Executive Summary of the Beryllium Health & Safety Committee (BHSC) 2023 Spring Meeting

The Beryllium Health and Safety Committee (BHSC)
Washington, DC, U.S.A.
URL: https://berylliumhealthandsafetycommittee.com/

Executive Summary of the Beryllium Health & Safety Committee (BHSC) 2023 Spring Meeting

Christopher DORN[1,2] and Josef SOBIERAJ[3] (Editors)

[1]Kyoto Fusioneering America Ltd., Seattle, Washington, U.S.A.
[2]Be4FUSION LLC, Upland, California, U.S.A.
[3]National Nuclear Security Administration (NNSA), U.S.A.

The Beryllium Health & Safety Committee (BHSC) 2023 Spring Meeting was held on 9-10 May 2023 at the Lawrence Livermore National Laboratory (LLNL) in Livermore, California. The meeting has been held annually since 1995, with a break due to the recent pandemic.

This Executive Summary is an abbreviated version of the Minutes of the Spring Meeting, which has omitted the images of the slides from the bulk of the technical presentations. A copy of the Meeting Minutes containing all presentation slides is available to dues-paid BHSC members in the Members Only area of the website, which may be accessed here: Login (berylliumhealthandsafetycommittee.com)

BHSC dues are $40 (USD) per individual per year and may be paid here:
Get Involved (berylliumhealthandsafetycommittee.com)

As participation in events like the BHSC Spring Meeting is offered with no registration fee, if attendees found the meeting to be worthwhile, it is hoped that they will consider becoming members. Support from paying dues helps to make it possible for the BHSC, a non-profit organization run exclusively by volunteers, to continue its work in the field and offer more meeting programs like this one in the future.

The BHSC 2023 Spring Meeting was organized by the BHSC's Meetings & Symposia Sub-Committee, with local support from LLNL. The meeting was held both in-person and online. Overall, there were more than 100 participants, who came mainly from the U.S., but also from Canada, the UK, France, Germany, Japan, China, India, and Russia.

Keywords: Beryllium Health & Safety Committee (BHSC), Beryllium, Beryllium Oxide, Fusion Engineering, Irradiation Effects, Beryllide Intermetallic Compounds, Plasma-Facing Materials, Neutron-Multiplier Materials, Health and Safety, Chronic Beryllium Disease, Beryllium Sensitization, Fusion Start-Ups, Molten Salt, FLiBe, National Ignition Facility (NIF), FLiBe Purification, FLiBe Corrosivity, Tritium Extraction, Fluorescence Analysis, Lawrence Livermore National Laboratory (LLNL)

 DOI: 10.13140/RG.2.2.29195.67368

Table of Contents

Introduction & Post-Meeting Overview

The Beryllium Health & Safety Committee (BHSC) 2023 Spring Meeting was held on 9-10 May 2023 at the Lawrence Livermore National Laboratory (LLNL) site in Livermore, California. This meeting has been held annually as an in-person event from 1995-2019. Due to the pandemic, the Spring Meeting was not held from 2020-2022, and it was finally resumed again this year. There is also an annual Fall Meeting, and a larger BHSC Symposium that typically happens bi-annually.

Mission Statement

The BHSC is committed to promoting activities/efforts that will help to understand and prevent beryllium-induced conditions and illnesses, including beryllium sensitization (BeS) and chronic beryllium disease (CBD), that may be caused or exacerbated by workplace exposure to beryllium. The BHSC mission is primarily educational in nature, and is accomplished through generation, collection, and dissemination of information to members and other interested parties.

The Spring Meeting is an activity resulting directly from carrying out the foregoing Mission Statement. This year's meeting was organized by the BHSC's Meetings & Symposia Sub-Committee, with major technical support from LLNL staff. Participants came mainly from the U.S., but also from Canada, the UK, France, Germany, Japan, China, India, and Russia. Some key aspects to this year's meeting:

- Run in a hybrid format with both in-person and online attendees and presenters
- Highlighted beryllium molten salt (FLiBe) as an up-and-coming product form
- Featured presentations from both fission and fusion companies and research organizations
- Offered a tour of the National Ignition Facility (NIF), a laser inertial fusion project at LLNL
- Included participation from vendors, who presented their products and services in the field

The technical portions of the meeting were comprised of 14 presentations, including industrial-scale use of beryllium molten salt (FLiBe) in new fission reactors, potential for use of FLiBe in future fusion reactors, sampling studies being conducted at two major fusion research organizations, an overview of beryllium product forms and their uses in fission and fusion applications, an update on beryllium disease prevention regulations, the latest in beryllium analytical techniques, and products and services offered by the vendors. All of these presentations called attention to the importance of beryllium health and safety to ensure the success of the research.

There was also a BHSC business meeting, at which the point was raised that there is still a vacancy on the Board for the position of Recording Secretary, hopefully soon to be filled. The other important highlight was the announcement of the BHSC 2023 Fall Meeting, which will be held from 6-8 November 2023 at DOE's Forrestal Building in Washington, DC.

The final BHSC 2023 Spring Meeting agenda is included near the beginning of these Meeting Minutes to introduce the abstracts and presentations that follow. A list of the registered participants may be found in the Appendices of this document. Thanks again to all who participated to make this a great meeting.

Josef SOBIERAJ
Chair, BHSC Meetings & Symposia Sub-Committee
May 2023

BHSC 2023 Spring Meeting Agenda

The meeting agenda was organized under the leadership of BHSC Meetings & Symposia Sub-Committee Chair, Josef SOBIERAJ, with help from Committee Members Chris DORN of Kyoto Fusioneering and Be4FUSION, Gary GRIFFIN of GEG Consulting, as well as BHSC Chair Roland CHRETIEN. Local support at LLNL was provided by Jack BENNETT, Juliana SAGERT, and Eric ARELLANO. This is the version of the agenda that was distributed to the participants at the meeting.

AGENDA – Beryllium Health and Safety Committee Meeting
May 9-10, 2023 – Lawrence Livermore National Laboratory
Also available virtually; links to be provided later

All times listed below are Pacific Daylight Time (PDT)

Day 1 – Tuesday, May 9, 2023

Time (EST)	Activity	Task Lead(s) or Speaker(s)
Morning (PDT) - available via webinar		
07:30	Coffee and Pastries	
08:00	Welcome and Overview	Chretien
08:30	*'Case Studies of FLiBe Handling to Inform Industrial Practices'*	Merwin *et al.*
09:00	'*Beryllium Worker Protection Model for the Production and Handling of FLiBe'*	Heldt, G.
09:30	'*Safety Considerations Associated with FLiBe as an Advanced Breeder-Coolant for Fusion Tritium Breeding Blankets'*	Dorn *et al.*
10:00	Break	
10:15	*'Standardized Methods for Molecular Fluorescence Measurement of Trace Beryllium'*	Ashley *et al.*
10:45	Badging / Lunch	
Afternoon (PDT) – available via webinar except for Tours		
13:00	*'National Ignition Facility (NIF) Fusion Shot, to include a Discussion on Beryllium Operations and Analysis'*	Beale, R.
13:30	Travel and Coordination to the National Ignition Facility (NIF) / Discovery Center	Bennett, J.
14:30	NIF Tours / Discovery Center	Bennett, J.
16:30	**Adjourn Tours (End of Day)**	
18:00	Evening Social – Location TBD	

Day 2 – Wednesday, May 10, 2023

Time (EDT)	Activity	Task Lead(s) or Speaker(s)
Morning (PDT) – available via webinar		
07:45	Coffee and Pastries	
08:00	Second-day agenda review	Chretien
08:15	*'Analysis of Beryllium Surface Contamination Levels of In-Vessel Components for the ITER Project'*	Kurinskiy *et al.*
08:45	*'Analysis of Surface Sampling Techniques: Discussion of Results from UKAEA Pilot Study and Follow-on Progress'*	McKeon *et al.*
09:15	Break	
09:30	*'10 CFR 850 Chronic Beryllium Disease Prevention Program Updates'*	Brown, A.
10:00	*'Reduction of Airborne Beryllium Exposure by Automated Refurbishment of Z Machine Surfaces'*	Pass *et al.*
10:30	Break	
10:45	BHSC Business Meeting	Board Members
11:30	Lunch	
Afternoon (PDT) – available via webinar		
12:30	Vendor Technical Presentations	Moderator: Gary Griffin
13:15	Break	
13:30	*'Beryllium and its Compounds Including Be Metal, BeO, FLiBe and Other Compounds and Their Manufacture and Uses in Nuclear Reactors'*	Smith, K.
14:00	'*Experimental Development of Tritium Breeding Tests with 14MeV Neutrons and FLiBe'*	Woller *et al.*
14:30	Field/Mobile Accreditation for Be	Griffin/Brisson
14:40	Break	
15:00	Subcommittee Breakout Sessions	Members
16:00	Reports from Subcommittee Breakouts	S/C Chairs
16:30	Wrap-up	
End of Day 2		

(BHSC Board meeting: Mon, May 8)
(JOWOG 30-21 meeting: Thu/Fri, May 11-12)

BHSC Meetings & Symposia Sub-Committee

Name	Position	Organization
Josef SOBIERAJ	Chair	National Nuclear Security Administration
Chris DORN	Logo Design, Communications, Meeting Minutes	Kyoto Fusioneering America Ltd. Be4FUSION LLC
Gary GRIFFIN	Vendor & Sponsor Liaison	GEG Consulting LLC

BHSC 2023 Spring Meeting Vendor Organizations

The organizers of the BHSC 2023 Spring Meeting would like to thank the following vendors for their support of the event:

ALS Testing Services Salt Lake City, Utah, U.S.A.	Bureau Veritas North America Novi, Michigan, U.S.A. Lake Zurich, Illinois, U.S.A.	Scientific Sales, Inc. Oak Ridge, Tennessee, U.S.A.

Day 1: Beryllium H&S: FLiBe Molten Salt, Analysis & Uses in Fusion

Case Studies of FLiBe Handling to Inform Industrial Practices

A. MERWIN et al. (Kairos Power Inc., California, USA)

Case Studies of FLiBe Handling to Inform Industrial Practices

Augustus MERWIN[1], Terrence WILLIAMS[1], Karleen JAMES[2], and Alan KRUIZENGA[1]

[1]Kairos Power, Alameda, California, USA
[2]Kairos Power, Albuquerque, New Mexico, USA

The Kairos Power fluoride-salt-cooled, high-temperature reactor (KP- FHR) can be deployed with robust safety, affordable costs, and flexible operation to accommodate the expansion of variable renewables. The KP-FHR utilizes a mixture of lithium fluoride (LiF) and beryllium fluoride (BeF_2), also called FLiBe, for its unique properties as a liquid coolant and heat transfer fluid. While FLiBe offers advantages as a reactor coolant, it requires working with the beryllium fluoride at the industrial scale, which has associated environmental considerations in addition to needing robust worker health and safety practices.

Kairos Power has been working extensively with FLiBe for more than 2.5 years in a laboratory designed and built for this purpose. Lab operations have varied from closed systems, such as gloveboxes or inert piping, to open handling with engineering controls, such as ventilation, in addition to administrative controls and worker PPE. During these operations Kairos Power has gathered a variety of data; beryllium air monitoring and surface contamination data, photos and descriptions of operations, interview experience with the operators, and inspections that are compiled to provide lessons learned for improved work practices. A series of case studies on these operations, and the efficacy of the associated hazard controls will be presented to summarize findings from these laboratory experiences.

As Kairos Power scales towards deploying commercial reactors these laboratory findings are being used to inform industrial practices. Kairos Power has produced several tons of FLiBe for the Engineering Test Unit (ETU). ETU is Kairos Power's non-nuclear demonstration unit which has been hot commissioned and will demonstrate pumping tons of molten FLiBe at prototypic operating conditions for the first time. Strategies for applying the learnings from the laboratory case studies to industrial operations will be presented.

Corresponding Author:
Dr. Augustus MERWIN
merwin@kairospower.com
Kairos Power Inc.
707 West Tower Avenue
Alameda, California 94501
U.S.A.

Beryllium Worker Protection Model for the Production and Handling of FLiBe
G. HELDT (Materion Brush Inc., Ohio, USA)

Beryllium Worker Protection Model for the Production and Handling of FLiBe

Gregory H. HELDT, MS MPH CIH

Materion Brush Inc., Mayfield Heights, Ohio, USA

Lithium beryllium fluoride (Li_2BeF_4), or FLiBe, is a molten salt made from a mixture of lithium fluoride (LiF) and beryllium fluoride (BeF_2) with potential applications as a coolant in molten salt-cooled nuclear reactors and as a liquid blanket for ARC fusion reactors. Beryllium, as either an insoluble or soluble compound, can cause beryllium sensitization (BeS) and chronic beryllium disease (CBD) in susceptible individuals.

Beryllium salts, such as BeF_2 and FLiBe, are soluble compounds. However, most beryllium worker protection efforts are concentrated around operations that process commercially available forms of insoluble beryllium such as beryllium metal, beryllium alloys, and beryllia ceramics. Recently renewed interest in the research and production of FLiBe resulted in the construction of a molten salt purification operation in at the Materion Brush Inc facility in Elmore, OH, where BeF_2 is readily available as a feedstock.

Industrial hygiene design considerations for the production and handling of FLiBe were required to address controls for both BeF_2 salt and molten FLiBe. These efforts included the utilization of existing beryllium worker protection controls used in the production of BeF_2 with the addition of an enclosed design, local exhaust ventilation, administrative procedures for process upsets, and personal protective equipment designed for working with soluble compounds. Initial industrial hygiene beryllium exposure assessments are currently underway.

Corresponding Author:
Mr. Gregory H. HELDT, MS MPH CIH
Manager, Product Stewardship
gregory.heldt@materion.com
Materion Brush, Inc.
6070 Parkwood Boulevard
Mayfield Heights, Ohio 44124
U.S.A.

Safety Considerations Associated with FLiBe as an Advanced Breeder-Coolant for Fusion Tritium Breeding Blankets

C.K. DORN (Kyoto Fusioneering America Ltd., Washington, USA) et al.

Safety Considerations Associated with FLiBe as an Advanced Breeder-Coolant for Fusion Tritium Breeding Blankets

Christopher DORN[1], Paul BARRON[2], Colin BAUS[2,3],
Gerald DEGREEF[2], Reuben HOLMES[2], Takashi INO[2], Satoshi KONISHI[2,3], Keisuke MUKAI[2,3],
Richard PEARSON[3,4], Masato TABUCHI[2], Bibake UPPAL[1], and Juro YAGI[3]

[1]Kyoto Fusioneering America, Seattle, Washington, USA
[2]Kyoto Fusioneering Japan, Tokyo, Japan
[3]Kyoto University, Kyoto, Japan
[4]Kyoto Fusioneering UK, Reading, UK

Kyoto Fusioneering (KF), a private fusion technology company based in Japan, is exploring the use of FLiBe (a lithium fluoride and beryllium fluoride eutectic mixture) molten salt as a promising breeder-coolant for tritium breeding in fusion reactors. FLiBe has many attractive features, such as: high neutron multiplication, excellent tritium breeding properties, low tritium solubility, limited interaction with the strong magnetic fields present in a magnetic fusion reactor, and the ability for operation at relatively low pressures. However, FLiBe and its associated technologies are at relatively low technology readiness levels and its use also raises several safety concerns that need to be addressed before it can be deployed in experimental - and, ultimately, commercial - fusion reactors. In collaboration with Kyoto University, KF is currently working with lab-scale quantities of FLiBe in a benchtop loop to develop our experience and capabilities, marking the start of the FLiBe-oriented arm of our overall tritium breeding research and development programme in the coming years (other breeder-coolants under exploration are lithium-lead and pure lithium). This work provides an overview of the identified safety issues associated with the use of FLiBe.

In a FLiBe breeding blanket, tritium will be produced by the interaction of neutrons with the lithium. This results in the production of tritium fluoride (TF), which is highly reactive and corrosive to the structural and functional materials, as well as components. The occurrence of corrosion comes with a risk of releasing materials to the environment, which could have serious safety consequences from both a conventional and radiological point of view. Additionally, a fusion reactor must breed its own fuel, so any tritium produced in the form of TF must also be separated out from the coolant to be injected back into the fusion reactor as fuel. TF is difficult to handle and transport due to its high reactivity and mobility, and thus specialized equipment and facilities are required for handling. It is thus desirable to remove TF, and strategies to remove TF using Be and Li in redox reactions are being investigated by KF.

The corrosion behavior of FLiBe is worsened by the presence of impurities contained with the mixture, which can be introduced either from the raw material of LiF and BeF_2 before mixing, or from corrosion during operation, meaning purification processes are desirable when operating a FLiBe coolant loop. These processes involve the use of H_2 and HF gas, both of which come with their own safety considerations.

Known FLiBe-compatible materials are limited, and nickel-based alloys known to have good compatibility produce large quantities of undesirable radioactive products under neutron irradiation. Finding suitable materials is thus also driven by safety considerations.

KF is exploring whether FLiBe has promise as a breeding blanket material, and is sharply focused on identifying and resolving safety concerns. Proper handling and containment measures should be incorporated into the design at the earliest stages, to mitigate risks associated with its use. Here, the challenges, as well as KF's programme to understand and find solutions, are presented.

Corresponding Author:
Mr. Chris DORN
Technical & Business Advisor
c.dorn@kyotofusioneering.com
Kyoto Fusioneering America Ltd.
600 Stewart Street, Suites 300 & 400
Seattle, Washington 98101
U.S.A.

Standardized Methods for Molecular Fluorescence Measurement of Trace Beryllium
K. ASHLEY (Ashley Analytical Associates LLC, Arizona, USA) et al.

Standardized Methods for Molecular Fluorescence Measurement of Trace Beryllium

Kevin ASHLEY[1], John P. CRONIN[2], Anoop AGRAWAL[2], and Lori ADAMS[2]

[1]Ashley Analytical Associates LLC, Amado, Arizona, USA
[2]Berylliant Inc., Tucson, Arizona, USA

Standardized protocols have been developed based on a molecular fluorescence method for the determination of trace beryllium (Be) in samples collected in occupational and environmental settings. The methodology, which is field-portable, entails extraction of collected samples in dilute ammonium bifluoride (NH_4HF_2, aqueous), followed by fluorescence measurement of the complex formed between Be and hydroxybenzoquinoline sulfonate (HBQS). The technique has been optimized to achieve an estimated method detection limit (MDL) of ≤1ng Be/sample, with a dynamic range extending to >10µg Be/sample. Potentially interfering metals (in >400-fold excess concentration compared to that of Be) are negligible or minimal. The estimated MDL of the fluorescence method is the lowest attained by means of conventional laboratory techniques.

Besides beryllium salts and other Be compounds, the fluorescence procedure is effective for the dissolution and quantitative determination of Be extracted from refractory beryllium oxide (BeO) particles. The method has also been successfully modified for measuring Be content in soil samples. The performance of the procedure compares favorably with methods employing sample digestion in acid mixtures that include hydrofluoric acid (HF), followed by inductively coupled plasma-mass spectrometry (ICP-MS). ASTM International voluntary consensus standards and U.S. National Institute for Occupational Safety and Health (NIOSH) methods based on the methodology have been published. The sampling and analytical protocol has been thoroughly evaluated and validated through intra- and inter-laboratory testing. These methods are recognized by laboratory accrediting organizations in the USA and in Europe. Application to the measurement of trace Be in occupational and environmental samples has been successfully extended to:

- Workplace air samples
- Surface wipe samples (media: cellulosic and polyvinyl alcohol)
- Cellulosic inserts for air & micro-vacuum samples
- High-fired (calcined) BeO
- Beryllium salts (e.g., BeF_2, FLiBe)
- Cotton gloves
- Nanoparticles (airborne)
- Soil samples

Corresponding Author:
Dr. Kevin ASHLEY
keadash4@live.com
Ashley Analytical Associates LLC
1921 West Eagle Way
Amado, Arizona 85645
U.S.A.

National Ignition Facility (NIF) Fusion Shot, to include a Discussion on Beryllium Operations and Analysis

R. BEALE (Lawrence Livermore National Laboratory, California, USA)

National Ignition Facility (NIF) Fusion Shot, to include a Discussion on Beryllium Operations and Analysis

Richard BEALE

Lawrence Livermore National Laboratory, Livermore, California, U.S.A.

The National Ignition Facility (NIF) is the world's most energetic laser system, enabling the study of high energy density conditions to support:

- Stockpile Stewardship
- Inertial Confinement Fusion (ICF)
- Discovery Science

NIF is the size of a sports stadium—three football fields could fit inside. NIF's unique energy and power enable cutting-edge research to help keep the U.S. safe and secure, explore new frontiers of science, and lay the groundwork for a clean, sustainable source of energy.

NIF is also the world's most precise and reproducible laser system. It precisely guides, amplifies, reflects, and focuses 192 powerful laser beams into a target about the size of a pencil eraser in a few billionths of a second, delivering more than 2 million joules of ultraviolet energy and 500 trillion watts of peak power.

NIF generates temperatures in the target of more than 180 million degrees Fahrenheit and pressures of more than 100 billion Earth atmospheres. Those extreme conditions cause hydrogen atoms in the target to fuse and release energy in a controlled thermonuclear reaction. Ignition provides fresh impetus and the scientific foundation for inertial fusion energy.

- Inertial Fusion Energy (IFE) is the next grand challenge
- Realizing the potential of IFE will require developing new technologies
- The scale of investment needed will be comparable or more to the investment required to obtain ignition

In partnership with the community and in a manner synergistic with our stewardship mission, LLNL seeks to enable an ecosystem to accelerate IFE in support of DOE's decadal vision for accelerating the commercialization of fusion energy.

Corresponding Author:
Mr. Richard BEALE
NIF Deputy Radiation Safety Officer
beale2@llnl.gov
Lawrence Livermore National Laboratory (LLNL)
National Ignition Facility (NIF)
7000 East Avenue
Livermore, California 94550
U.S.A.

Day 2: Beryllium H&S: Air & Surface Sampling in Fusion, FLiBe Molten Salt Use, and Disease Prevention Update

Analysis of Beryllium Surface Contamination Levels of In-Vessel Components for the ITER Project

P. KURINSKIY (ITER Organization, France) et al.

Analysis of Beryllium Surface Contamination Levels of In-Vessel Components for the ITER Project

Petr KURINSKIY[1], Russell EATON[1], Paul EDWARDS[1], Liman BAO[1], Jiming CHEN[2], Pinghuai WANG[2], Jialin LI[2], Kun WANG[3], D. GLAZUNOV[4], and S. BOBROV[4]

[1]ITER Organization, St. Paul Lez Durance, France
[2]Southwestern Institute of Physics (SWIP), Beijing, China
[3]China ITER Domestic Agency (CN DA), Beijing, China
[4]D.N. Efremov Institute of Electrophysical Apparatus, Saint-Petersburg, Russia

Beryllium-bearing First Wall (FW) panels provided by suppliers in China, Europe, and Russia are specified for use in the ITER project. These FW panels will be transported to France and stored in the Tokamak Assembly Preparation Building (TAPB) on the ITER site. The ITER site is an Installation Nucléaire de Base (INB), making the FW panels subject to key safety requirements for working with and storage of beryllium-containing parts. One such requirement specifies the degree of control and monitoring of beryllium dust associated with these components. Associated with this scope, we have undertaken beryllium surface sampling campaigns on beryllium-clad panels in each of the three FW-supplying countries to better understand expected surface contamination quantities and the relation to certain processes during the panel lifecycle.

In this work, we adapted the sampling method based on NIOSH (National Institute for Occupational Safety and Health) procedure to collect beryllium dust (loose particles) by surface wiping. Following sampling, we analyzed smear filters using fluorometric or ICP-MS/AES (Inductively Coupled Plasma Mass Spectrometry/ Atomic Emission Spectroscopy) methods to obtain surface contamination levels (expressed in $\mu g/m^2$).

We collected data to investigate the effect on surface contamination of beryllium components in different conditions, including:

- As-received (as-manufactured) state
- After cleaning
- After High-Heat Flux (HHF) testing
- After repeatable cleaning/surface sampling

Finally, based on performed data analysis, conclusions related to cleaning efficiency and influence of HHF testing on the amount of collected beryllium dust will be presented.

Corresponding Author:
Dr. Petr KURINSKIY
petr.kurinskiy@iter.org
ITER Organization
Route de Vinon sur Verdon, CS 90 046
13067 St. Paul Lez Durance Cedex
FRANCE

Analysis of Surface Sampling Techniques: Discussion of Results from UKAEA Pilot Study and Follow-On Progress

E. McKEON et al. (UK Atomic Energy Authority, UK)

Analysis of Surface Sampling Techniques: Discussion of Results from UKAEA Pilot Study and Follow-on Progress

Eilish MCKEON, Amy BLEASDALE, and Lia AU YEUNG

UK Atomic Energy Authority, Culham Centre for Fusion Energy, Abingdon, UK

At the UK Atomic Energy Authority (UKAEA), surface sampling for beryllium is performed by Health Physics technicians trained in standard processes. Given the manual nature of the task, natural variations occur from person to person. Current UKAEA research aims to aid in the development of robotic sampling methods by determining the typical performance of operators.

A pilot study was initially performed to determine the feasibility of studying sampling variability between technicians, investigating the effect of pressure exerted on beryllium recovery. Technicians used both Whatman filters (dry) and Ghost Wipes (wet), and despite the small sample sizes used, results indicated a significant relationship between pressure and beryllium recovery when using Ghost Wipes. During the pilot study it was noted that Whatman filters are routinely used at UKAEA. Ghost Wipes are used less frequently. It was concluded that one of the potential reasons that average pressure was not significant for Whatman filters might be because the technicians are more familiar with this sampling medium and rely on their own techniques to get better results, rather relying on pressure alone. Alternatively, no significant relationship may have been picked up by the model due to the granularity of the study which resulted in small subsets of data.

The second study phase aims to further the understanding of surface sampling variables, pertaining to operator input, including force application, surface types, and sampling protocol. Determining the effect of these factors on sampling results is expected to inform the development of remote sampling techniques through the development of complex swabbing motions for more efficacious and repeatable swabbing using a robotic arm, comparing robotic and manual sampling efficiency using qualitative measures.

Corresponding Author:
Ms. Eilish McKEON
eilish.mckeon@ukaea.uk
UK Atomic Energy Authority (UKAEA)
Culham Centre for Fusion Energy (CCFE)
Abingdon, Oxfordshire OX14 3DB
UNITED KINGDOM

10 CFR 850 Chronic Beryllium Disease Prevention Program Updates

A. BROWN (US Department of Energy, Maryland, USA)

10 CFR 850 Chronic Beryllium Disease Prevention Program Updates

April BROWN, CIH

US Department of Energy, Office of Health & Safety, Germantown, Maryland, USA

EHSS-11 is amending the Chronic Beryllium Disease Prevention Program (10 CFR 850) regulation. To make these amendments to the final rule, we are revising the economic assessment for the Office of Management and Budget (OMB). An economic assessment ensures OMB that decisions to update rules are based on the most accurate information available and provides the Department with the data necessary to compare the action with acceptable alternatives. The data required to update the costs, benefits, and administrative burden statistics support an economic assessment for modifications to 10 CFR 850 comes from the sites with beryllium operations.

Corresponding Author:
Ms. April Brown, CIH
april.brown@hq.doe.gov
U.S. Department of Energy
Worker Safety and Health Policy
Office of Environment, Health, Safety, and Security
Office of Health and Safety (EHSS-11)
19901 Germantown Road
Germantown, Maryland 20874
U.S.A.

Automated Refurbishment of MITL Surfaces (ARMS)

K.D. PASS et al. (Sandia National Laboratories, New Mexico, USA)

Automated Refurbishment of MITL Surfaces (ARMS)

Diego LUCERO and K.D. PASS

Sandia National Laboratories, Albuquerque, New Mexico, USA

Sandia's "Z Machine" is the world's most powerful and efficient laboratory radiation source. It uses high magnetic fields associated with high electrical currents to produce high temperatures, high pressures, and powerful X-rays for research in high energy density physics. **The Z Machine creates conditions found nowhere else on Earth**.

https://www.sandia.gov/z-machine/

The Z Machine Beryllium Minimization Program's primary goal is to reduce worker exposure to airborne beryllium during our Magnetically Insulated Transmission Lines (MITLs) Refurbishment process. Currently this is a hands-on activity and has the highest potential to exceed the US Department of Energy (DOE) Action Limit of 0.2µg/m^3. The goal is to realize a fully functional automated MITL cleaning system.

Corresponding Author:
Ms. K.D. (Kathleen) PASS
kpass@sandia.gov
Industrial Hygienist
Sandia National Laboratories
Environment, Health & Safety
Building MO294, Room 27
Albuquerque, New Mexico
U.S.A.

Experimental Development of Tritium-Breeding Tests with 14MeV Neutrons and FLiBe
K. WOLLER (Massachusetts Institute of Technology, Massachusetts, USA) et al.

Experimental Development of Tritium-Breeding Tests with 14MeV Neutrons and FLiBe

Kevin B. WOLLER, C. CUMMINGS, R. DELAPORTE-MATHURIN, C.S. DUNN, E. EDWARDS, S.E. FERRY, N. GOLEŠ, A.T. LANZRATH, R. LECCACORVI, E.E. PETERSON, S. SEGANTIN, R. VIEIRA, D.G. WHYTE, L. ZHOU, and W. ZHOU

Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

M.D EKLUND, T.F. FUERST, H. GIETL, A.A. RIET, and C.N. TAYLOR

Idaho National Laboratory, Idaho Falls, Idaho, USA

Experimental development of liquid FLiBe tritium breeder technology is underway at the Massachusetts Institute of Technology Plasma Science and Fusion Center (PSFC) with modeling and design support from Idaho National Laboratory (INL) Safety and Tritium Applied Research (STAR) Facility. The project goal is to investigate tritium breeding and release from molten FLiBe at up to 700˚C with a source of D-T fusion neutrons. This environment ensures relevant conditions for comparison to Fusion Power Plants (FPP). In order to reach prototypical neutron energy spectrum conditions throughout the breeding blanket, path lengths greater than 30cm of FLiBe are required. Neutronics modeling of a prototype blanket of this scale indicates tritium-breeding ratios (TBR) approaching unity.

Safe handling and management of FLiBe, taking into account the hazards of corrosive fluoride compounds and beryllium toxicity, are paramount. Efforts to document and share safe practices in addition to scientific results are treated just as importantly. Working directly with high-energy D-T fusion neutrons forces experiments not only to account for optimizing tritium breeding, just as would need to be done by FPP developers, but also pushes experimental design to take into account tradeoffs in shielding material versus breeding material.

Corresponding Author:
Dr. Kevin B. WOLLER
kbwoller@mit.edu
Massachusetts Institute of Technology (MIT)
Plasma Science & Fusion Center (PSFC)
77 Massachusetts Avenue
Cambridge, Massachusetts 02139
U.S.A.

Beryllium and its Compounds Including Be Metal, BeO, FLiBe, and Other Compounds and their Manufacture and Uses in Nuclear Reactors

K. SMITH et al. (Materion Brush Inc., Ohio, USA)

Beryllium and its Compounds Including Be Metal, BeO, FLiBe and Other Compounds and their Manufacture and Uses in Nuclear Reactors

Keith J. SMITH[1], Ron W. TOWNSEND[2], and Gregory H. HELDT[3]

[1]Materion Brush, Inc., Elmore, Ohio, USA
[2]Materion Brush, Inc., El Segundo, California, USA
[3]Materion Brush, Inc, Mayfield Heights, Ohio, USA

Beryllium has a unique combination of properties desirable for nuclear applications. These include high neutron flux, low neutron absorption, high neutron scattering, high thermal conductivity, transparency to most forms of radiation, and the ability to maintain its characteristics at elevated temperatures.

These characteristics make beryllium an excellent candidate for nuclear reactors. Historical uses have generally been limited to nuclear test reactors and particle accelerators. Today, advanced next generation nuclear reactor design for both fission and fusion reactors may use pure beryllium metal, beryllium oxide, FLiBe, a molten salt containing lithium fluoride and beryllium fluoride, and beryllium intermetallic compounds.

This presentation will include an overview of the manufacture of Be, BeO, FLiBe, and other compounds by Materion in the United States. In addition, the general nuclear reactor uses for these materials will be presented.

Corresponding Author:
Mr. Keith J. SMITH
keith.smith@materion.com
Materion Brush Inc.
14710 West Portage River South Road
Elmore, Ohio 43416
U.S.A.

Day 2: BHSC Business Meeting

Led by Roland CHRETIEN, BHSC Chair

Business Meeting Minutes compiled by Josef SOBIERAJ

BHSC Business Meeting
Original Agenda (Black Font)
Minutes Added (Red Font)

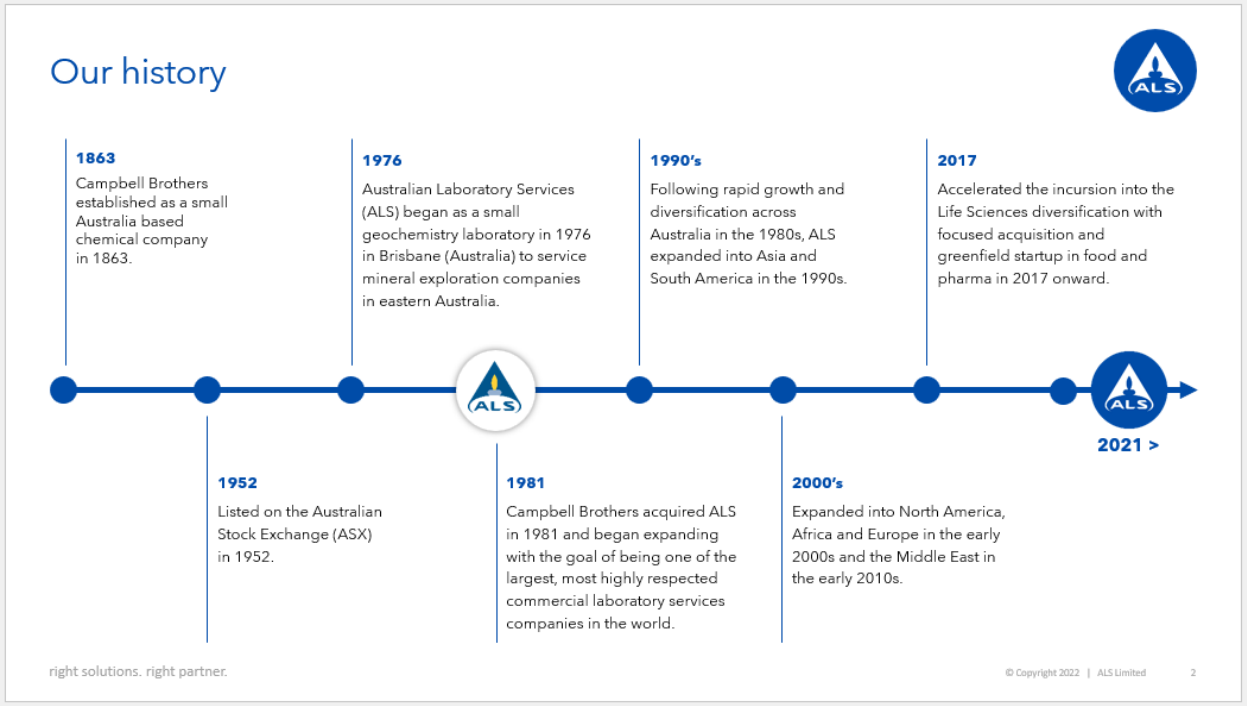
Wednesday, 10 May 2023 – At BHSC Spring Meeting & MS Teams Online
13:45 (1:45pm) - Eastern Daylight Time

1. Review and Approval of meeting agenda – Chair Roland presented the agenda. Motion to Approve as written – Chris Dorn. Second – Mike Brisson
2. Roll-Call – Recording Secretary (Chair or designee) Julie Fowler took roll call for all members including in-person and virtual attendees. The meeting had a quorum.
3. Election of Officers Danny Field stated there is a Recording Secretary vacancy. As part of succession planning, BHSC has opportunities to serve as Chair for subcommittees and overall Chair of BHSC. Beth Walker stated that she would like to volunteer as needed.
4. Other New Business Items No new business items.
5. Chairman's Report Roland reviewed activities since 11/22. Roland also spoke on the need for succession planning.
6. Status of Funds Roland paid Jackie Rogers $50 for renewal of business license.
    i. PayPal Dan Jensen stated this account has $4,253.70.
    ii. Wells Fargo Dan Jensen stated this account has $7,710.64.
    iii. Total balance of $11,964.34.
7. Membership Report Julie stated that BHSC currently has 31 paid members and 203 contacts and subscribers.
8. Website Report Julie stated that BHSC is updating its website with many enhancements forthcoming.
9. Plans for Fall BHSC Meeting Josef summarized the planning details for the 11/6-8/23 Fall BHSC Meeting to be held at Forrestal Building in Washington DC. A Meetings and Symposia Subcommittee planning meeting will be held later this day with additional details presented to the entire group.
10. Subcommittee Chairs
    - Risk Communication – Nothing to report
    - Research Needs – Nothing to report
    - Technical Standards/Practitioners Guide/Measures – Seuri stated that this group is waiting for the 10 CFR 850 Rule changes, which will drive changes to the Practitioners Guide
    - Med/Epi Lisa stated that this group has been meeting every other month with 15 active members. This group is taking a deep dive in evaluating the BAWR to improve data quality in sections so that it can be better utilized to inform health and safety data and trends for sites and the DOE.
    - Meetings and Symposia Josef presented on the updated details from the Fall BHSC planning meeting. Separate meeting minutes were prepared and disseminated.
11. New Business None
12. Adjournment Motion to Adjourn at 1434 EDT – Chris Dorn. Second – Josef

Day 2: Vendor Technical Presentations

ALS Testing Services, Salt Lake City, Utah, USA

Bevan MEADE and Lisa REID

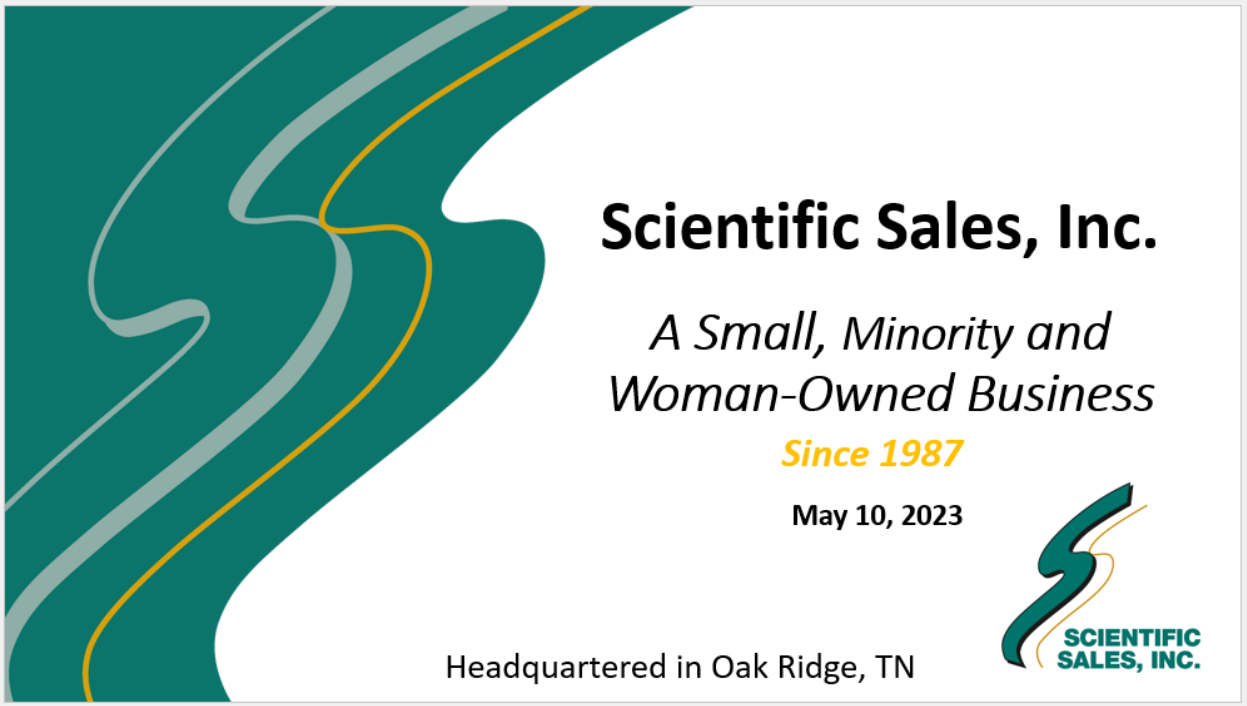


Bureau Veritas North America, Michigan & Illinois, USA

Mike DEW

Scientific Sales, Inc., Oak Ridge, Tennessee, USA

Cynthia BULLARD



Appendices

BHSC 2023 Spring Meeting Participants List

Below is a sampling of some of the organizations that were represented at the meeting. For access to the complete BHSC 2023 Spring Meeting Participant List, please see a copy of the complete Meeting Minutes.

Family Name	First Name	Organization	Country	Status
		Ashley Analytical Associates LLC	USA	
		Kyoto Fusioneering America Ltd.	USA	
		Karlsruhe Beryllium Handling Facility	Germany	
		UK Atomic Energy Authority	UK	
		Materion Brush Inc.	USA	
		General Dynamics	USA	
		Safer Environment Ltd.	UK	
		ITER Organization	France	
		Be4FUSION LLC	USA	
		Kairos Power Inc.	USA	
		US Department of Energy	USA	
		Berylliant Inc.	USA	
		Lawrence Livermore National Lab	USA	
		Savannah River National Lab	USA	
		Massachusetts Institute of Technology	USA	

Meeting & Venue Photos

Below is a sampling of some of the photos that were taken of the in-person meeting in Livermore. For access to all BHSC 2023 Spring Meeting photos, please see a copy of the complete Meeting Minutes.


Left: Roland CHRETIEN, BHSC Chair, delivers his opening remarks. Right: More than 40 in-person attendees listened to Richard BEALE giving his presentation about beryllium use in the National Ignition Facility (NIF) prior to going on guided tours of the facility. Photo credits: Julie FOWLER, NNSA.

NIF Tour Group from the JOWOG Meeting held on Thursday, 11 May 2023. Photo credit: LLNL.