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California Air Resources Board (CARB)
Implementation of California Climate-Disclosure Legislation | Stakeholder Engagement

This comment is intended to recommend the use of the carbon-14 testing method to determine the share of biogenic carbon content of feedstocks, fuels and emissions in all scopes 1 and 2 emissions. Biogenic content measurements following methods such as ASTM D6866 Method B currently provide critical value to leading international programs regulating decarbonization activities, including California's existing Cap-and-Trade and Low Carbon Fuel Standard (LCFS) programs.

Included here you will find:

Recommendations for Implementation of California Climate-Disclosure Legislation

Our recommendation is that CARB should use direct biogenic content testing requirements following the ASTM D6866 Method B standard for any feedstocks, fuels or emissions seeking recognition of renewable (biogenic) content to implement California's Climate-Disclosure Legislation (Senate Bills 253, 261 and 219). Direct biogenic testing requirements are the only reliable method of incentivizing the use of biomass-derived content to reduce emissions while guaranteeing compliance. This section will discuss the importance of and best practices for regulating biogenic content with regard to the relevant questions posed in this information solicitation.

General: Standards in Regulation

> *3. CARB is tasked with implementing both SB 253 and 261 in ways that would rely on protocols or standards published by external and potentially non-governmental entities.*

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a. How do we ensure that CARB's regulations address California-specific needs and are also kept current and stay in alignment with standards incorporated into the statute as these external standards and protocols evolve?
b. How could CARB ensure reporting under the laws minimizes duplication of effort for entities that are required to report GHG emissions or financial risk under other mandatory programs and under SB 253 or 261 reporting requirements?
c. To the extent the standards and protocols incorporated into the statute provide flexibility in reporting methods, should reporting entities be required to pick a specific reporting method and consistently use it year-to-year?

One standard which should be followed to address all three aspects of this question, particularly part b, is the ASTM D6866 Method B standard for any entities seeking recognition of emissions reductions from biogenic content in feedstocks, fuels and emissions for climate disclosure under this law. ASTM D6866 is an independent, internationally recognized standard accepted by the scientific community and routinely updated to reflect the current state of the industry. The standard is currently used by California's existing Cap-and-Trade and Low Carbon Fuel Standard (LCFS) programs, so applying the same standard to this law would minimize duplications of effort for entities reporting emissions reductions from the use of biogenic content.

ASTM D6866 is currently required for reporting biogenic emissions under the following emissions reduction programs (please see specific rules hyperlinked):

- The US Greenhouse Gas Reporting Program (GHGRP) requires quarterly testing following ASTM D6866 for biogenic emissions from co-firing and municipal solid waste (MSW) combustion.[1]
- California's Cap-and-Trade requires quarterly testing following ASTM D6866 for biogenic emissions from co-firing and MSW combustion.[2]
- Canada's Greenhouse Gas Reporting Program (GHGRP) requires routine direct testing following ASTM D6866, "if combusted fuels or fuel mixtures contain a biomass fraction that is unknown or cannot be documented."[3]
- Ontario's Emissions Performance Standards (EPS) requires quarterly testing following ASTM D6866 to report biogenic content in fuel combustion and petrochemical production.[4]
- The EU's Emissions Trading System (ETS) requires quarterly routine direct testing for biogenic portions of obligated materials, fuels and emissions.[5]

[1] 2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *National Archives Code of Federal Regulations*
[2] 2016. "40 CFR Part 98 Subpart C– General Stationary Fuel Combustion Sources." *California Air Resources Board*
[3] 2020. "Canada's Greenhouse Gas Quantification Requirements." *Environment and Climate Change Canada*
[4] 2020. "Guideline for Quantification, Reporting and Verification of Greenhouse Gas Emissions." *Ontario MECP*
[5] 2022. "Biomass issues in the EU ETS." *European Commission*

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ASTM D6866 is also currently required for reporting biogenic content under the following fuel decarbonization programs (please see specific rules hyperlinked):

- The US RFS currently requires routine direct testing following ASTM D6866 for fuels produced from co-processing, municipal solid waste (MSW), biogas and renewable natural gas (RNG).[6]
- California's LCFS requires routine direct testing for fuels produced from co-processing and recommends for fuels produced from MSW.[7]
- Oregon's CFP requires routine direct testing following the protocols of the US RFS third-party engineering reviews.[8]
- Washington's CFS requires routine direct testing following the protocols of the US RFS third-party engineering reviews.[9]
- Canada's CFR requires routine direct testing for any fuels produced from co-processing and their co-products, as well as to verify biogenic feedstocks.[10]
- British Columbia's LCFS requires monthly testing for any fuels produced from co-processing and quarterly testing for their co-products, as well as to verify biogenic feedstocks.[11]
- The EU's RED requires routine direct testing for any fuels produced from co-processing or biogas and renewable natural gas (RNG).[12]

ASTM D6866 is also required for reporting the biobased content of renewable chemicals, bioplastics and other biobased products under the following renewable product incentivization programs (please see specific rules hyperlinked):

- The USDA BioPreferred Program requires ASTM D6866 Method B testing for any biobased products, including renewable chemicals, seeking recognition of renewable content.[13]
- The EU's Policy Framework for Biobased, Biodegradable and Compostable Plastics recommends direct Carbon-14 testing as its preferred method for determining biobased products.[14]
- Four US states have Renewable Chemicals Act laws which provide incentives for biobased chemical production requiring ASTM D6866 testing: Iowa, Kentucky, Minnesota and Maine. There is also a bill for a federal Renewable Chemicals Act which proposes to require ASTM D6866 testing as well.
- The leading biobased product certification programs in the market require Carbon-14 testing to verify biobased content including: TUV Ok Biobased, DIN CERTCO Biobased, UL 9798 biobased

[6] 2010. "40 CFR Part 80 Subpart M– Renewable Fuel Standard." *National Archives Code of Federal Regulations*
2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
[7] 2020. "Reporting Co-Processing and Renewable Gasoline Emissions Under MRR." *California Air Resources Board*
[8] 2023. "Oregon Clean Fuels Program." *Oregon Department of Environmental Quality*
[9] 2022. "Chapter 173-424 WAC: Clean Fuels Program Rule." *Washington State Legislature*
[10] 2022. "Clean Fuel Regulations: Quantification Method for Co-Processing in Refineries." *Environment and Climate Change Canada*
[11] 2025. "Low Carbon Fuel Regulation: Co-Processing Methodology" *British Columbia Ministry of Energy and Climate Solutions*
[12] 2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." *European Commission*
[13] 2018. "What is the BioPreferred® Program?" *US Department of Agriculture*
[14] 2022. "EU Policy Framework on Biobased, Biodegradable and Compostable Plastics." *European Commission*

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content validation, SGS Green Mark, Nordic Swan Ecolabel, Germany's Blue Angel Ecolabel, Braskem I'm Green™, Leadership in Energy and Environmental Design (LEED) and CertiPUR-US®.

As a result, it would be in CARB's best interest to implement the same testing requirements for California's climate disclosure reporting to maintain consistency with the established best practice for reporting emissions reductions from the use of biogenic content. For Scopes 1-2 emissions reductions, in most cases, entities seeking credit for reducing emissions using biogenic content will already be conducting testing for one or more of the programs listed above.

SB 253: Climate Corporate Data Accountability Act

> *7. Entities must measure and report their emissions of greenhouse gases in conformance with the GHG Protocol, which allows for flexibility in some areas (i.e. boundary setting, apportioning emissions in multiple ownerships, GHGs subject to reporting, reporting by sector vs business unit, or others). Are there specific aspects of scopes 1, 2, or 3 reporting that CARB should consider standardizing?*

As discussed in the response to question 3, CARB should standardize reporting of biogenic content for Scope 1-3 under this program, particularly for feedstocks, fuels and emissions in Scopes 1-2. This is the only method to accurately measure the biogenic content in resulting emissions, enabling CARB to only recognize real contributions to decarbonization. Requiring routine testing following ASTM D6866 is the established best practice for reporting emission reductions from biogenic content in the programs listed above, including California's Cap-and-Trade and LCFS programs.

Avoid Mass Balance for Quantification of Biogenic Content

Beta believes it is not in the best interest of CARB's climate disclosure program to allow any mass balance calculations to be used for reporting biogenic content under this program. If CARB does allow any use of mass balance calculations, it is critically important to require these calculations to be verified by routine direct testing. We stress the importance of reviewing other programs' experiences with these calculation-based approaches to understand the risk they would introduce to the program.

Producers and industry lobbying groups favor calculation-based approaches such as mass balance because they enable facilities to make claims solely based on material inputs in production. These calculations allow producers to assume that all of their biomass inputs end up in their facilities' outputs, despite it being well understood in the industry that the input of renewable feedstocks is not the same as the output because performance varies and renewable feedstocks don't produce the same quantity of material as their fossil counterparts.[15] By basing their calculations solely on production inputs rather than outputs these methods systematically over-report the renewable share of fuels.

[15] 2006. "Determining the modern carbon content of biobased products using radiocarbon analysis." *Bioresource Technology*, 97(16), 2084-2090.

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Calculation-based approaches also use a system of free allocation, meaning they do not have to guarantee that there is any renewable content in a given fuel. Producers prefer this because if 10% of their feedstocks are biogenic they can claim that 10% of their products are biogenic, even if that's not the case because biobased can go in different amounts to different products in the co-process. Even further, free allocation also allows them to claim that 10% of their products are 100% biogenic and the rest are 0%, even if all of the products should be 10% biogenic based on calculations (and would likely C14 test below that).[16]

These calculations' reliance on free allocation creates the potential for double counting of renewable content, leaving low-carbon fuel programs susceptible to a high risk of greenwashing and fraud. For example, this threat is highlighted by the recent mass balance fraud challenges faced by the ISCC regarding fraudulent biodiesel submissions from China which "caused a dramatic fall in biodiesel prices in European markets" in July 2023.[17] In response to this situation, the EU quickly updated the RED's co-processing rules to uniformly require direct testing, including verifying the calculations of producers choosing to use calculation-based approaches.[18]

The importance of limiting the role of mass balance for reporting the biogenic content of fuels is articulated very well by a recent opinion of the Advocate General of the EU Court of Justice (CJEU) on the roles of mass balance and C-14 for reporting biogenic content in co-processing. The official opinion found that mass balance calculations are not intended to quantify the share of biogenic contained in a biofuel produced by co-processing.[19] The opinion was reiterated in the final ruling of the case which found that mass balance is not intended to determine the share of biogenic carbon for fuel decarbonization programs.[20] This judgment was issued in response to a case brought by BP France against the French government regarding a tax incentive requiring C-14 testing to verify claims of renewable content. BP is also notably a board member of the ISCC.[21]

Recently in the US issues with mass balance in the recycling industry have received increasing attention. A ProPublica investigation published in June 2024 that products advertised as 30% recycled through mass balance often contained less than 1% recycled content.[22] Similar concerns were shown by the US EPA as early as 2023, which described the mass-balance methodology as deceptive and advised against promoting it. In August 2024, the US Environmental Protection Agency (EPA) launched a federal action against the mass-balance methodology used in the recycling sector.

[16] 2024. "The Mass Balance Approach." *International Sustainability & Carbon Certification*
[17] 2023. "ISCC Press Release July 27, 2023." *International Sustainability & Carbon Certification*
[18] 2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." *European Commission*
[19] 2024. "Opinion of Advocate General Campos Sánches-Bordona Delivered on 11 January 2024: Case C-624/22." *Court of Justice of the EU*
[20] 2024. "Judgement of the Court (Third Chamber) of 29 July 2024." *Court of Justice of the European Union*
[21] 2024. "Board Members of the ISCC Association." *International Sustainability & Carbon Certification*
[22] 2024. "Biden EPA Rejects Plastics Industry's Fuzzy Math That Misleads Customers About Recycled Content." *ProPublica*

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In September 2024 California Attorney General Rob Bonta filed a lawsuit against ExxonMobil claiming that the oil major "deceptively" promoted chemical recycling as a solution to the plastic crisis, citing their use of mass balance calculations such as ISCC Plus.[23] That lawsuit directly challenges the standard's use of ISCC's free allocation method as a system designed to enable greenwashing.[24] The New York Times also recently published a relevant article on the challenges that mass balance presents to the recycling industry, which aligns with the challenges experienced in the renewable products industry.[25]

It is in the best interest of California's decarbonization goals not to allow any producers to report their biogenic content using mass balance calculations, especially given the role of mass balance in the state's current lawsuit against ExxonMobil. However, if mass balance is used at all in this methodology, these calculations must be routinely verified by direct testing. The advantage of the updated RED protocol is that producers can choose to use calculations internally, while the program still ensures the information reported is accurate through direct Carbon-14 analysis. This is the only way to mitigate the risk to the program introduced by these calculations.

Conclusion

The development of this climate disclosure program is a critical step in California's decarbonization journey and will be a key example for similar programs developed around the world going forward. By implementing best practices for verification established by similar state, federal and international emission reduction programs, CARB can best prepare this program to successfully achieve and measure its goals. Routine direct testing following ASTM D6866 Method B is the most effective way to incentivize and validate the use of biogenic content under this program. As California continues to develop programs to advance its decarbonization goals we recommend reviewing the use of biogenic testing in leading programs around the world.

What is Biogenic Testing (Carbon-14)?

Carbon-14 analysis is a reliable method used to distinguish the percentage of biobased carbon content in a given material. The radioactive isotope carbon-14 is present in all living organisms and recently expired material, whereas any fossil-based material that is more than 50,000 years old does not contain any carbon-14 content. Since Carbon-14 is radioactive, the amount of carbon-14 present in a given sample begins to gradually decay after the death of an organism until there is no carbon-14 left. Therefore, a radiocarbon dating laboratory can use carbon-14 analysis to quantify the carbon-14 content present in a sample, determining whether the sample is biomass-based, fossil fuel-derived, or a combination.

[23] 2024. "The People of the State of California v. Exxon Mobil Corporation." *Superior Court of the State of California*
[24] 2024. "ExxonMobil Accused of "Deceptively" Promoting Chemical Recycling as a Solution for the Plastics Crisis." *ProPublica*
[25] 2024. "Is Your Water Bottle Really Made From Recycled Plastic?" *The New York Times*

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The analysis is based on standards such as ASTM D6866 and its international equivalents developed for specific end uses, such as ISO 13833. ASTM D6866 is an international standard developed for measuring the biobased carbon content of solid, liquid, and gaseous samples using radiocarbon dating.[26] There are also many international standards based on the specific use of direct Carbon-14 testing, such as ISO 13833, which is an international standard developed for measuring the biogenic carbon content of stationary sources emissions.[27]

Carbon-14 analysis yields a result reported as % biobased carbon content. If the result is 100% biobased carbon, this indicates that the sample tested is completely sourced from biomass material such as plant or animal byproducts. A result of 0% biobased carbon means a sample is only fossil fuel-derived. A sample that is a mix of both biomass sources and fossil fuel sources will yield a result that ranges between 0% and 100% biobased carbon content. Carbon-14 testing has been incorporated into several regulations as the recommended or required method to quantify the biobased content of a given material.

ASTM D6866 Method B - The Most Reliable Method

Carbon-14 is a very well-established method which has been in use by many industries (including the fossil fuel industry) and academic researchers for several decades.

Carbon-14 measurements done by commercial third party testing is robust, consistent, and with quantifiable accuracy/precision of the carbon-14 amount under **ASTM D6866 method B**. The EN 16785 is the only standard that allows a variant of the Mass Balance (MB) method of 'carbon counting' under EN 16785-2. The EN 16785-1 requires that the biocarbon fraction be determined by the carbon-14 method. However, when incorporating this EN 16785 method, certification schemes like the "Single European Bio-based Content Certification" **only** allow the use of EN 16785-1 due to its reliability and the value of a third-party certification. http://www.biobasedcontent.eu/en/about-us/

In ASTM D6866 method B, the carbon-14 result is provided as a single numerical result of carbon-14 activity, with graphical representation that is easily understood by regulators, policy makers, corporate officers, and more importantly, the public. The overwhelming advantage of carbon-14 is that it is an independent and standardized laboratory measurement of any carbon containing substance that produces highly accurate and precise values. In that regard, it can stand alone as a quantitative indicator of the presence of biobased vs. petroleum feedstocks. When carbon-14 test results are challenged, samples can be rapidly remeasured to verify the original

[26] 2021. "Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis." *ASTM International (D6866-21)*
[27] 2013. "ISO 13833:2013 Stationary source emissions: Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide." *International Organization for Standardization*

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reported values (unlike mass balance).

The quantification of the biobased content of a given product can be as low as 0.1% to 0.5% (1 relative standard deviation – RSD) based on Instrumental error for Method B (AMS). This error is exclusive of indeterminate sources of error in the origin of the biobased content, and manufacturing processes. As such a total error of +/-3% (absolute) has been assigned to the reported Biobased Content to account for determinate and indeterminate factors.[28]

It is also important that the program should always require ASTM D6866 Method B, rather than allow Method C for any use. Where ASTM D6866 Method B uses the AMS Instrument to measure ^{14}C, Method C uses Liquid Scintillation Counting (LSC). In Method B, the AMS Instrument directly measures the ^{14}C isotopes. However, in Method C, scintillation molecules indirectly absorb the beta molecules that release with the decay of ^{14}C and convert the energy into photons which are measured proportionally to the amount of ^{14}C in the sample. Since Method B directly measures the ^{14}C isotopes and Method C measures them indirectly, Method B is significantly more precise and should be prioritized in regulations.[29] LSC measurements, like those used in Method C, are commonly used as an internal testing tool when samples are limited and accuracy does not need to be extremely high.

About Beta Analytic

Beta Analytic was among the originators of the use of Accelerator Mass Spectrometry (AMS) for the ASTM D6866 biobased / biogenic testing standard using Carbon-14 to distinguish renewable carbon sources from petroleum sources. Beta began testing renewable content in 2003 at the request of United States Department of Agriculture (USDA) representatives who were interested in Beta's Carbon-14 capabilities for their BioPreferred® Program (www.biopreferred.gov). At their request, Beta joined ASTM under subcommittee D20.96. Beta's previous president, Darden Hood, was positioned as a technical contact for the USDA and within 3 months completed the ASTM D6866-04 standard. The Carbon-14 technique is now standardized in a host of international standards including ASTM D6866, CEN 16137, EN 16640, ISO 16620, ISO 19984, BS EN ISO 21644:2021, ISO 13833 and EN 16785. Carbon-14 analysis can be used on various types of samples (gas, liquids and solids). Beta Analytic continues to be a technical contact for ASTM D6866 with current president Ron Hatfield and is involved with all their latest ASTM D6866 versions.

The Carbon-14 standardized method is also incorporated in a variety of regulatory programs including the California AB32 program, US EPA GHG Protocol, US EPA Renewable Fuels Standard, United Nations

[28] 2021. Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis. *ASTM International (D6866-21).* pp 1-19. doi: 10.1520/D6866-21.
[29] 2022. "Testing the methods for determination of radiocarbon content in liquid fuels in the Gliwice Radiocarbon and Mass Spectrometry Laboratory." *Radiocarbon*

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Carbon Development Mechanism, Western Climate Initiative, Climate Registry's Greenhouse Gas Reporting Protocol and EU Emissions Trading Scheme.

We are currently technical experts on Carbon-14 in the following committees:

ASTM D6866 (D20.96) Plastics and Biobased Products (Technical Advisor)
ASTM (D02.04) Petroleum Products, Liquid Fuels and Lubricants (Technical Advisor)
ASTM (061) US TAG to ISO/TC 61 Plastics (Technical Expert)
USDA BioPreferred Program TAC (Technical Advisor)
ISO/TC 61/SC14/WG1 Terminology, classifications, and general guidance (Technical Expert)
CEN/TC 411 Biobased Products
CEN/TC 411/WG 3 Biobased content
CEN/TC 61/SC 14/WG 1 Terminology, classifications, and general guidance (Technical Expert)

ISO/IEC 17025:2017 Accredited Laboratory

To ensure the highest level of quality, laboratories performing ASTM D6866 testing should be ISO/IEC 17025:2017 accredited or higher. This accreditation is unbiased, third party awarded and supervised. It is unique to laboratories that not only have a quality management program conformant to the ISO 9001:2008 standard, but more importantly, have demonstrated to an outside third-party laboratory accreditation body that Beta Analytic has the technical competency necessary to consistently deliver technically valid test results. The ISO 17025 accreditation is specifically for natural level radiocarbon activity measurements including biobased analysis of consumer products and fuels, and for radiocarbon dating.

Required tracer-free facility for Carbon-14

For carbon-14 measurement to work, be accurate, and repeatable, the facility needs to be a tracer-free facility, which means artificial/labeled carbon-14 is not and has never been handled in that lab. Facilities that handle artificial carbon-14 use enormous levels relative to natural levels and it becomes ubiquitous in the facility and cross contamination within the facility, equipment and chemistry lines is unavoidable. Results from a facility that handles artificial carbon-14 would show elevated renewable contents (higher pMC, % Biobased / Biogenic values), making those results invalid. Because of this, Federal contracts and agency programs (such as the USDA BioPreferred Program) require that AMS laboratories must be 14C tracer-free facilities in order to be considered for participation in solicitations.

Areas where cross-contamination might occur include but are not limited to; biomedical or nuclear reactors, isotope enrichment / depletion columns, water, soil, plant, or air samples collected near or at biomedical / nuclear reactor sites, medical, industrial, or hazardous waste sites, samples specifically manipulated to study the uptake / fractionation of stable isotopes due to biological or metabolic

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processes. To learn more about the risks associated with testing natural levels Carbon-14 samples in a facility handling artificially enhanced isotopes please see the additional information provided after this comment.

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Demand a Tracer-Free Laboratory for Radiocarbon Dating

As part of its commitment to provide high-quality results to its clients, ISO/IEC 17025-accredited Beta Analytic does not accept pharmaceutical samples with "tracer Carbon-14" or any other material containing artificial Carbon-14 (14C) to eliminate the risk of cross-contamination. Moreover, the lab does not engage in "satellite dating" – the practice of preparing individual sample graphite in a remote chemistry lab and then subcontracting an AMS facility for the result.

High Risk of Cross-Contamination

Pharmaceutical companies evaluate drug metabolism by using a radiolabeled version of the drug under investigation. AMS biomedical laboratories use 14C as a tracer because it can easily substitute 12C atoms in the drug molecule, and it is relatively safe to handle. Tracer 14C is a well-known transmittable contaminant to radiocarbon samples, both within the AMS equipment and within the chemistry lab.

Since the artificial 14C used in these studies is phenomenally high (enormous) relative to natural levels, once used in an AMS laboratory it becomes ubiquitous. Cross-contamination within the AMS and the chemistry lines cannot be avoided. Although the levels of contamination are acceptable in a biomedical AMS facility, it is not acceptable in a radiocarbon dating facility.

Biomedical AMS facilities routinely measure tracer-level, labeled (Hot) 14C samples that are hundreds to tens of thousands of times above the natural 14C levels found in archaeological, geological, and hydrological samples. Because the 14C content from the biomedical samples is so high, even sharing personnel will pose a contamination risk; "Persons from hot labs should not enter the natural labs and vice versa" (Zermeño et al. 2004, pg. 294). These two operations should be absolutely separate. Sharing personnel, machines, or chemistry lines run the risk of contaminating natural level 14C archaeological, geological, and hydrological samples.

Avoid the Risks

Find out from the lab that you are planning to use that they have never in the past and will never in the future:

- accept, handle, graphitize or AMS count samples containing Tracer or Labeled (Hot) 14C.

- share any laboratory space, equipment, or personnel with anyone preparing (pretreating, combusting, acidifying, or graphitizing) samples that contain Tracer or Labeled (Hot) 14C.

- use AMS Counting Systems (including any and all beam-line components) for the measurement of samples that contain Tracer or Labeled (Hot) 14C.

Tracer-Free Lab Required

Recently, federal contracts are beginning to specify that AMS laboratories must be 14C tracer-free facilities in order to be considered for participation in solicitations.

A solicitation for the National Oceanic and Atmospheric Administration (NOAA) has indicated that "the AMS Facility utilized by the Contractor for the analysis of the micro-samples specified must be a 14C tracer-level-free facility." (Solicitation Number: WE-133F-14-RQ-0827 - Agency: Department of Commerce)

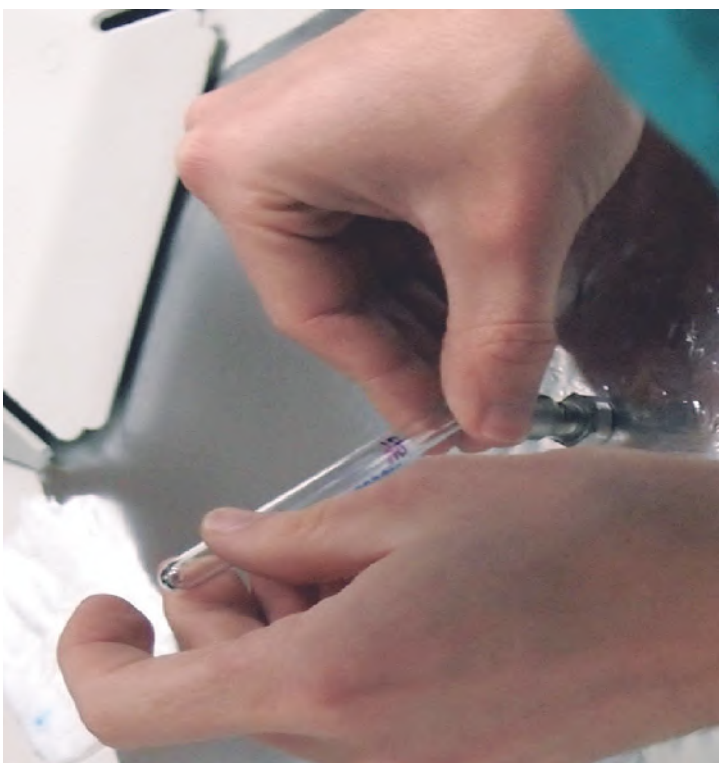
As a natural level radiocarbon laboratory, we highly recommend that researchers require the AMS lab processing their samples to be Tracer-free.

No Exposure to Artificial Carbon-14

According to ASTM International, the ASTM D6866 standard is applicable to laboratories working without exposure to artificial carbon-14 routinely used in biomedical studies. Artificial carbon-14 can exist within the laboratory at levels 1,000 times or more than 100 % biobased materials and 100,000 times more than 1% biobased materials. Once in the laboratory, artificial 14C can become undetectably ubiquitous on materials and other surfaces but which may randomly contaminate an unknown sample producing inaccurately high biobased results. Despite vigorous attempts to clean up contaminating artificial 14C from a laboratory, isolation has proven to be the only successful method of avoidance. Completely separate chemical laboratories and extreme measures for detection validation are required from laboratories exposed to artificial 14C. Accepted requirements are:

(1) disclosure to clients that the laboratory working with their products and materials also works with artificial 14C
(2) chemical laboratories in separate buildings for the handling of artificial 14C and biobased samples
(3) separate personnel who do not enter the buildings of the other
(4) no sharing of common areas such as lunch rooms and offices
(5) no sharing of supplies or chemicals between the two
(6) quasi-simultaneous quality assurance measurements within the detector validating the absence of contamination within the detector itself.

ASTM D6866-22 – Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis.



Useful Reference

1. Memory effects in an AMS system: Catastrophe and Recovery. J. S. Vogel, J.R. Southon, D.E. Nelson. Radiocarbon, Vol 32, No. 1, 1990, p. 81-83 doi:10.2458/azu_js_rc.32.1252 (Open Access)

"... we certainly do not advocate processing both labeled and natural samples in the same chemical laboratory." "The long term consequences are likely to be disastrous."

2. Recovery from tracer contamination in AMS sample preparation. A. J. T. Jull, D. J. Donahue, L. J. Toolin. Radiocarbon, Vol. 32, No.1, 1990, p. 84-85 doi:10.2458/azu_js_rc.32.1253 (Open Access)

"... tracer 14C should not be allowed in a radiocarbon laboratory." "Despite vigorous recent efforts to clean up the room, the "blanks" we measured had 14C contents equivalent to modern or even post -bomb levels."

3. Prevention and removal of elevated radiocarbon contamination in the LLNL/CAMS natural radiocarbon sample preparation laboratory. Zermeño, et. al. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms
Vol. 223-224, 2004, p. 293-297
doi: 10.1016/j.nimb.2004.04.058

"The presence of elevated 14C contamination in a laboratory preparing samples for natural radiocarbon analysis is detrimental to the laboratory workspace as well as the research being conducted."

4. High level 14C contamination and recovery at XI'AN AMS center. Zhou, et. al. Radiocarbon, Vol 54, No. 2, 2012, p. 187-193
doi:10.2458/azu_js_rc.54.16045

"Samples that contain high concentrations of radiocarbon ("hot" samples) are a catastrophe for low background AMS laboratories." "In our case the ion source system was seriously contaminated, as were the preparation lines."

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