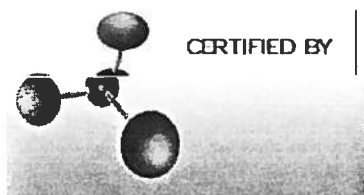
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SWRI Chem ID: 69579

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SWRI Chem ID: 69579



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SWRI Chem ID: 69579



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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69591

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69591



*Edgar E. Hane*

Lab Manager Fair Lawn

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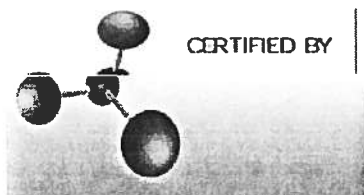
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Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SWRI Chem ID: 69590

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SWRI Chem ID: 69590



*Edgar E. Hane*

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SWRI Chem ID: 69590



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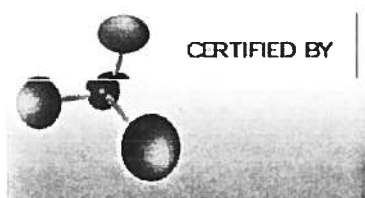
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69589

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69589



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701.

\*Based on suggested storage condition.

SwRI Chem ID: 69589



1 Reagent Lane  
Fair Lawn, NJ 07410  
201.796.7100 tel  
201.796.1329 fax

## Certificate of Analysis

Fisher Scientific's Quality System has been found to conform to Quality Management System Standard ISO9001:2008 standard by SAI Global Certificate Number CERT - 0064970

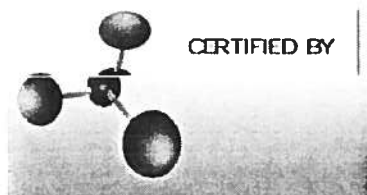
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69588

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69588



*Edgar E. Hane*

Lab Manager Fair Lawn

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\*Based on suggested storage condition.

SwRI Chem ID: 69588



1 Reagent Lane  
Fair Lawn, NJ 07410  
201.796.7100 tel  
201.796.1329 fax

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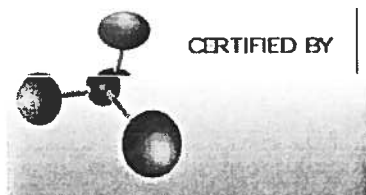
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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SWRI Chem ID: 69587

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SWRI Chem ID: 69587



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701.  
\*Based on suggested storage condition.

SWRI Chem ID: 69587



1 Reagent Lane  
Fair Lawn, NJ 07410  
201.796.7100 tel  
201.796.1329 fax

## Certificate of Analysis

Fisher Scientific's Quality System has been found to conform to Quality Management System  
Standard ISO9001:2008 standard by SAI Global Certificate Number CERT - 0064970

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Catalog Number	A586	Quality Test / Release Date	3/10/2015
Lot Number	151052		
Description	ALUMINUM NITRATE, A.C.S.		
Country of Origin	India	* Suggested Retest Date	Mar-2020

SwRI Chem ID: 69586

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	COLOLRESS CRYSTALS
ASSAY	%	Inclusive Between 98.0 - 102.0	99.2
CALCIUM (Ca)	%	<= 0.005	0.0010
CHLORIDE	%	<= 0.001	<0.0010
HEAVY METALS (as Pb)	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
INSOLUBLE MATTER	%	<= 0.005	<0.005
IRON (Fe)	%	<= 0.002	<0.0020
MAGNESIUM (Mg)	%	<= 0.001	0.0010
PH 5% SOLUTION @ 25 DEG C		Inclusive Between 2.5 - 3.5	3.0
POTASSIUM (K)	%	<= 0.002	0.0020
SODIUM (Na)	%	<= 0.005	0.0020
SULFATE (SO4)	%	<= 0.005	<0.005

SwRI Chem ID: 69586



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-6701.  
\*Based on suggested storage condition.

SwRI Chem ID: 69586





Version 0  
 Molecular weight 236.15  
 Molecular formula  $\text{Ca N}_2 \text{O}_6 \cdot 4 \text{H}_2 \text{O}$   
 CAS No 13477-34-4  
 Linear formula  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$   
 Flash point (°C)

SwRI Chem ID: 69608

## Certificate of Analysis

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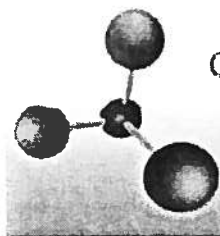
Catalog Number	42353	Quality Test / Release Date	27 January 2016
Lot Number	A0369187	Suggested Retest Date	January 2021
Description	Calcium nitrate tetrahydrate, 99+%, ACS reagent		
Country of Origin	UNITED STATES OF AMERICA		
Declaration of Origin	synthetic		

Origin Comment
----------------

Result Name	Specifications	Test Value
Appearance (Color)	White	White
Appearance (Form)	Crystals	Crystals
Titration Complexometric	99.0 to 103.0 %	100.6 %
Heavy metals (as Pb)	$\leq 5$ ppm	$\leq 5$ ppm
pH	5.0 to 7.0 (5 % at 25°C)	5.9 (5 % at 25°C)
Insoluble matter	$\leq 0.005$ %	$\leq 0.005$ %
Chloride (Cl)	$\leq 50$ ppm	$\leq 50$ ppm
Sulfate (SO <sub>4</sub> )	$\leq 20$ ppm	1 ppm
Barium (Ba)	$\leq 50$ ppm	$\leq 5$ ppm
Iron (Fe)	$\leq 5$ ppm	$\leq 5$ ppm
Nitrite (NO <sub>2</sub> )	$\leq 10$ ppm	ppm (none detected)
Magnesium (Mg)	$\leq 500$ ppm	9 ppm
Potassium (K)	$\leq 50$ ppm	20 ppm
Sodium (Na)	$\leq 100$ ppm	4 ppm
Strontium (Sr)	$\leq 500$ ppm	2 ppm

SwRI Chem ID: 69608

SwRI Chem ID: 69608



CERTIFIED BY

L. Van den Broek, QA Manager

Issued: 25 April 2016

Acros Organics

ENA23, zone 1, nr 1350, Janssen Pharmaceuticaaan 3a, B-2440 Geel, Belgium

Tel +32 14/57.52.11 - Fax +32 14/59.34.34 Internet: <http://www.acros.com>

1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



Version 0  
 Molecular weight 236.15  
 Molecular formula  $\text{Ca N}_2 \text{O}_6 \cdot 4 \text{H}_2 \text{O}$   
 CAS No 13477-34-4  
 Linear formula  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$   
 Flash point (°C)

SwRI Chem ID: 69607

## Certificate of Analysis

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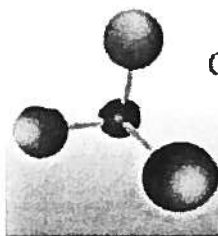
Catalog Number	42353	Quality Test / Release Date	27 January 2016
Lot Number	A0369187	Suggested Retest Date	January 2021
Description	Calcium nitrate tetrahydrate, 99+%, ACS reagent		
Country of Origin	UNITED STATES OF AMERICA		
Declaration of Origin	synthetic		

Origin Comment	
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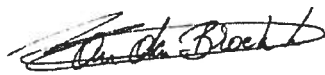
Result Name	Specifications	Test Value
Appearance (Color)	White	White
Appearance (Form)	Crystals	Crystals
Titration Complexometric	99.0 to 103.0 %	100.6 %
Heavy metals (as Pb)	$\leq 5$ ppm	$\leq 5$ ppm
pH	5.0 to 7.0 (5 % at 25°C)	5.9 (5 % at 25°C)
Insoluble matter	$\leq 0.005$ %	$\leq 0.005$ %
Chloride (Cl)	$\leq 50$ ppm	$\leq 50$ ppm
Sulfate (SO <sub>4</sub> )	$\leq 20$ ppm	1 ppm
Barium (Ba)	$\leq 50$ ppm	$\leq 5$ ppm
Iron (Fe)	$\leq 5$ ppm	$\leq 5$ ppm
Nitrite (NO <sub>2</sub> )	$\leq 10$ ppm	ppm (none detected)
Magnesium (Mg)	$\leq 500$ ppm	9 ppm
Potassium (K)	$\leq 50$ ppm	20 ppm
Sodium (Na)	$\leq 100$ ppm	4 ppm
Strontium (Sr)	$\leq 500$ ppm	2 ppm

SwRI Chem ID: 69607

SwRI Chem ID: 69607



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L. Van den Broek, QA Manager

Issued: 25 April 2016

Acros Organics

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SwRI Chem ID: 69607

SwRI Chem ID: 69607

SwRI Chem ID: 69607



Version 0  
 Molecular weight 400.14  
 Molecular formula  $\text{Cr N}_3 \text{O}_9 \cdot 9 \text{H}_2 \text{O}$   
 CAS No 7789-02-8  
 Linear formula  $\text{Cr}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$   
 Flash point (°C)

SwRI Chem ID: 66141

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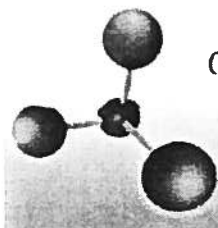
Catalog Number	21920	Quality Test / Release Date	8 May 2015
Lot Number	A0359678	Suggested Retest Date	May 2020
Description	Chromium(III) nitrate nonahydrate, 99%		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment	
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Result Name	Specifications	Test Value
Appearance (Color)	Dark purple to black	Dark purple
Appearance (Form)	Crystalline chunks	Crystalline chunks
Titration Iodometric	$\geq 98.5\%$	102.3 %
pH	2 to 3 (5% aq. soln.)	2.1 (5% aq. soln.)
Calcium (Ca)	$\leq 50$ ppm	21 ppm
Cadmium (Cd)	$\leq 10$ ppm	8 ppm
Cobalt (Co)	$\leq 10$ ppm	2 ppm
Copper (Cu)	$\leq 10$ ppm	2.3 ppm
Iron (Fe)	$\leq 200$ ppm	158 ppm
Magnesium (Mg)	$\leq 50$ ppm	12 ppm
Manganese (Mn)	$\leq 10$ ppm	1 ppm
Sodium (Na)	$\leq 50$ ppm	12 ppm
Nickel (Ni)	$\leq 50$ ppm	18 ppm
Lead (Pb)	$\leq 20$ ppm	4 ppm
Strontium (Sr)	$\leq 50$ ppm	6.2 ppm
Zinc (Zn)	$\leq 10$ ppm	4.5 ppm
Chloride (Cl)	$\leq 20$ ppm	$\leq 20$ ppm
Sulfate (SO <sub>4</sub> )	$\leq 50$ ppm	$\leq 50$ ppm
Ammonium (NH <sub>4</sub> )	$\leq 10$ ppm	$\leq 10$ ppm
Subst not pptd by NH <sub>4</sub> OH	$\leq 0.2\%$ (as SO <sub>4</sub> )	0.085 % (as SO <sub>4</sub> )

SwRI Chem ID: 66141

SwRI Chem ID: 66141



CERTIFIED BY

L. Van den Broek, QA Manager

Issued: 14 January 2016

Acros Organics

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1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



Version 0  
 Molecular weight 400.14  
 Molecular formula  $\text{Cr N}_3 \text{O}_9 \cdot 9 \text{H}_2 \text{O}$   
 CAS No 7789-02-8  
 Linear formula  $\text{Cr}(\text{NO}_3)_3 \cdot 9 \text{H}_2 \text{O}$   
 Flash point (°C)

SwRI Chem ID: 63857

## Certificate of Analysis

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Catalog Number	21920	Quality Test / Release Date	23 January 2014
Lot Number	A0343253	Suggested Retest Date	January 2019
Description	Chromium(III) nitrate nonahydrate, 99%		
Country of Origin	UNITED STATES OF AMERICA		
Declaration of Origin	synthetic		

Origin Comment
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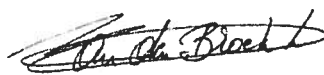
Result Name	Specifications	Test Value
Appearance	dark purple to black crystalline chunks	black crystalline chunks
Titration Iodometric	$\geq 98.5 \%$	101.9 %
pH	2 to 3 (5% aq. soln.)	2.1 (5% aq. soln.)
Trace analysis	Type: Ca measure $\leq 50$ PPM	Type: Ca measure 5 PPM
Trace analysis	Type: Cd measure $\leq 10$ PPM	Type: Cd measure 3 PPM
Trace analysis	Type: Co measure $\leq 10$ PPM	Type: Co measure 5 PPM
Trace analysis	Type: Cu measure $\leq 10$ PPM	Type: Cu measure 7 PPM
Trace analysis	Type: Fe measure $\leq 200$ PPM	Type: Fe measure 178 PPM
Trace analysis	Type: Mg measure $\leq 50$ PPM	Type: Mg measure 6 PPM
Trace analysis	Type: Mn measure $\leq 10$ PPM	Type: Mn measure 7 PPM
Trace analysis	Type: Na measure $\leq 50$ PPM	Type: Na measure 17 PPM
Trace analysis	Type: Ni measure $\leq 50$ PPM	Type: Ni measure 8 PPM
Trace analysis	Type: Pb measure $\leq 20$ PPM	Type: Pb measure 4 PPM
Trace analysis	Type: Sr measure $\leq 50$ PPM	Type: Sr measure 11 PPM
Trace analysis	Type: Zn measure $\leq 10$ PPM	Type: Zn measure 4 PPM
Trace analysis	Type: Cl measure $\leq 20$ PPM	Type: Cl measure $\leq 20$ PPM
Trace analysis	Type: $\text{SO}_4$ measure $\leq 50$ PPM	Type: $\text{SO}_4$ measure $\leq 50$ PPM
Trace analysis	Type: $\text{NH}_4$ measure $\leq 10$ PPM	Type: $\text{NH}_4$ measure $\leq 10$ PPM
Subst not pptd by $\text{NH}_4\text{OH}$	$\leq 0.2 \%$ (as $\text{SO}_4$ )	$\leq 0.0077 \%$ (as $\text{SO}_4$ )

SwRI Chem ID: 63857

SwRI Chem ID: 63857



CERTIFIED BY



L. Van den Broek, QA Manager

Issued: 28 October 2015

Acros Organics

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1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



3050 Spruce Street, Saint Louis, MO 63103, USA

Website: www.sigmaaldrich.com

Email USA: techserv@sial.com

Outside USA: eurtechserv@sial.com

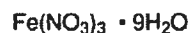
SwRI Chem ID: 63604

## Certificate of Analysis

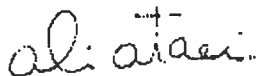
Product Name:

Iron(III) nitrate nonahydrate – ACS reagent, ≥98%

**Product Number:** 216828  
**Batch Number:** MKBT4080V  
**Brand:** SIAL  
**CAS Number:** 7782-61-8  
**MDL Number:** MFCD00149708  
**Formula:** FeN3O9 · 9H2O  
**Formula Weight:** 404.00 g/mol  
**Quality Release Date:** 09 DEC 2014



Test	Specification	Result
Appearance (Color) Off-White to Pale Purple	Conforms to Requirements	Off-White
Appearance (Form) Moist Crystals	Conforms to Requirements	Crystals
Infrared Spectrum	Conforms to Structure	Conforms
Titration by Na2S2O3	98.0 - 101.0 %	100.0 %
Insoluble Matter c = 10 %; Dilute HNO3	≤ 0.005 %	0.003 %
Chloride (Cl)	≤ 5 ppm	< 5 ppm
Sulfate (SO4)	≤ 0.01 %	< 0.01 %
Calcium (Ca)	≤ 0.01 %	< 0.01 %
Magnesium (Mg)	≤ 0.005 %	< 0.001 %
Potassium (K)	≤ 0.005 %	< 0.001 %
Sodium (Na)	≤ 0.05 %	< 0.01 %
Meets ACS Requirements Tenth Edition	Current ACS Specification	Conforms



Ali Ataei, Manager  
 Quality Control  
 Milwaukee, WI US

Sigma-Aldrich warrants, that at the time of the quality release or subsequent retest date this product conformed to the information contained in this publication. The current Specification sheet may be available at Sigma-Aldrich.com. For further inquiries, please contact Technical Service. Purchaser must determine the suitability of the product for its particular use. See reverse side of invoice or packing slip for additional terms and conditions of sale.

SwRI Chem ID: 63604

SwRI Chem ID: 63604

## Certificate of Analysis

Product Name:

Iron(III) nitrate nonahydrate – ACS reagent, ≥98%

**Product Number:** 216828  
**Batch Number:** MKBW6908V  
**Brand:** SIAL  
**CAS Number:** 7782-61-8  
**MDL Number:** MFCD00149708  
**Formula:** FeN3O9 · 9H2O  
**Formula Weight:** 404.00 g/mol  
**Quality Release Date:** 16 OCT 2015

Fe(NO<sub>3</sub>)<sub>3</sub> · 9H<sub>2</sub>O

Test	Specification	Result
Appearance (Color) Off-White to Pale Purple	Conforms to Requirements	Off-White
Appearance (Form) Moist Crystals	Conforms to Requirements	Crystals
Infrared Spectrum	Conforms to Structure	Conforms
Titration by Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	98.0 - 101.0 %	98.9 %
Insoluble Matter c = 10 %; Dilute HNO <sub>3</sub>	≤ 0.005 %	< 0.005 %
Chloride (Cl)	≤ 5 ppm	< 5 ppm
Sulfate (SO <sub>4</sub> )	≤ 0.01 %	< 0.01 %
Calcium (Ca)	≤ 0.01 %	< 0.01 %
Magnesium (Mg)	≤ 0.005 %	< 0.001 %
Potassium (K)	≤ 0.005 %	< 0.001 %
Sodium (Na)	≤ 0.05 %	< 0.01 %
Meets ACS Requirements Tenth Edition	Current ACS Specification	Conforms

Michael Grady, Manager  
 Quality Control  
 Milwaukee, WI US

Sigma-Aldrich warrants, that at the time of the quality release or subsequent retest date this product conformed to the information contained in this publication. The current Specification sheet may be available at [Sigma-Aldrich.com](http://Sigma-Aldrich.com). For further inquiries, please contact Technical Service. Purchaser must determine the suitability of the product for its particular use. See reverse side of invoice or packing slip for additional terms and conditions of sale.



Version 0  
 Molecular weight 256.40  
 Molecular formula  $\text{Mg N}_2 \text{O}_6 \cdot 6 \text{H}_2\text{O}$   
 CAS No 13446-18-9  
 Linear formula  $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$   
 Flash point (°C) 93.3

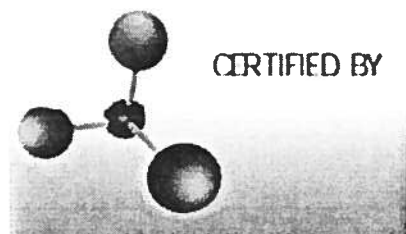
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Catalog Number	44754	Quality Test / Release Date	13 November 2014
Lot Number	A0353513	Suggested Retest Date	November 2019
Description	Magnesium nitrate hexahydrate, extra pure		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment	
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Result Name	Specifications	Test Value
Appearance	white crystals	white crystals
Titration Complexometric	98 to 102 %	100.3 %
pH	5 to 8.2 (5%, aq. soln.)	6 (5%, aq. soln.)
Heavy metals (as Pb)	$\leq 0.001$ %	$\leq 0.0005$ %
Chloride (Cl)	$\leq 0.001$ %	$\leq 0.001$ %
Iron (Fe)	$\leq 0.001$ %	$\leq 0.0005$ %
Sulfate (SO <sub>4</sub> )	$\leq 0.005$ %	$\leq 0.005$ %



*L. Van den Broek*  
 L. Van den Broek, QA Manager

Issued: 25 April 2016

Acros Organics  
 ENA23, zone 1, nr 1350, Janssen Pharmaceuticaal 3a, B-2440 Geel, Belgium  
 Tel +32 14/57.52.11 - Fax +32 14/59.34.34 Internet: <http://www.acros.com>  
 1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



Version 0  
 Molecular weight 256.40  
 Molecular formula  $\text{Mg N}_2 \text{O}_6 \cdot 6 \text{H}_2 \text{O}$   
 CAS No 13446-18-9  
 Linear formula  $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$   
 Flash point (°C) 93.3

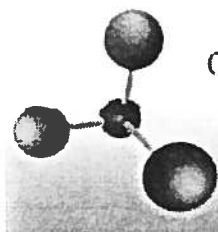
## Certificate of Analysis

This is to certify that units of the below mentioned lot number were tested and found to comply with the specifications of the grade listed. Certain data have been supplied by third parties. Acros Organics expressly disclaims all warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose. Unless otherwise stated, these products are not intended for dialysis, parenteral or injectable use without further processing. The following are the actual analytical results obtained:

Catalog Number	44754	Quality Test / Release Date	13 November 2014
Lot Number	A0353513	Suggested Retest Date	November 2019
Description	Magnesium nitrate hexahydrate, extra pure		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment

Result Name	Specifications	Test Value
Appearance	white crystals	white crystals
Titration Complexometric	98 to 102 %	100.3 %
pH	5 to 8.2 (5%, aq. soln.)	6 (5%, aq. soln.)
Heavy metals (as Pb)	$\leq 0.001$ %	$\leq 0.0005$ %
Chloride (Cl)	$\leq 0.001$ %	$\leq 0.001$ %
Iron (Fe)	$\leq 0.001$ %	$\leq 0.0005$ %
Sulfate (SO <sub>4</sub> )	$\leq 0.005$ %	$\leq 0.005$ %



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L. Van den Broek, QA Manager

Issued: 25 April 2016

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Version 0  
 Molecular weight 84.99  
 Molecular formula N Na O3  
 CAS No 7631-99-4  
 Linear formula NaNO3  
 Flash point (°C)

SwRI Chem ID: 69611

## Certificate of Analysis

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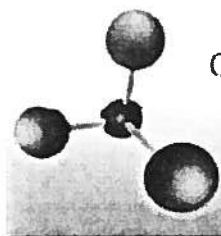
Catalog Number	42434	Quality Test / Release Date	2 November 2015
Lot Number	A0365903	Suggested Retest Date	November 2020
Description	Sodium nitrate, 99+%, ACS reagent		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment
----------------

Result Name	Specifications	Test Value
Appearance (Color)	White	White
Appearance (Form)	Crystals	Crystals
Titration after Ion exchange	≥99.0 %	100.2 %
Heavy metals (as Pb)	≤5 ppm	≤5 ppm
Insoluble matter	≤0.005 %	0.004 %
pH	5.5 to 8.3 (5% soln. at 25°C)	6.1 (5% soln. at 25°C)
Chloride (Cl)	≤10 ppm	7 ppm
Iodate (IO3)	≤5 ppm	ppm (none detected)
Phosphate (PO4)	≤5 ppm	≤5 ppm
Iron (Fe)	≤3 ppm	≤3 ppm
Sulfate (SO4)	≤30 ppm	10 ppm
Calcium (Ca)	≤50 ppm	1.4 ppm
Magnesium (Mg)	≤20 ppm	8 ppm
Nitrite (NO2)	≤10 ppm	ppm (none detected)

SwRI Chem ID: 69611

SwRI Chem ID: 69611



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L. Van den Broek, QA Manager

Issued: 25 April 2016

Acros Organics

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1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



Version 0  
 Molecular weight 331.20  
 Molecular formula  $N_2 O_6 Pb$   
 CAS No 10099-74-8  
 Linear formula  $Pb(NO_3)_2$   
 Flash point ( $^{\circ}C$ )

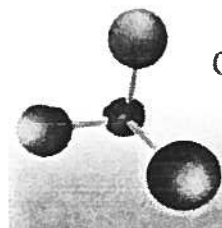
## Certificate of Analysis

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Catalog Number	21156	Quality Test / Release Date	29 September 2015
Lot Number	A0364649	Suggested Retest Date	September 2017
Description	Lead(II) nitrate, 99+%		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment	
----------------	--

Result Name	Specifications	Test Value
Appearance (Color)	White	White
Appearance (Form)	Crystalline powder	Crystalline powder
Titration Complexometric	$\geq 99\%$	99.9 %
Chloride (Cl)	$\leq 10$ ppm	$\leq 10$ ppm
Iron (Fe)	$\leq 5$ ppm	3.2 ppm



CERTIFIED BY

L. Van den Broek, QA Manager

Issued: 7 January 2016

Acros Organics  
 ENA23, zone 1, nr 1350, Janssen Pharmaceuticaal 3a, B-2440 Geel, Belgium  
 Tel +32 14/57.52.11 - Fax +32 14/59.34.34 Internet: <http://www.acros.com>  
 1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



Version 0  
 Molecular weight 331.20  
 Molecular formula N<sub>2</sub>O<sub>6</sub>Pb  
 CAS No 10099-74-8  
 Linear formula Pb(NO<sub>3</sub>)<sub>2</sub>  
 Flash point (°C)

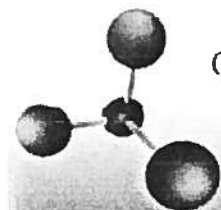
## Certificate of Analysis

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Catalog Number	21156	Quality Test / Release Date	29 September 2015
Lot Number	A0364649	Suggested Retest Date	September 2017
Description	Lead(II) nitrate, 99+%		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment	
----------------	--

Result Name	Specifications	Test Value
Appearance (Color)	White	White
Appearance (Form)	Crystalline powder	Crystalline powder
Titration Complexometric	>=99 %	99.9 %
Chloride (Cl)	=<10 ppm	=<10 ppm
Iron (Fe)	=<5 ppm	3.2 ppm



CERTIFIED BY

L. Van den Broek, QA Manager

Issued: 26 April 2016

Acros Organics  
 ENA23, zone 1, nr 1350, Janssen Pharmaceuticaaan 3a, B-2440 Geel, Belgium  
 Tel +32 14/57.52.11 - Fax +32 14/59.34.34 Internet: <http://www.acros.com>  
 1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329





Version 0  
 Molecular weight 331.20  
 Molecular formula N<sub>2</sub>O<sub>6</sub>Pb  
 CAS No 10099-74-8  
 Linear formula Pb(NO<sub>3</sub>)<sub>2</sub>  
 Flash point (°C)

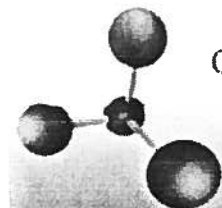
## Certificate of Analysis

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Catalog Number	21156	Quality Test / Release Date	29 September 2015
Lot Number	A0364649	Suggested Retest Date	September 2017
Description	Lead(II) nitrate, 99+%		
Country of Origin	INDIA		
Declaration of Origin	synthetic		

Origin Comment	
----------------	--

Result Name	Specifications	Test Value
Appearance (Color)	White	White
Appearance (Form)	Crystalline powder	Crystalline powder
Titration Complexometric	≥99 %	99.9 %
Chloride (Cl)	≤10 ppm	≤10 ppm
Iron (Fe)	≤5 ppm	3.2 ppm



CERTIFIED BY

L. Van den Broek, QA Manager

Issued: 26 April 2016

Acros Organics  
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 1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329



Version 0  
 Molecular weight 126.04  
 Molecular formula  $C_2H_2O_4 \cdot 2H_2O$   
 CAS No 6153-56-6  
 Linear formula  $HO_2CCO_2H \cdot 2H_2O$   
 Flash point ( $^{\circ}C$ )

SwRI Chem ID: 69684

## Certificate of Analysis

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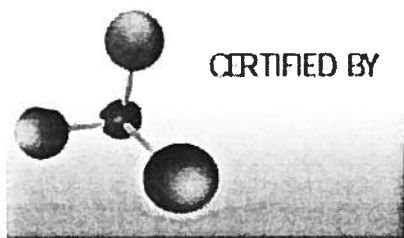
Catalog Number	42315	Quality Test / Release Date	10 December 2014
Lot Number	A0354614	Suggested Retest Date	December 2019
Description	Oxalic acid dihydrate, 99.5+%, ACS reagent		
Country of Origin	SPAIN		
Declaration of Origin	synthetic		

Origin Comment	
----------------	--

Result Name	Specifications	Test Value
Appearance	white crystalline powder	white crystals
Infrared spectrometry	authentic	authentic
Assay Titrimetry	99.5 to 102.5 %	99.9 %
Heavy metals (as Pb)	$\leq 5$ ppm	$\leq 2.5$ ppm
Residue after ignition	$\leq 0.01$ %	0.004 %
Nitrogen compounds (as N)	$\leq 0.001$ %	$\leq 0.001$ %
Trace analysis	Type: Cl measure $\leq 20$ ppm	Type: Cl measure $< 5$ ppm
Trace analysis	Type: SO <sub>4</sub> measure $\leq 50$ ppm	Type: SO <sub>4</sub> measure $< 20$ ppm
Trace analysis	Type: Ca measure $\leq 10$ ppm	Type: Ca measure $< 1$ ppm
Trace analysis	Type: Fe measure $\leq 2$ ppm	Type: Fe measure $< 2$ ppm
Insoluble matter	$\leq 0.005$ %	$\leq 0.005$ %
Substance darkened by H <sub>2</sub> SO <sub>4</sub>	passes test	passes test

SwRI Chem ID: 69684

SwRI Chem ID: 69684



CERTIFIED BY

L. Van den Broek, QA Manager

Issued: 27 April 2016

Acros Organics

ENA23, zone 1, nr 1350, Janssen Pharmaceuticaaan 3a, B-2440 Geel, Belgium

Tel +32 14/57.52.11 - Fax +32 14/59.34.34 Internet: <http://www.acros.com>

1 Reagent Lane, Fair Lawn, NJ 07410, USA Fax 201-796-1329

## Certificate of Analysis

SwRI Chem ID: 65593

**Product Name:** NICKEL(II) NITRATE HEXAHYDRATE  
 purum p.a., crystallized, >= 97.0 % KT  
**Product Number:** 72253  
**Batch Number:** BCBP4160V  
**Brand:** Sigma-Aldrich  
**CAS Number:** 13478-00-7  
**Formula:** Ni(NO<sub>3</sub>)<sub>2</sub> • 6H<sub>2</sub>O  
**Formula Weight:** 290.79  
**Quality Release Date:** 26 JAN 2015

TEST	SPECIFICATION	RESULT
APPEARANCE (COLOR)	BLUE-GREEN TO DEEP BLUE-GREEN	BLUE-GREEN
APPEARANCE (FORM)	CRYSTALS	CRYSTALS
TITRATION (KT) EDTA 0.1M	97.0 - 103.0 %	97.0 %
METAL TRACE ANALYSIS (ICP)	CORRESPONDS TO REQUIREMENTS	PASSED
CALCIUM (ICP)	≤ 50 MG/KG	< 50 MG/KG
CADMIUM (ICP)	≤ 50 MG/KG	< 50 MG/KG
COBALT (ICP)	≤ 500 MG/KG	< 500 MG/KG
COPPER (ICP)	≤ 50 MG/KG	< 50 MG/KG
IRON (ICP)	≤ 50 MG/KG	< 50 MG/KG
POTASSIUM (ICP)	≤ 100 MG/KG	< 100 MG/KG
SODIUM (ICP)	≤ 100 MG/KG	< 100 MG/KG
LEAD (ICP)	≤ 50 MG/KG	< 50 MG/KG
ZINC (ICP)	≤ 50 MG/KG	< 50 MG/KG
TOTAL SULFUR AS SO <sub>4</sub> (ICP)	≤ 50 MG/KG	< 50 MG/KG
CHLORIDE (CL)	≤ 50 MG/KG	< 50 MG/KG



Dr. Claudia Geitner  
 Manager Quality Control  
 Buchs, Switzerland

SwRI Chem ID: 65593

Sigma-Aldrich warrants that at the time of the quality release or subsequent retest date this product conformed to the information contained in this publication. The current specification sheet may be available at Sigma-Aldrich.com. For further inquiries, please contact Technical Service. Purchaser must determine the suitability of the product for its particular use. See reverse side of invoice or packing slip for additional terms and conditions of sale.

SwRI Chem ID: 65593



1 Reagent Lane  
Fair Lawn, NJ 07410  
201.796.7100 tel  
201.796.1329 fax

## Certificate of Analysis

Fisher Scientific's Quality System has been found to conform to Quality Management System Standard ISO9001:2008 standard by DNV Certificate number CERT-08052-2006-AQ-HOU-ANAB

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<b>Catalog Number</b>	<b>A509</b>	<b>Mfg. Date</b>	11/4/2015
<b>Lot Number</b>	<b>1115100</b>	<b>Sample Id</b>	N/A
<b>Product Description</b>	Nitric Acid (TRACEMETAL GRADE)		
<b>Country Origin</b>	Canada		
<b>Chemical Origin</b>	Inorganic		

**BSE/TSE Comment:** No animal products are used as starting raw material ingredients, or used in processing, including lubricants, processing aids, or any other material that might migrate to the finished product.

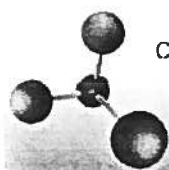
Result Name	Units	Specifications	Test Value
Expiry Date	mm/dd/yyyy	2 yrs	11/04/2017
Assay (HNO <sub>3</sub> , w/w)	% by w/w	67 - 70	69
Color	APHA	<= 10	< 7
Aluminum (Al)	ppb	<= 1	< 0.5
Antimony (Sb)	ppb	<= 0.5	< 0.1
Arsenic (As)	ppb	<= 0.5	< 0.1
Barium (Ba)	ppb	<= 0.1	< 0.1
Beryllium (Be)	ppb	<= 0.1	< 0.1
Bismuth (Bi)	ppb	<= 0.1	< 0.1
Boron (B)	ppb	<= 1	< 0.5
Cadmium (Cd)	ppb	<= 0.5	< 0.1
Calcium (Ca)	ppb	<= 1	< 0.5
Cerium (Ce)	ppb	<= 0.1	< 0.1
Cesium (Cs)	ppb	<= 0.1	< 0.1
Chromium (Cr)	ppb	<= 1	< 0.5
Cobalt (Co)	ppb	<= 0.5	< 0.1
Copper (Cu)	ppb	<= 0.5	< 0.2
Dysprosium (Dy)	ppb	<= 0.1	< 0.1
Erbium (Er)	ppb	<= 0.1	< 0.1
Europium (Eu)	ppb	<= 0.1	< 0.1
Gadolinium (Gd)	ppb	<= 0.1	< 0.1
Gallium (Ga)	ppb	<= 0.1	< 0.1
Germanium (Ge)	ppb	<= 0.1	< 0.1
Gold (Au)	ppb	<= 0.1	< 0.1
Hafnium (Hf)	ppb	<= 0.1	< 0.1
Holmium (Ho)	ppb	<= 0.1	< 0.1
Indium (In)	ppb	<= 0.1	< 0.1
Iron (Fe)	ppb	<= 1	< 0.5
Lanthanum (La)	ppb	<= 0.1	< 0.1
Lead (Pb)	ppb	<= 0.1	< 0.1
Lithium (Li)	ppb	<= 0.1	< 0.1

SwRI Chem ID: 67843

SwRI Chem ID: 67843

SwRI Chem ID: 67843

Lutetium (Lu)	ppb	$\leq 0.1$	$< 0.1$
Magnesium (Mg)	ppb	$\leq 1$	$< 0.2$
Manganese (Mn)	ppb	$\leq 0.1$	$< 0.1$
Mercury (Hg)	ppb	$\leq 0.1$	$< 0.02$
Molybdenum (Mo)	ppb	$\leq 0.1$	$< 0.1$
Neodymium (Nd)	ppb	$\leq 0.1$	$< 0.1$
Nickel (Ni)	ppb	$\leq 0.5$	$< 0.5$
Niobium (Nb)	ppb	$\leq 0.1$	$< 0.1$
Palladium (Pd)	ppb	$\leq 0.5$	$< 0.1$
Platinum (Pt)	ppb	$\leq 0.5$	$< 0.1$
Potassium (K)	ppb	$\leq 1$	$< 0.2$
Praseodymium (Pr)	ppb	$\leq 0.1$	$< 0.1$
Rhenium (Re)	ppb	$\leq 0.1$	$< 0.1$
Rhodium (Rh)	ppb	$\leq 0.5$	$< 0.1$
Rubidium (Rb)	ppb	$\leq 0.1$	$< 0.1$
Ruthenium (Ru)	ppb	$\leq 0.5$	$< 0.1$
Samarium (Sm)	ppb	$\leq 0.1$	$< 0.1$
Scandium (Sc)	ppb	$\leq 0.1$	$< 0.1$
Selenium (Se)	ppb	$\leq 1$	$< 0.1$
Silver (Ag)	ppb	$\leq 0.1$	$< 0.1$
Sodium (Na)	ppb	$\leq 1$	$< 0.3$
Strontium (Sr)	ppb	$\leq 0.1$	$< 0.1$
Tantalum (Ta)	ppb	Information Only	$< 0.1$
Tellurium (Te)	ppb	$\leq 0.1$	$< 0.1$
Terbium (Tb)	ppb	$\leq 0.1$	$< 0.1$
Thallium (Tl)	ppb	$\leq 0.1$	$< 0.1$
Thorium (Th)	ppb	$\leq 0.1$	$< 0.1$
Thulium (Tm)	ppb	$\leq 0.1$	$< 0.1$
Tin (Sn)	ppb	$\leq 0.5$	$< 0.1$
Titanium (Ti)	ppb	$\leq 0.5$	$< 0.1$
Tungsten (W)	ppb	$\leq 0.1$	$< 0.1$
Uranium (U)	ppb	$\leq 0.1$	$< 0.1$
Vanadium (V)	ppb	$\leq 0.5$	$< 0.1$
Ytterbium (Yb)	ppb	$\leq 0.1$	$< 0.1$
Yttrium (Y)	ppb	$\leq 0.1$	$< 0.1$
Zinc (Zn)	ppb	$\leq 0.5$	$< 0.2$
Zirconium (Zr)	ppb	$\leq 0.1$	$< 0.1$
Chloride (Cl-)	ppm	$\leq 0.2$	$< 0.2$
Total Phosphorus (P)	ppm	$\leq 0.01$	$< 0.01$
Total Sulfur (S)	ppm	$\leq 0.3$	$< 0.3$



CERTIFIED BY

*Edgar E. Hess*  
Lab Manager Fair Lawn

*Joel Boland*  
Lab Manager BPF

*Note: The data listed is valid for all package sizes of this lot of product, expressed as an extension of the catalog number listed above. If there are any questions with this certificate, please call Chemical Services at 1.800.227.6701.*

## Certificate of Analysis



1 Reagent Lane  
Fair Lawn, NJ 07410  
201.796.7100 tel  
201.796.1329 fax

INORGANIC LABS/RADCHEM LABS

DATE RECEIVED: 7/16/12  
DATE EXPIRED: 9/11/2016  
DATE OPENED: 7/18/12  
INORG: 9980 PO: E37845E

Page 1 of 1

## Certificate of Analysis

Fisher Scientific's Quality System has been found to conform to Quality Management System  
Standard ISO9001:2008 standard by DNV Certificate number CERT-08052-2006-AQ-HOU-ANAB

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Catalog Number	A840	Mfg. Date	9/23/2011
Lot Number	114303		
Description	CITRIC ACID, ANHYDROUS, A.C.S.		
Country of Origin	United States	Recommended Retest Date	Sep-2016
Chemical Origin	Organic - Plant		
BSE/TSE Comment	No animal products are used as starting raw material ingredients, or used in processing, including lubricants, processing aids, or any other material that might migrate to the finished product.		

Result name	Units	Specifications	Test Value
APPEARANCE		REPORT	Fine, white crystals
ASSAY	%	>= 99.5	99.6
CHLORIDE	%	<= 0.001	<0.0010
IDENTIFICATION	PASS/FAIL	= PASS TEST	PASS TEST
IGNITION RESIDUE	%	<= 0.02	<0.020
INSOLUBLE MATTER	%	<= 0.005	<0.0050
IRON (Fe)	ppm	<= 3	<3.0
LEAD (Pb)	ppm	<= 2	<2.0
OXALATE	PASS/FAIL	= P.T. (ABOUT 0.05%)	P.T. (ABOUT 0.05%)
PHOSPHATE (PO4)	%	<= 0.001	<0.0010
SUBST. CARBONIZED BY H2SO4	PASS/FAIL	= PASS TEST	PASS TEST
SULFUR COMPOUNDS	%	<= 0.002	<0.0020



*Edgar E. Hane*

Lab Manager Fair Lawn

Note: The data listed is valid for all package sizes of this lot of this product, expressed as a extension of this catalog number listed above. If there are any questions with this certificate, please call Chemical Services at (800) 227-8701.

SwRI Chem ID: 36116

SwRI Chem ID: 36116

SwRI Chem ID: 36116