Fall 2015

VALIDATION OF CLEANING METHOD FOR VARIOUS PARTS FABRICATED AT A BERYLLIUM FACILITY

Cynthia Zelic
Montana Tech of the University of Montana

VALIDATION OF CLEANING METHOD FOR VARIOUS PARTS FABRICATED AT A BERYLLIUM FACILITY

by

Cynthia Zelic-Davis

A report submitted in partial fulfillment of the
requirements for the degree of

Master of Science
Industrial Hygiene Distance Learning / Professional Track

Montana Tech of the University of Montana

2015

LA-UR-15-29552

Abstract

This study evaluated and documented a cleaning process that is used to clean parts that are fabricated at a beryllium facility at Los Alamos National Laboratory. The purpose of evaluating this cleaning process was to validate and approve it for future use to assure beryllium surface levels are below the Department of Energy's release limits without the need to sample all parts leaving the facility. Inhaling or coming in contact with beryllium can cause an immune response that can result in an individual becoming sensitized to beryllium, which can then lead to a disease of the lungs called chronic beryllium disease, and possibly lung cancer.

Thirty aluminum and thirty stainless steel parts were fabricated on a lathe in the beryllium facility, as well as thirty-two beryllium parts, for the purpose of testing a parts cleaning method that involved the use of ultrasonic cleaners. A cleaning method was created, documented, validated, and approved, to reduce beryllium contamination.

Keywords: beryllium, ultrasonic cleaner, cleaning method, cleaning validation, free release

Dedication

I wish to thank current and past colleagues for their assistance and support while accomplishing my educational goals, as well as in my career. I couldn’t have done it without you! I would also like to thank my husband and family for supporting me along the way.

Acknowledgements

This study was carried out under U.S. Department of Energy at Los Alamos National Laboratory, with funding provided by the Manufacturing Science and Engineering Group as well as the Industrial Hygiene and Safety Division. The support necessary to complete this study also included management support and work performed by machinists from Prototype Fabrication (PF) Division and advice from industrial hygiene and safety colleagues.

Table of Contents

List of Tables

List of Figures

1. Introduction

The element beryllium is a grey metal that is stronger than steel and lighter than aluminum. The physical properties of beryllium make it an essential material for the aerospace, telecommunications, defense, computer, medical, and nuclear industries. These properties include great strength-to-weight ratio, excellent thermal stability and conductivity, reflectivity, high melting point, and transparency to X-rays (Occupational Safety and Health Administration).

Although beryllium has great physical properties for a number of industries and products, beryllium is also hazardous to human health. Workers in industries where beryllium is processed or fabricated, as well as those who receive items that are contaminated with beryllium, may be exposed by inhaling or coming in contact with the beryllium metal particulates. Inhaling beryllium can cause an immune response that can result in an individual becoming sensitized to beryllium, which can then lead to a disease of the lungs called chronic beryllium disease (sometimes called berylliosis), and possibly lung cancer (Occupational Safety and Health Administration). Chronic beryllium disease (CBD) is a chronic granulomatous lung disease caused by inhaling airborne beryllium particulates after becoming sensitized to beryllium. Common symptoms include shortness of breath, unexplained coughing, fatigue, fever, weight loss, and night sweats. It is thought that CBD can result from inhalation exposure to beryllium at levels below the current Occupational Health and Safety Administration's (OSHA) Permissible Exposure Limit (PEL) of $2.0\mu/m^3$. This PEL is currently being evaluated and OSHA has proposed a new beryllium standard which includes lowering PELs for general industry that will replace the existing outdated PELs (Beryllium Health Hazards). There is no cure for CBD and treatment can vary for each patient, depending on the severity of the disease.

Los Alamos National Laboratory performs various types of beryllium work to include research activities as well as fabrication of different metals and materials. Beryllium is the main metal that is machined at one machine shop, but other metals such as aluminum, steel and precious metals may also be machined. At this point in time, all non-beryllium parts that leave the facility are sampled to determine beryllium surface levels. If the levels are below the free release limit, then non-beryllium parts will be released as a free release part, with no restrictions. When beryllium parts are made and need to be released, they are released as beryllium parts.

The Los Alamos Chronic Beryllium Disease Prevention Program, P101-21, which was derived from DOE 10 CFR Part 850, Chronic Disease Prevention Program; Final Rule (Chronic Disease Prevention Program; Final Rule, 1999), and Beryllium Release Form 2120 (Appendix A), provide guidelines that are followed to determine what type of release a part or item should be. In the procedure mentioned above, P101-21, one option is that the parts may be cleaned using a cleaning process that is validated and approved by the internal occupational safety and industrial hygiene group for specific items or part types. There currently is not a cleaning method that has been validated and approved. The purpose of this study is to document a cleaning method, test the method on beryllium parts and other metals, and potentially validate the cleaning method that will save time and money in the future. If a cleaning method can be documented, validated, and approved, customers can expect their product/part about seven days sooner. Each part sampled costs about $35.00/sample, so this cost would also be eliminated as well as the time spent by industrial hygienists performing sampling activities, paperwork, data entry, etc.

2. Design and Methodology

2.1. Approach

Beryllium, aluminum, and stainless steel are the three main metals that are used for part fabrication; therefore, the focus of the study was on these three metals. Thirty parts of each stainless steel and aluminum, along with thirty-two beryllium parts were manufactured in the beryllium facility. All parts were cut and finished at approximately 7.6 centimeters in diameter and 0.9525 centimeters thick (3 inches in diameter x 0.375 inches thick), which is roughly a surface area of $114cm^2$. Parts were finished on the same machine, a lathe, for the purpose of consistency as well as a worst case scenario. This machine uses recycled coolant and parts are cut under a full flood so it is considered to be the most contaminated piece of equipment used in fabrication process.

Sampling was conducted on every other part before it was cleaned and every part in its final state. Cost for analysis and budget constraints were the reason that not every part was sampled before cleaning. After the parts were initially sampled, they were then put through a cleaning method and sampled post cleaning.

2.2. Cleaning Method

Each part was cleaned using the identical cleaning method. All parts were cleaned immediately after being removed from the machine or after initial sampling. Cleaning was initially done manually, using pre-moistened clean wipes that consisted of 70% isopropyl alcohol and 30% de-ionized water. The parts were then individually placed in an ultrasonic cleaner that contained de-ionized water for one minute. Parts were removed from the cleaner, dried with a dry Kimwipe™ and cleaned once more with a pre-moistened wipe. Surface wipes were then taken on the parts, post-cleaning. Two ultrasonic cleaners were used in order to prevent cross contaminated between the beryllium parts and the non-beryllium parts. One ultrasonic cleaner was designated and labeled “for beryllium parts only”. The water in the ultrasonic cleaners was replaced after every five parts. Parts may stay in the ultrasonic cleaner longer, but is not always possible due to the type of part, therefore, this is the reason it was sampled after one minute. The documented cleaning method can be found in Appendix B.

The purpose of cleaning parts that are made of non-beryllium metals is to achieve a beryllium surface level below the Department of Energy’s (DOE) free release limit of 0.2 micrograms of beryllium per 100 square centimeters (µg/100cm^2) (Federal Register 10 CFR 850, 2006). On beryllium parts, the goal was to determine the 95th percentile, and use the data to make determinations on the release of beryllium parts for future work. The beryllium parts that are fabricated here at the Beryllium Facility are always released to another beryllium area, packaged and labeled properly, unless it is in its final finished state. Below are pictures of each material post-cleaning.

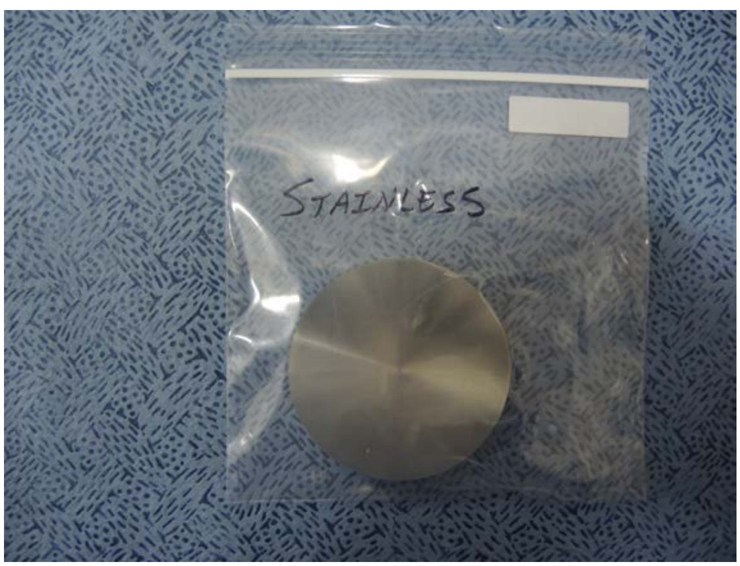


Figure 1 Stainless Steel Disk

Figure 2 Aluminum Disk

Figure 3 Beryllium Disk

2.3. Sampling and Analytical Methods

Surface wipe samples were collected in accordance the Occupational Safety and Health Administration sampling method ID-125G (Method ID-125G). Whatman 541 hardened ashless filters were used to collect the samples.

Using clean nitrile gloves for each sample, to prevent cross contamination, a single filter was moistened with approximately 200µL de-ionized water and was firmly pressed on the surface of each part (front, back, and sides) using vertical strokes. The filter was then folded inward, and was used to wipe the part horizontally. The filter was folded again into a quarter, and the part was wiped again in a diagonal fashion. The sample was placed into a petri dish and sealed. All dishes were pre-labeled with sample numbers. The parts were intentionally made to size, to have an estimated $100cm^2$ surface area. Each day sampling took place, ten percent of field blanks were submitted to the laboratory.

Samples and field blanks were analyzed by an AIHA accredited laboratory. Samples and field blanks were analyzed using the National Institute for Occupational Safety and Heath Method 7300 by inductively coupled argon plasma, atomic emission spectroscopy (National Institute for Occupational Safety and Health, 2003).

3. Results and Discussion

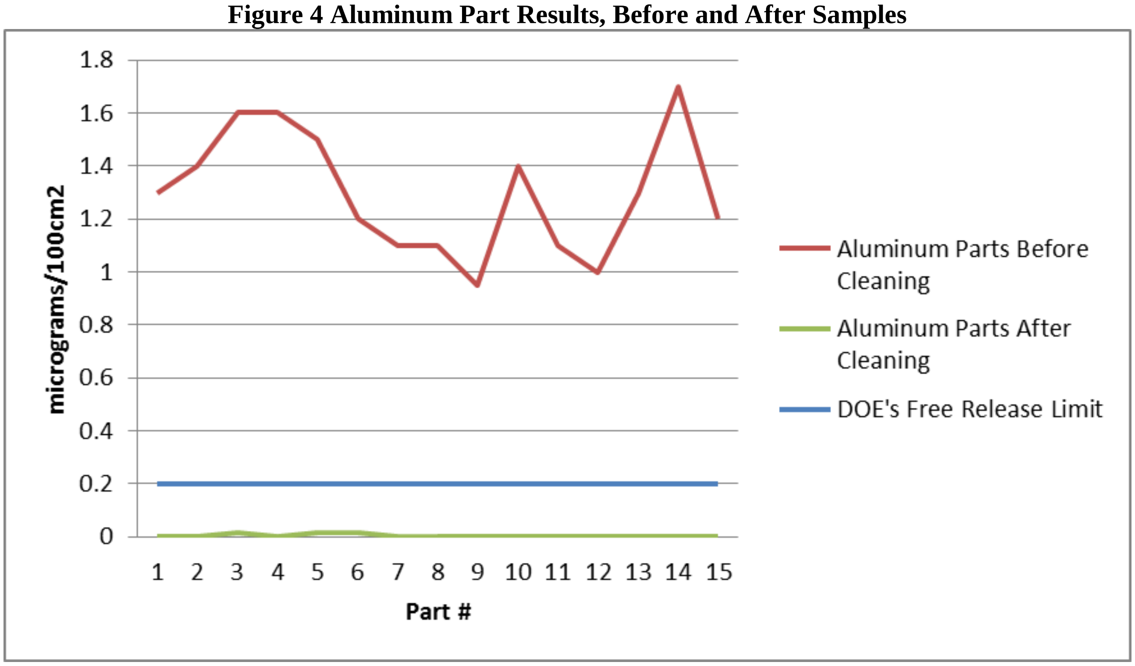
3.1. Aluminum

Thirty aluminum parts were sampled for beryllium surface contamination after being cleaned using the cleaning method mentioned in section 2.2. Table 2 shows the descriptive statistics for the aluminum parts before and after cleaning. Some samples resulted in results that were less than the analytical laboratories reporting limit for beryllium, therefore, for the purpose of statistical analysis, these results were substituted by using the method $LOD/\sqrt{2}$. The reporting limit for beryllium at the laboratory was 0.013µg/sample, therefore, samples that resulted in <0.013 were substituted with $0.0027µg/100cm^2$. Table 1 and Figure 4 show the difference in removable beryllium contamination before and after being cleaned.

Table 1 Aluminum Part Results

Part	Aluminum Parts Before Cleaning (µg/100cm^2)	Aluminum Parts After Cleaning (µg/100cm^2)
1	1.3	0.0027
2	1.4	0.0027
3	1.6	0.015
4	1.6	0.0027
5	1.5	0.015
6	1.2	0.017
7	1.1	0.0027
8	1.1	0.0027
9	0.95	0.0027
10	1.4	0.0027
11	1.1	0.0027
12	1	0.0027
13	1.3	0.0027
14	1.7	0.0027
15	1.2	0.0027

Figure 4 Aluminum Part Results, Before and After Samples



Samples prior to the cleaning process ranged from 0.95μg/100cm^2 to 1.7μg/100cm2 beryllium surface contamination. The mean for parts sampled before the cleaning process was 1.3μg/100cm^2. After sampling, the mean was 0.012 μg/100cm^2, which is well below the DOE's free release limit of 0.2μg/100cm^2. One hundred percent of samples taken on the aluminum parts after they were cleaned are below the free release limit of 0.2μg/100cm^2.

Table 2 Descriptive Statistics for Aluminum Parts

Aluminum Parts Before Cleaning		***Aluminum Parts After Cleaning***	
Mean	1.296666667	Mean	0.00536
Standard Error	0.059854321	Standard Error	0.000992542
Median	1.3	Median	0.0027
Mode	1.1	Mode	0.0027
Standard Deviation	0.231814786	Standard Deviation	0.005436378
Sample Variance	0.053738095	Sample Variance	2.95542E-05
Range	0.75	Range	0.0153
Minimum	0.95	Minimum	0.0027
Maximum	1.7	Maximum	0.018
Sum	19.45	Sum	0.1608
Count	15	Count	30

A paired sample t-Test was conducted to compare beryllium surface contamination before and after cleaning, and is shown in Table 3. There was a significant difference in the samples before cleaning (M=1.30, SD=0.231) and after cleaning (M=0.012, SD=0.003) parts; t(14) = 21.54958403, p=1.95069E-12. These results suggest that the cleaning process reduces the beryllium surface contamination, significantly.

Table 3 Paired t-Test, Aluminum Parts

	Aluminum Parts Before Cleaning	*Aluminum Parts After Cleaning*
Mean	1.296666667	0.010493333
Variance	0.053738095	7.35924E-06
Observations	15	15
Pearson Correlation	0.248141604	
Hypothesized Mean Difference	0	
df	14	
t Stat	21.54958403	
P(T<=t) one-tail	1.95069E-12	
t Critical one-tail	1.761310115	
P(T<=t) two-tail	3.90138E-12	
t Critical two-tail	2.144786681	

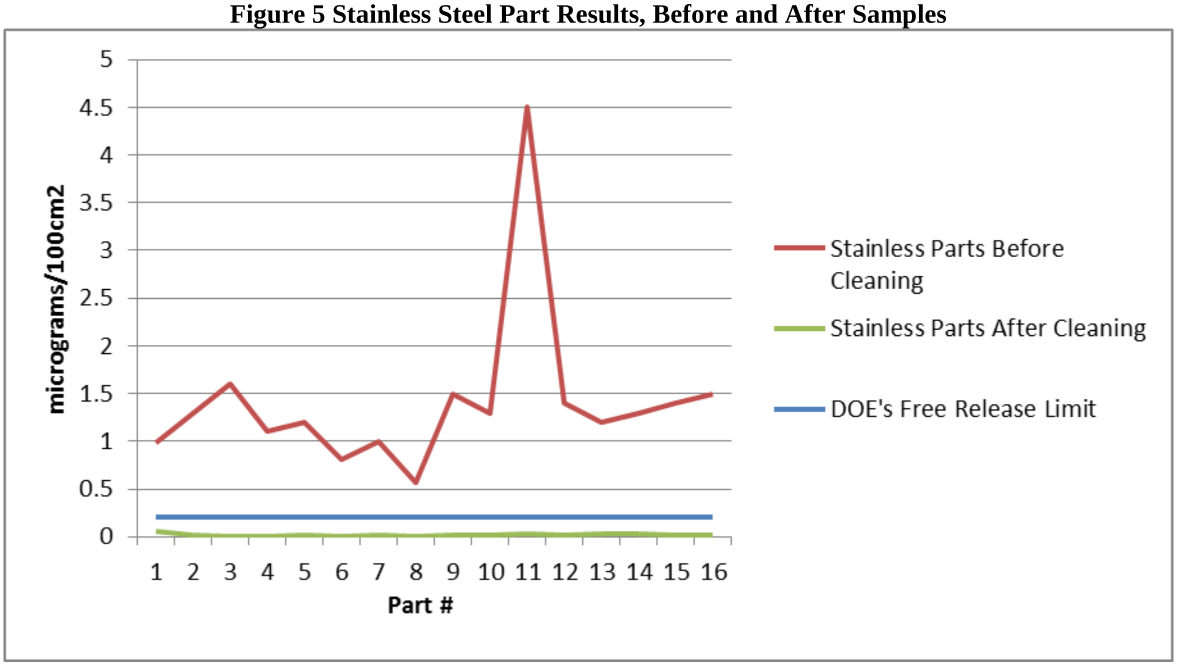
3.2. Stainless Steel

Thirty stainless steel parts were sampled for beryllium surface contamination after being cleaned using the cleaning method mentioned in section 2.2. Table 5 shows the descriptive statistics for the stainless steel parts before and after cleaning. Some samples resulted in results that were less than the analytical laboratories reporting limit for beryllium, therefore, for the purpose of statistical analysis, these results were substituted by using the method LOD/√2. The reporting limit for beryllium at the laboratory was 0.013μg/sample, therefore, samples that resulted in <0.013 were substituted with 0.0027μg/100cm^2. Table 4 and Figure 5 show the difference in removable beryllium contamination before and after being cleaned.

Table 4 Stainless Steel Part Results

Part	*Stainless Parts Before Cleaning ($\mu g/100cm^2$)*	*Stainless Parts After Cleaning ($\mu g/100cm^2$)*
1	0.99	0.055
2	1.3	0.017
3	1.6	0.0027
4	1.1	0.0027
5	1.2	0.018
6	0.81	0.0027
7	1.0	0.015
8	0.57	0.0027
9	1.5	0.019
10	1.3	0.02
11	4.5	0.03
12	1.4	0.021
13	1.2	0.025
14	1.3	0.025
15	1.4	0.02
16	1.5	0.023

Figure 5 Stainless Steel Part Results, Before and After Samples



Samples prior to the cleaning process ranged from $0.57\mu g/100cm^2$ to $4.5\mu g/100cm^2$ beryllium surface contamination. The mean for parts sampled before the cleaning process was $1.42\mu g/100cm^2$. After sampling, the mean was $0.017\ \mu g/100cm^2$, which is also well below the

DOE's free release limit of 0.2µg/100cm^2. One hundred percent of samples taken after the stainless steel parts were cleaned are below the DOE's free release limit of 0.2µg/100cm^2.

Table 5 Descriptive Statistics for Stainless Steel Parts

Stainless Parts Before Cleaning		***Stainless Parts After Cleaning***	
Mean	1.416875	Mean	0.016533333
Standard Error	0.216319052	Standard Error	0.002223016
Median	1.3	Median	0.0185
Mode	1.3	Mode	0.0027
Standard Deviation	0.865276208	Standard Deviation	0.012175961
Sample Variance	0.748702917	Sample Variance	0.000148254
Range	3.93	Range	0.0523
Minimum	0.57	Minimum	0.0027
Maximum	4.5	Maximum	0.055
Sum	22.67	Sum	0.496
Count	16	Count	30

A paired sample t-Test was conducted to compare beryllium surface contamination before and after cleaning, and is shown in Table 6. There was a significant difference in the samples before cleaning (M=1.42, SD=0.865) and after cleaning (M=0.017, SD=0.012) parts; t(15) = 6.488729075, p=5.11442-06. These results suggest that the cleaning process reduces the beryllium surface contamination, significantly.

Table 6 Paired t-Test, Stainless Steel Parts

	Stainless Parts Before Cleaning	***Stainless Parts After Cleaning***
Mean	1.416875	0.018675
Variance	0.748702917	0.000172871
Observations	16	16
Pearson Correlation	0.261960882	
Hypothesized Mean Difference	0	
df	15	
t Stat	6.488729075	
P(T<=t) one-tail	5.11442E-06	
t Critical one-tail	1.753050356	
P(T<=t) two-tail	1.02288E-05	
t Critical two-tail	2.131449546	

3.3. Beryllium

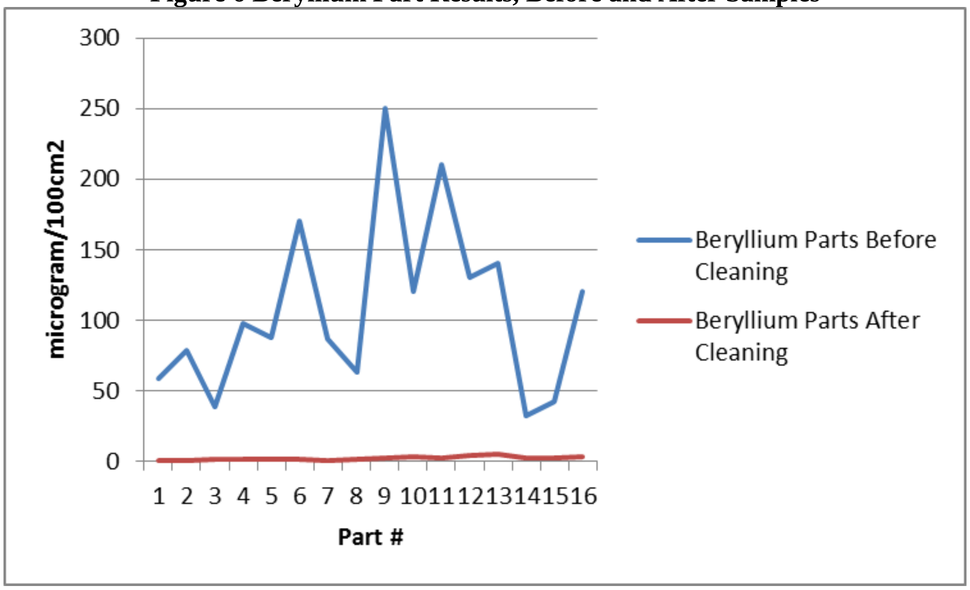
Thirty-two beryllium parts were sampled for beryllium surface contamination after being cleaned using the cleaning method mentioned in section 2.2. The beryllium data was analyzed differently than the data from the aluminum and stainless steel data because they will be released to other beryllium areas and 10 CFR 850 was not intended to apply to beryllium articles, per 10 CFR 850.2(b). A free release limit standard, which allows for the item to be moved to any location, including the public, is not practicable for a pure beryllium item leaving the facility. The beryllium parts are released as a restricted release or a beryllium release, to other beryllium areas, or can be released as a beryllium article if it has been cleaned to prevent the release of particles that could result in exposure or contamination spread. The Department of Energy implements a surface contamination limit of 3.0µg/100cm^2 for areas that are posted as a "beryllium area". 10 CFR 850.31 also states that the responsible employer must clean beryllium contaminated equipment and other items to the lowest contamination level practicable but should not exceed 3.0µg/100cm^2 removable contamination when releasing to another beryllium area (Federal Register 10 CFR 850, 2006), therefore, the results for samples taken on beryllium parts after being cleaned were compared to this limit. The results of this study will allow us to make determinations on the packaging and labeling requirements of beryllium parts. The guidelines for release can be found in Appendix A.

Table 7 and Figure 6 show the difference in removable beryllium contamination before and after being cleaned. Samples prior to the cleaning process ranged from 32µg/100cm^2 to 250µg/100cm^2 beryllium surface contamination, and 0.47µg/100cm^2 to 5.7µg/100cm^2 after the cleaning process. The mean for parts sampled before the cleaning process was 107.9µg/100cm^2. After sampling, the mean was 2.18µg/100cm^2. The post-cleaning beryllium results analyzed using the IH Stat tool in order to determine the 95th percentile, as well as the percentage of samples that resulted in beryllium concentrations above 3.0µg/100cm^2. The data resulted in a lognormal distribution with the 95th percentile at 5.29µg/100cm^2. The upper confidence limit on the exceedance fraction was set at 95% therefore we are 95% confident that 33% of the true values of the samples will exceed the beryllium release limit of 3.0µg/100cm^2.

Table 7 Beryllium Part Results

Part	***Beryllium Parts Before Cleaning (µg/100cm^2)***	***Beryllium Parts After Cleaning (µg/100cm^2)***
1	59	0.49
2	79	0.63
3	39	1.7
4	98	1.6
5	88	1.3
6	170	1.8
7	87	0.72
8	63	1.4
9	250	2.1
10	120	3
11	210	2.1
12	130	4.2
13	140	5
14	32	2
15	42	2.2
16	120	2.9

Figure 6 Beryllium Part Results, Before and After Samples



The results clearly show that the cleaning method significantly reduces the beryllium contamination, but does not reduce to the levels needed to meet the DOE's release limit, one hundred percent of the time.

4. Concluding remarks

The review of data for the stainless steel and aluminum parts, post-cleaning, shows that the cleaning method that was utilized to clean these parts will reduce beryllium contamination below the free release limit. At this point, we can approve the method for future non-beryllium parts fabricated at the beryllium facility. The cleaning method will be inserted into our beryllium procedure as a "validated and approved" method. The method should be reviewed/sampled every 6 months in order to verify the process is continuing to reduce contamination to meet the free release limits.

The review of data from the beryllium parts shows that the cleaning method significantly reduces beryllium contamination, but not enough to comply with the standards. Beryllium parts in their finished form should be labeled and double bagged with new, clean packaging materials in order to confirm the outer packaging is below $0.2 \mu g/100cm^2$. This cleaning method cannot be approved for beryllium parts at this time. More research is needed and possibly a change to the cleaning method.

Beryllium surface contamination should always be as low as feasible in order to protect the health and safety of employees. Housekeeping efforts need to play a large role when working with and around beryllium. Reducing and eliminating beryllium exposure is the most important factor in the facility and is part of the reason this study was conducted. We can confidently move forward knowing that the aluminum and stainless steel parts that are fabricated at the beryllium facility can be free released after being cleaned with the method, and without the need for sampling. The use of the cleaning method will save money on sampling costs as well as the time spent by industrial hygienists performing sampling activities, paperwork, data entry, etc. Customers that request non-beryllium parts to be fabricated at our facility will also receive their items approximately 7 days sooner.

Bibliography

Beryllium Health Hazards. (n.d.). Retrieved November 20, 2015, from OSHA: https://www.osha.gov/SLTC/beryllium/healtheffects.html

Energy, D. o. (1999). Chronic Disease Prevention Program; Final Rule. In *Federal Register* (pp. 68854–68914). Federal Register.

Federal Register 10 CFR 850. (2006, February 9). *Chronic Beryllium Disease Prevention Program (10 CFR 850).* Retrieved November 14, 2015, from Office of Environment, Health, Safety and Security: http://www.occ.gov/news-issuances/federal-register/71fr6847.pdf

Method ID-125G. (n.d.). Retrieved October 4, 2015, from Occupational Safety and Health Administration: https://www.osha.gov/dts/sltc/methods/inorganic/id125g/id125g.pdf

National Institute for Occupational Safety and Health. (2003, March 15). Retrieved October 4, 2015, from Centers for Disease Control: http://www.cdc.gov/niosh/docs/2003-154/pdfs/7300.pdf

Appendix A: Beryllium Release Form

NOTE: Use these buttons to print or save the form. DO NOT use the browser tool bar. SAVE PRINT

Los Alamos NATIONAL LABORATORY EST. 1943

Form 2120

Beryllium Release Form

Released From

TA:	Bldg:	Room or Area:		
Name:		Z No.:	Org:	Phone:

Released To

TA:	Bldg:	Room or Area:		
Name:		Z No.:	Org:	Phone:
Organization and Address if not LANL: *(use comma to separate lines if needed)*				

Release Details

Item Description (**NO PART NUMBERS; NO CLASSIFIED INFORMATION**; check box if ☐ UCNI):

DC Review (as needed): ☐ UCNI ☐ Unclassified Z#/Signature/Date: ____

Surface contamination level determined by (*Check all that apply*):

☐ Sampling (CTS Survey ID#: ____________ or attach results) ☐ Approved Cleaning Method (*identify method*)

☐ Maintained Control of Item ☐ Knowledge of Process/History (*attach justification*)

Recipient commitment to implement controls confirmed by:

☐ Written Commitment (attached) ☐ Approved Subcontractor/Supplier

☐ Releaser can attest that recipient has knowledge of beryllium hazards and will implement controls (LANL only).

If batch release, number of packages: ____________

Type of Release (*check and complete one*)

☐ **Free Release NO LABEL REQUIRED.** Surface contamination < 0.2 ug/100 cm^2 and no potential for internal or hidden contamination. Determination has been made that item is not contaminated.

☐ **General Release LABEL B REQUIRED.** Surface contamination < 0.2 ug/100 cm^2. Potential internal or hidden contamination.

Responsible Associate Director approval for release to the general public:

Name: ________________________ Z#: ________ Signature/Date: ____________________________________

☐ **Restricted Release LABEL C REQUIRED.** Release to other designated beryllium areas only.

☐ Surface beryllium contamination < 3.0 ug/100 cm^2. Item packaged.

☐ Surface beryllium contamination ≥ 3.0 ug/100 cm^2. Item double packaged.

All outer package surface beryllium contamination < 0.2 ug/100 cm^2.

☐ Confirmed by sampling (attach results) ☐ Confirmed by new, clean materials

☐ **Beryllium Release LABEL A REQUIRED.** Unless beryllium article; release to other beryllium areas or approved recipients only.

☐ Powder or liquid forms of beryllium must be double packaged (check to confirm).

All outer package surface beryllium contamination < 0.2 ug/100 cm^2.

☐ Confirmed by sampling (*attach results*) ☐ Confirmed by new, clean materials

Release Approved By

Name:	Z No.:	Org:	Phone:
Signature:	Title:		Date:

2120 (12/10) SAVE PRINT CLEAR FORM Page 1 of 2

Instructions for Completing the Beryllium Release Form

Refer to P101-21 for details on release requirements.

1. Fill in the information for each section below:

   Released From:

   Location the item is being released from.

   Contact information for the person/group releasing the item.

   Released To:

   Location the item is being released to.

   Contact information for the person/group receiving the item. If not LANL, include a mailing address for the contact.

   Item Description:

   Enter a brief description of the item. Include enough detail to clearly identify the item. Description should note any unusual conditions or hazards associated with the item. Do not enter part numbers or classified information. UCNI information may be entered if necessary to adequately describe the item and/or release locations. Clearly mark form if UCNI is entered. If in a controlled area or you are uncertain, a review by a Derivative Classifier (DC) may be appropriate.

2. Check to indicate how the beryllium contamination level on the accessible surfaces of the item was determined (check all that apply).
   - Sampling is the preferred method. Enter the CTS Survey ID# or attach a summary copy of the sampling results.
   - A cleaning method that is validated and approved by IHS-IH may be used in place of sampling for small items that are processed in a routine manner.
   - Items that have been under constant control of a worker and have no potential for contamination do not require sampling.
   - Knowledge of a process, the history of an item, and the control of the item can be used to support the determination that an item is either contaminated or clean. Attach a written justification by a QIH or a RLM designated responsible person.
3. Check to indicate how the recipient commitment to implement controls to prevent exposure was confirmed.
   - Written commitment is preferred and is required for release outside of LANL (email acceptable).
   - Subcontractor/Supplier control requirements are incorporated into Lab issued contracts (see P101-21).
   - Within LANL, the releaser can attest that recipient has knowledge of beryllium hazards and will implement appropriate controls.
4. If this is a release of a batch of items, indicate the total number of packages.
5. Check and complete <u>one</u> of the boxes, depending on the type of release.

   Free Release:

   Determination was made that the item is <u>not</u> contaminated. Item may be released from the beryllium area without labels or restrictions.

   General Release:

   Item may be released from the beryllium area with Label B attached and recipient commitment to implement controls to prevent exposure.

   Release of items with potential hidden contamination to the general public is strongly discouraged. Directorate level approval is required for release to the general public. Release to an approved Subcontractor/Supplier is not considered a release to the general public.

   Restricted Release:

   Item may be released from the beryllium area to another beryllium area with Label C attached. Item must be packaged according to P101-21. If item beryllium contamination > 3.0 ug/100 cm^2 it must be double packaged with labels warning of the condition on the inner package. Check to indicate how the outer package surface was determined to be <0.2 ug/100 cm^2.

   Beryllium Release:

   Item may be released from the beryllium area when packaged according to P101-21 and with Label A attached. Check to indicate how the outer package surface was determined to be < 0.2 ug/100 cm^2.

6. Release is approved by a QIH or a RLM designated responsible person working under the guidance of a QIH. The release form travels with the item. Forward a copy of the completed Beryllium Release Form to IHS-IH at K494 or beryllium@lanl.gov.

Notes:

Appendix B: Cleaning Method

Parts Cleaning Method

1. When a part is completed, clean part with a pre-moistened alcohol wipes (70% isopropyl alcohol/30% deionized water) as soon as it is removed from chuck/machine/vise/etc. Use as many wipes necessary for part size
2. Place part in ultrasonic cleaner, filled with deionized water, for at least 1 minute. Time can be longer, depending on type of part fabricated
3. Remove part from ultrasonic cleaner, dry with clean cloth (Kimwipe™ or similar) clean once more with alcohol wet wipe and place in a new clean bag.
4. Label part as necessary on inner bag. Beryllium part, etc.
5. Place in a second clean bag, if beryllium
6. Replace water in cleaner after 5 parts are cleaned or at the end of the day, whichever comes first.