12/13/19 ADF Regulation Workshop review and potential areas for improvement:

Overview:

- CE-CERT's testing: 1). Procedures and lab testing, which included numerous variables (some of which were listed on slide 14), could not reproduce the same results as those achieved during additive certifications, thereby indicating that procedure/regulations need improvement to provide necessary reproducibility; 2). Due to numerous variables (some of which were listed on slide 14), the CE-CERT testing was not suitable for determining the efficacy of tested additives.
- Currently, too many variables exist, which compromise repeatability, reproducibility and confidence. Some variables are allowed within the regulation, other variables are caused by undefined procedures, and some variables are caused by allowing procedures outside the regulation.
- Written established procedures must be followed. If there is a loss of confidence in any written regulation or accepted procedure that results in concern that the regulation may fail to ensure that in-use fuels meet with the intent of the regulation (as indicated in slide 8), such regulation must be changed via the regulatory process until the intent of the regulation is met (as indicated in slide 3). Regardless of intentions, any attempt at controlling a program via unwritten requirements, or circumventing written requirements, circumvents the rulemaking process (including workshops, public comment, peer review, hearings, OAL, etc.).
- Written established procedures and regulations should be developed that improve the repeatability and reproducibility of ADF certifications. Repeatability and reproducibility improvements are even more important now than they were in the past (due to blended fuels adding more variables, and due to quantifying smaller emissions improvements).
- Bulk quantities of Standard Average CARB Diesel reference fuel, in conjunction with a Standard Average CA unadditized B99/B100 Biodiesel Certification fuel, and potentially a Standard unadditized B20 Candidate Fuel, should be used for all testing. This would go a long way towards minimizing variables and improving reproducibility.
- Establishing product and additive handling, blending, sampling, CofA, Chain of Custody, and witnessed certification procedures would go a long way towards improving reproducibility and validity.
- Establishing emission lab repeatability and reproducibility standards/requirements to obtain CARB approval, could go a long way towards improving repeatability and reproducibility.
- While developing these new CARB/stakeholder written procedures and regulatory requirements, care must be taken to ensure compliance, without creating unnecessary constraints and costs that would curtail regulatory participation.

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Additional Detail:

- CE-CERT's testing:
    - A few observations:
        - CE-CERT testing showed that when using a different reference fuel (a reference fuel that was produced from different feedstock, with different fuel qualities, such as higher cetane, lower aromatics, etc.), in conjunction with a different biodiesel (produced from different feedstocks and with different fuel qualities), utilizing different (non-standard) additive and fuel handling procedures, along with different (non-standard) blending procedures, in a different environment (atmospheric), utilizing different types of emissions test equipment, by different people, and with different test sequences (non-standard, including some of which were abbreviated), with the only constant being the additive, different comparative emission results were shown (than during certification testing).
        - Excessive variables compromised reproducibility and validity, including but not limited to those listed in slide 14, additive and product handling practices, and CE-CERT's emission result repeatability and reproducibility problems.
- Concerns and Issues to be addressed:
    - Reproducibility of Certification Testing
        - Currently no repeatability or reproducibility standard exists, and particularly not for B20.
            - Suggest performing emission labs round robin testing to develop necessary repeatability standards and reproducibility standards. Repeatability standards should be based upon same fuels, day, operator and equipment. Reproducibility standards should be based upon different operators, different days, different labs, different equipment of the same specification, using allowable range fuels (at opposing ends of the range), along with established product handling and blending procedures (if applicable).
        - Currently, no written certification procedures exist to establish CARB approval of emission testing labs (as would be necessary to ensure that that only labs capable of meeting established repeatability and reproducibility standards are qualified to conduct CARB certification testing).
            - Suggest that upon completion of the round robin testing above, reasonable repeatability and reproducibility standards should be established. Once the standards are established, emissions labs to be accepted by CARB should meet such standards along with all applicable CFRs.
    - Practices related to Certification Testing and reproduction of Certification Testing. Current allowable practices may introduce an excessive amount of variables, which could compromise reproducibility. 1). Certification procedures should be standardized (without any significant allowable variations in practice). 2). To ensure validity, repeatability, and

reproducibility, variables and potential errors must be minimized or eliminated during any testing to, verify, or reproduce certification testing, as may be necessary to determine continued approval of EOs.

- Suggest minimizing or eliminate reference fuel variability: Initially, when developing the 2282 CARB diesel regulation, a lab / pilot plant produced CARB diesel reference fuel was required for base line comparison, because low emission CARB diesel did not exist. However, commercial low emission CARB diesel now exists, and the ADF regulation has been put in place to ensure that ADFs do not result in more emissions than in-use CARB diesel fuel. Therefore, instead of using lab created fuels, from various labs, from different feedstocks, with unknown production variations, larger quantities of average in-use CARB diesel (such as from a combination of Southern and Northern CA comingled pipeline diesel fuel), could be acquired by CARB and stored under nitrogen blanket for maximum longevity. Those that want to certify (or develop) additives could purchase the "Average Standard" CARB diesel fuel to be used as the reference fuel (in other words, everyone would be using the same fuel and that fuel would be average CA CARB diesel fuel). CARB/stakeholders should be able to develop an established shelf life for the fuel, and the large reference batches could be renewed at such established intervals. Not only does the large batch fuel concept ensure that everyone is using the same reference fuel, the reference fuel could likely be sourced less expensively than current custom lab options, and more importantly, using average in-use CARB Diesel for blending and producing the B20 candidate fuel would better ensure that the B20 candidate fuel and its associated emissions characteristics are indeed representative of the average in use emissions characteristics of fuels produced pursuant to the associated EO.
- Suggest minimizing or eliminating B99/B100 biodiesel variability: Instead of using fuels sourced from single suppliers, from different feedstocks (between each participant, or attempted reproduction), with unknown production variations, and unknown existing production additives, larger quantities of average California in-use low saturation B99/B100 biodiesel (obtained from a group of various producers, that would best look like the state average low sat biodiesel and its associated average low sat feedstocks, without additives) could be acquired by CARB and stored under nitrogen blanket for maximum longevity. Those that want to certify or develop additives could purchase the "average standard" in-use CA B99/B100 biodiesel fuel to be used as the B99/B100 biodiesel additive certification fuel. In other words, everyone would be using the same biodiesel fuel and that fuel would be average CA biodiesel. CARB/stakeholders should be able to establish a shelf life for the fuel and the large batches could be renewed at established intervals. The large batch fuel concept would ensure that everyone is using the same biodiesel additive certification fuel. Using the average in-use CA biodiesel for blending and producing the B20 candidate fuel would also better ensure that the B20 candidate

fuel and its associated emissions characteristics are representative of the average in-use CARB ADF B20 fuels.

- Suggest establishing well defined written chain of custody, witnessing, product and additive handling, additive blending, product blending, and CofA testing procedures, etc. (which becomes much easier and more uniform with CARB provided fuels).
    - When average California reference diesel and B99/B100 biodiesel fuels are acquired, each should be circulated in bulk, for a defined CARB/stakeholder approved period of time or volume, to ensure uniformity. Upon completion of circulation and settling of the fuel, top, middle, bottom, and average samples should be obtained from the bulk container. The top, middle and bottom samples will have a limited set of CARB/stakeholder developed lab tests performed to ensure uniformity of fuel, and the full CofA will be run on the average (providing that the top, middle and bottom samples meet established criteria). If desired by CARB, the emissions testing lab, prior to emission testing, could obtain an average sample from each drum, for the same limited testing as required above of top, middle, & bottom samples, to provide additional confirmatory integrity assurance that the fuels received are the same fuels represented in the Protocol.
    - Product Handling: Products/fuels must be handled in such a manner as to ensure product/fuel integrity via CARB/stakeholder developed standards (such as out of light, out of heat, minimize or eliminate exposure to air, established circulation procedures, established transfer procedures, established shipping procedures, etc.). The initial certification and any subsequent related testing must follow the same procedures.
    - Additive Handling: Additives must be handled in such a manner as to ensure their integrity via the more stringent of CARB/stakeholder developed additive handling procedures, MSDS requirements, additive manufacturer's product handling requirements, or a combination thereof. The initial certification and any subsequent related testing must follow the same procedures.
    - Product and Additive Blending: Product and additive blending must meet industry standards, thereby ensuring complete and uniform mixing (such as adding the additive to bulk, circulating in bulk for defined periods of time/volumes, ensuring that contaminants aren't introduced [i.e., water, unintended products, air], along with sampling/lab testing of the bulk blend as previously outlined to certify uniformity and accuracy.
        - A determination should be made whether an average unadditized CARB B20 candidate fuel should be produced in bulk by CARB, upon acquisition of average CARB Diesel reference and average

unadditized CA B99/B100 in bulk, for use in certification testing/emission lab certification/additive R&D.

- Pros: One less variable, thereby improving repeatability and reproducibility.
- Cons: May not specifically mirror in-use conditions, in which B99/B100 is additized, stored, then blended with CARB diesel to produce CARB ADF B20. CARB/stakeholders would have to determine if the intermediate additized B99/B100 step is necessary to assure accurate B20 efficacy and, if so, can the blending criteria be well enough defined to provide the necessary repeatability and reproducibility.

- Witnessing: Suggest that CARB/stakeholders develop and establish an appropriate witnessing program. The witnessing program for intermediate steps should be developed in such a manner as to instill confidence, yet not be so burdensome/costly that it impacts participation in the program.
  - Suggest that CARB personnel or CARB designated observer (even if charged back to the applicant) witness important intermediate steps and emission testing certification, then perform any additional desired quality assurance or product integrity checks during the emission stage of certification.
    - Due to emission testing being the final stage of certification, prior to the issuance of an Executive Order, CARB's witnessing of the emissions testing is the most responsible and reasonable time for CARB to perform desired quality assurance and product integrity checks, because once the Executive Order is issued and the certification becomes law, binding commitments are made, supply and demand is balanced, and stakeholder's business decisions are made.
- Chain of Custody: Suggest that CARB/stakeholders develop and establish a standardized set of chain of custody procedures and requirements, including seal documentation, witnessed acknowledgement, etc., along with standardized forms to ensure the same.
- The witnessed chain of custody and documentation (including seal documentation) should follow the products from source to grave.
- Direct from source to lab does little to ensure product integrity (particularly if it is performed without seals, witnessing, documentation, independent lab testing, or if the supplier is the applicant). We should strive to avoid adding costs and increasing turnaround times while developing fuels, without any real product integrity benefit (much of which becomes much easier and more uniform with CARB provided fuels).

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- Emission Lab factors that can affect repeatability and or reproducibility. All items listed below have a significant effect on diesel engine NOx emissions and should be tightly controlled to CARB/stakeholder developed set points and ranges. In some cases correction factors are currently employed for differences, but in many cases, those correction factors either under or over compensate for differences.
    - Fuel temperature
        - Fuel temperatures, especially in newer engines, run at elevated temperatures.
        - A real world fuel temperature should be developed as a lab set point, to ensure against formulations that may decompose at temperatures lower than in-use fuel temps, and to ensure efficacy of formulations at true fuel operating temperatures.
        - A fairly narrow lab fuel temperature range should be established.
        - Fuel temperature effects viscosity, which effects fuel spray, fuel timing, etc.
    - Intake Air Temperature (before and after intercooler).
    - Humidity.
    - Barometric pressure.
    - Intake air source relative to sensors.
    - Background NOx (such as from freeway driving times associated with rush hour traffic).
    - Engine maintenance.
    - Fuel system and engine conditioning (some fuels such as biodiesel have a high solvency and tend to clean the fuel system. Other fuels have little solvency allowing fuel system deposits).
    - Engines should run for a CARB/stakeholder determined number of runs prior to conducting emission certification testing. These conditioning runs could be conducted on reference fuel and unadditized B20 to provide proof of conditioning completion and for appropriate emission lab repeatability and reproducibility confirmation prior to starting emission certification testing.

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Requirement	Current	CARB Consideration		Comments re: CARB consideration	BEST recommendation	
Cost to develop and certify	AVG (~$300M -$1.5MM)	(AVG X 3) min		Cost per Benefit analysis would likely kill project	$250M +	Reduce cost to enable new technology
Months required to develop and certify	6+	8+	Test time +, reiteration time +	Protocol/shipping/approval/reiteration time would likely kill project	4+	Reduce R&D, Protocol, and Cert time to enable new technology
Variables	9+	15+		Increases variables to the point of almost ensuring failure	3	Variable minimized.
Reproducibility	Poor	Impossible		If unable to reproduce one test, imagine trying to reproduce three tests with the introduction of a second diesel fuel	Good	Minimal Variables, established emissions testing repeatability and reproducibility standards, & In-Use standard test fuels = good reproducibility
Number of Emission Test Facilities	1	2		Increases variables, cost, & time, without improving Reproducibility, but may improve confidence	1	No need to incur cost and add variables associated with multiple emmision facilities, when lab cert requirements are established.
Number of Diesel Test Fuels	1	2	Ref & DEL	1 lab fuel and 1 refiner fuel is not representative of avg in use fuel	1	Everyone using the same Ref fuel and its representative of In-use CARB diesel.
Number of Biodiesel (B100) Cert Fuels	1	1			1	Everyone using the same Biodiesel and its representative of in use low sat CARB biodiesel
Number of Candidate Fuels	1	3		Increases variables, cost, & time, without improving Reproducibility, but may improve confidence	1	Either everyone using the same components to produce Candidate via standardized procedures, or everyone using the same B20 that will be representative of in-use B20.
Number of Emission Test Programs	1	3		Increases variables, cost, & time, without improving Reproducibility, but may improve confidence	1	No need to incur cost and add variables with multiple test programs, when lab standards, and standardized fuels are used.
Number of Equivalence Demonstrations	1	3		Increases variables, cost, & time, without improving Reproducibility, but may improve confidence	1	No need to incur cost and add variables with multiple test programs, when lab standards, and standardized fuels are used.
Observation of Candidate Fuel Blending	0	1	Ind, CA-lic eng hired by applicant	Would not alleviate 3rd party concerns	1	Should be witnessed by CARB rep., even if CARB is reimbursed for expenses. CARB B20 would eliminate applicant involvement
Obervation of Emission Testing	0	1	Ind, CA-lic eng hired by applicant	Would not alleviate 3rd party concerns	1	Should be witnessed by CARB rep., even if CARB is reimbursed for expenses. CARB B20 would eliminate applicant involvement
Direct Shipping of Fuels and Components	0	1	Rqd, from source to emission facilty	Would not alleviate 3rd party concerns, emission facilities now required to inventory fuels. CARB witnessed Seals/Chain of Custody more important	0	Standardized chain of custody that incorporates witnessing, seals, standard forms, along with confirmatory abreviated testing at emmissions lab provide integrity assurances.
Analysis of Fuels and Components	0	1	All, including add, from each em. Fac.	Difficult to perform Protocol step, & concerns that CARB/Ind lab can't maintain confidentiality of additive.	0.25	Gets much easier with standard CARB fuels. All fuels should be tested both for uniformity and C of A. Additionally, abreviated testing at emmissions lab should be performed to ensure product integrity
By the Same Independent Laboratory	0	1	Rqd for all samples from each em fac	Reasonable and reduces variables	1	Agreed
Retained Samples, Fuels and Components	0	1	Shipped to CARB after protocol appv.	Confidentiality can't be guaranteed, variables/errors introduced, and subjects stakeholders to unknown risk.	0	Quality and Integrity assurances best performed during CARB's witnessing of emissions testing phase.

BEST Corp notes