Beta Analytic
TESTING LABORATORY

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California Air Resources Board (CARB)
California Low Carbon Fuel Standard (LCFS) | Stakeholder Feedback

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 under California's Low Carbon Fuel Standard (LCFS). Biogenic content measurements following methods such as ASTM D6866 Method B currently provide critical value to prominent clean fuel standard programs including California's LCFS.

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Recommendations for California's Low Carbon Fuel Standard

Our recommendation is that California's Low Carbon Fuel Standard (LCFS) should include direct biogenic content testing requirements following the ASTM D6866 Method B standard for any fuels or feedstocks seeking recognition of renewable (biogenic) content. Routine direct biogenic testing requirements are the only reliable method of incentivizing the use of biomass derived content and guaranteeing compliance. Routine biogenic testing requirements currently play a critical role in California's LCFS and prominent similar programs.

California's LCFS currently requires testing following ASTM D6866 for any fuels produced from co-processing and recommends testing for fuels produced from municipal solid waste (MSW). Several of the updates being considered by the program could benefit from the introduction of similar testing requirements and offer opportunities to strengthen the existing requirements.

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Require Routine Biogenic Testing for Fuels Produced from MSW

Beta's first recommendation for this update to this LCFS is to introduce routine biogenic testing requirements for fuels produced from MSW in line with the program's requirements for co-processing. Given the heterogeneous nature of MSW, it is critical that routine testing requirements be maintained to make sure the program only rewards the renewable portion of those fuels.

Implementing routine testing for these fuels would be in line with the requirements of the US Renewable Fuel Standard (RFS), Canada's Clean Fuel Regulations (CFR), Oregon's Clean Fuels Program (CFP) and other leading programs.[1] As CARB updates the program, it is important to improve this policy from a recommendation to a requirement.

Update the Certification Framework for Biogas, Biomethane & RNG

Beta also recommends that CARB introduce routine biogenic testing requirements for fuels produced from biogas, biomethane and RNG. As CARB considers the best way to move forward with biogas, biomethane and RNG in the program, we recommend reviewing the Biogas Regulatory Reform Rule (BRRR), which the EPA included in the RFS Set Rule, the EU's updated methodology for biogas under the Renewable Energy Directive (RED), and Canada's Clean Fuel Regulations (CFR) Quantification Method (QM) for Co-Processing.[2] These recent policies reflect the leading best practices for regulating this sector under clean fuel programs.

The US introduced biogenic testing requirements for fuels produced from biogas in the 2023 Set Rule update to the US Renewable Fuel Standard (RFS), in a section called the Biogas Regulatory Reform Rule.[3] This update requires routine biogenic testing for any biogas or RNG fuels seeking to generate RINs under the RFS. Starting on July 1st, 2024 for new facilities and January 1st, 2025 for existing facilities, fuels produced from biogas will need to submit biogenic test results of the biogas at the point of production from the digester/landfill, at the point of upgrading, and after upgrading prior to pipeline injection.

The EU introduced biogenic testing requirements for fuels produced from biogas in a June 2023 update to the EU Renewable Energy Directive (RED) titled, "Renewable energy- method for calculating the share of renewables in the case of co-processing."[4] This update was specifically issued in response to the discovery of a major case of fraud within the RED program stemming from biodiesel submissions from China which were approved by mass balance calculations.[5] The EU investigation into this issue is still

[1] 2010. "40 CFR Part 80 Subpart M– Renewable Fuel Standard." *National Archives Code of Federal Regulations*
2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." *European Commission*
2022. "Clean Fuel Regulations: Quantification Method for Co-Processing in Refineries." *Environment and Climate Change Canada*
[2] 2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
[3] 2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*
[4] 2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." *European Commission*
[5] 2023. "ISCC Press Release July 27, 2023." *International Sustainability & Carbon Certification*

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ongoing, and the full extent of the damage is not yet known, but this was a significant setback for the program and quickly plummeted biodiesel prices in the EU.

The EU tied biogas, biomethane and RNG into the update in order to address these concerns for any fuels containing a mixture of biogenic and fossil content. The advantage of this framework is that the EU was able to continue to accept calculation based methodologies like mass and energy balance by requiring routine direct biogenic testing to validate the data. However, calculation based approaches are much more common for co-processing, where all inputs and outputs are concentrated in a single facility, as opposed to biomethane and RNG which are often produced, upgraded and blended at multiple facilities.

Canada's CFR introduced routine biogenic testing requirements for hydrocarbon gas fuels alongside co-processing in July 2022.[6] The program's QM for co-processing requires routine direct testing following ASTM D6866 for, "each co-processed fuel, product and hydrocarbon co-product produced in the project," including gasses beyond biogas, biomethane and RNG, such as renewable propane. Introducing these requirements for biogas, biomethane and RNG alongside co-processing in 2022 when the RFS, RED and LCFS only required testing for co-processing has allowed the CFR to avoid many of the sustainability and verification concerns currently impacting the market for these fuels in California, the US and the EU. We recommend that CARB use this update to apply the same requirements in place for co-processing under the LCFS to biogas, biomethane and RNG.

Require Biogenic Testing as Sustainability Criteria for Waste Feedstocks

We recommend that CARB also consider the BRRR Set Rule update when updating the program's sustainability criteria for waste feedstocks. The BRRR requires testing at the point of biogas production, at the point of upgrading to a fuel and at the point of blending with any non-renewable components prior to pipeline injection.[7] This approach provides a simple but comprehensive framework to apply for waste feedstocks. By testing the initial feedstock, the fuel at the point of upgrading and the final blended fuel, there is a clear demonstration of biogenic content from the waste feedstock to the final product. Given that these feedstocks need initial verification and that biogenic content ends up in various co-products during production, this approach provides a holistic way to incentivize only the renewable portion of fuels produced from these feedstocks.

It is critically important that this program require direct testing rather than allow calculation based approaches such as mass balance, which make claims 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

[6] 2022. "Clean Fuel Regulations: Quantification Method for Co-Processing in Refineries." *Environment and Climate Change Canada*
[7] 2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *EPA*

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as the output. Renewable feedstocks will often have different activity than their fossil counterparts and won't necessarily produce the same quantity of outputs.[8] By basing their calculations solely on production inputs rather than outputs these methods systematically over-report the renewable share of fuels.

We encourage CARB to review the recent mass balance fraud challenges faced by the EU Renewable Energy Directive (RED) program as an example of this risk, particularly pertaining to waste feedstock attestation.[9] In July 2023 the program discovered rampant fraudulent biodiesel submissions from China, which had been certified by ISCC mass balance. The discovery quickly "caused a dramatic fall in biodiesel prices in European markets."[10] In response to this situation the EU quickly updated the RED's rules to uniformly require routine direct testing, including for producers choosing calculation based approaches to verify their calculations.[11]

Implement Biogenic Testing Requirements for Intrastate Jet Fuels

As CARB looks to introduce intrastate fossil jet fuel to the program, we recommend that routine biogenic testing requirements be applied to these fuels as well. Routine biogenic testing requirements are the only way to reliably verify the renewable content included in mixed fuels, and therefore encourage the displacement of fossil content. Especially given the importance co-processing currently plays in the SAF industry's early development, requiring routine testing is the best way to incentivize renewable content and penalize fossil content.

Demand Legitimate Vetting From Certification Programs Leveraged by LCFS

In the workshop on these updates CARB specifically mentioned its intention to rely on existing certification programs such as "ISCC, RBS, REDcert, Bonsucro, etc." Beta would like to emphasize that not all of these certification programs are equally stringent or reliable, and encourage CARB not to rely on any certifications which would invite risk to the LCFS. It is critical that only certifications relying on internationally recognized testing standards be relied on by the program.

Beta would again urge CARB to review the recent case of fraudulent biodiesel fuels which were certified in the EU RED using ISCC mass balance. These calculations are preferred by the industry because they enable producers to systematically over-report their renewable content, allowing them to receive more government incentives and greenwash their products. We re-iterate with emphasis that these calculations ignore the fact that renewable feedstocks will often have different activity than their fossil counterparts and won't necessarily produce the same quantity of outputs.[12] By basing their calculations

[8] 2006. "Determining the modern carbon content of biobased products using radiocarbon analysis." *Bioresource Technology*, 97(16), 2084-2090.
[9] 2023. "ISCC Press Release July 27, 2023." *International Sustainability & Carbon Certification*
[10] 2023. "ISCC Press Release July 27, 2023." *International Sustainability & Carbon Certification*
[11] 2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." *European Commission*
[12] 2006. "Determining the modern carbon content of biobased products using radiocarbon analysis." *Bioresource Technology*, 97(16), 2084-2090.

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solely on production inputs rather than outputs these methods systematically over-report the renewable share of fuels. As a result relying on any certification based on these calculations would leave the program susceptible to embellished claims and potentially duplicated counting.

Certifications relying on mass balance such as the ISCC also allow producers to use book and claim, or 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, book and claim 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).[13]

This system is designed to allow producers to maximize the incentives they can receive from programs such as the LCFS, without guaranteeing that they are actually providing the sustainability benefits those incentives are meant to produce. Facilities certified using these calculations are also extremely difficult to audit as a result. There are multiple facilities across the globe using successfully Carbon-14 analysis of the actual output and it is the easiest and most trustworthy method.

Certifications which rely on direct testing following internationally recognized standards, such as the Roundtable on Sustainable Biomaterials (RSB) must be prioritized to protect the integrity of the LCFS.[14] As CARB considers which certifications to rely on, it is imperative that only programs which have demonstrated a commitment to creating stringent, scientifically proven frameworks be admitted.

Conclusion

California's LCFS is a critical tool for the state's decarbonization journey and an example relied on by other programs around the US and the entire world. By implementing best practices for verification established by a wide range of fuel decarbonization programs led by the LCFS, CARB can protect and strengthen its ability to successfully achieve and measure the goals of this program. Routine direct testing following ASTM D6866 Method B is the most effective way to incentivize and validate biogenic content under this program.

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

[13] 2024. "The Mass Balance Approach." *International Sustainability & Carbon Certification*
[14] 2023. "RSB Standard for Advanced Fuels." *Roundtable on Sustainable Biomaterials (RSB)*

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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.

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.[15] 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.[16]

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

[15] 2021. "Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis." *ASTM International (D6866-21)*
[16] 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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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 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.[17]

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.[18] 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

[17]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.
[18]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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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 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.

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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.

References

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

2010. "40 CFR Part 80 Subpart M– Renewable Fuel Standard." *National Archives Code of Federal Regulations* https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

2013. "ISO 13833:2013 Stationary source emissions: Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide." *International Organization for Standardization*

2020. "Reporting Co-Processing and Renewable Gasoline Emissions Under MRR." *California Air Resources Board* https://ww2.arb.ca.gov/sites/default/files/2020-09/MRR_coprocessing-slides_Sept_2020.pdf

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.

2022. "Clean Fuel Regulations: Quantification Method for Co-Processing in Refineries." *Environment and Climate Change Canada* https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-regulations/compliance/quantification-methodco-processing-refineries.html

2022. "Testing the methods for determination of radiocarbon content in liquid fuels in the Gliwice Radiocarbon and Mass Spectrometry Laboratory." *Radiocarbon*, 64(6), pp.1-10. DOI:10.1017/RDC.2022.35

2023. "Renewable energy- method for calculating the share of renewables in the case of co-processing." *European Commission* https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12711-Renewable-energy-method-for-calculating-the-share-of-renewables-in-the-case-of-co-processing_en

2023. "40 CFR Parts 80 and 1090– Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes." *Environmental Protection Agency* https://www.govinfo.gov/content/pkg/FR-2023-07-12/pdf/2023-13462.pdf

2023. "ISCC Press Release July 27, 2023." *International Sustainability & Carbon Certification* https://www.iscc-system.org/news/press-release-27-july-2023/

2023. "RSB Standard for Advanced Fuels." *Roundtable on Sustainable Biomaterials (RSB)* https://rsb.org/wp-content/uploads/2024/03/RSB-STD-01-010-RSB-Standard-for-advanced-fuels_v2.6-1.pdf

2024. "The Mass Balance Approach." *International Sustainability & Carbon Certification* https://www.iscc-system.org/certification/chain-of-custody/mass-balance/

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)

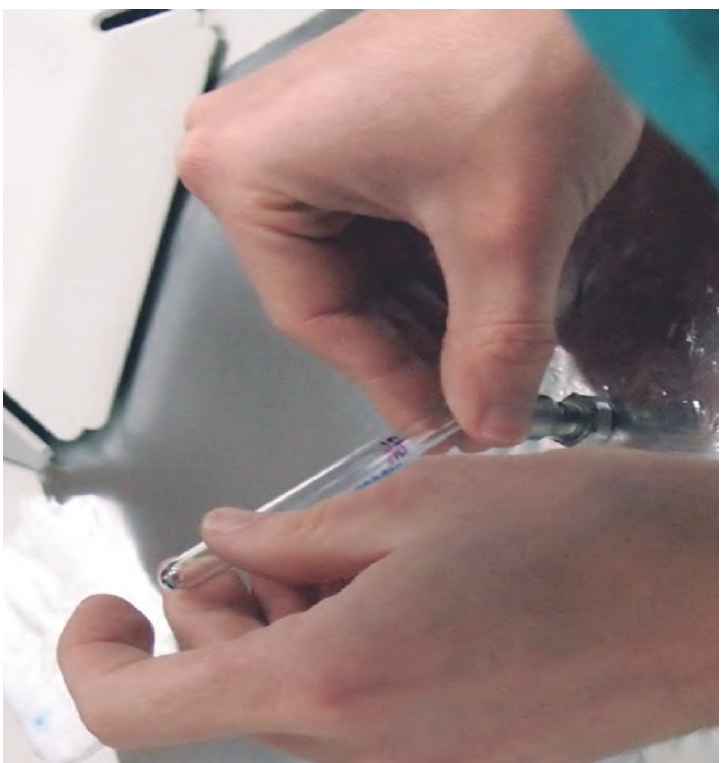
As a natural level radiocarbon laboratory, we highly recommend that researchers require the AMS lab processing their samples to be Tracer-free.

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."

BETA

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www.radiocarbon.com