BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking To Enhance the Role of Demand Response in Meeting the State's Resource Planning Needs and Operational Requirements.	Rulemaking 13-09-011 (Filed September 19, 2013)

JOINT REPLY OF ENERNOC, INC., AND COMVERGE, INC., TO RESPONSES TO PHASE 2 FOUNDATIONAL QUESTIONS

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December 31, 2013

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EnerNOC, Inc., and Comverge, Inc. (EnerNOC/Comverge) respectfully submit this Joint Reply to the Responses to the Phase 2 Foundational Questions posed in Attachment One of the Joint Assigned Commissioner and Administrative Law Judge Ruling and Scoping Memo issued in this proceeding on November 14, 2013 ("Scoping Memo"). This Joint Reply is filed and served pursuant to the Commission's Rules of Practice and Procedure and the Scoping Memo.

I. ENERNOC/COMVERGE SHARE THE VIEWS EXPRESSED BY SEVERAL PARTIES THAT, WHILE TERMINOLOGY IS IMPORTANT, IT IS MORE IMPORTANT THAT THE PURPOSE AND PROCESS FOR MAKING DEMAND RESPONSE CHANGES IS CLEARLY IDENTIFIED.

On December 13, 2013, EnerNOC and Comverge joined with Johnson Controls, Inc. (JCI) to file a Joint Response to the Phase 2 Foundational Questions posed in Attachment One of the Scoping Memo ("Joint Response"). The Joint Response presented a consensus position on several issues.

Specifically, the Joint Response presented options for describing differences among demand response (DR) resources.[1] Those DR resources that will not be bid into the California Independent System Operator's (CAISO's) markets would be considered demand-side, retail or load-modifying resources while those that are bid into the CAISO's markets would be considered wholesale or supply-side resources.

[1] Joint DR Parties Opening Response, at pp. 3-4, 6-7.

However, in Joint Response was not concerned about nomenclature alone. Irrespective of the decided terminology, DR resources, on either side of the ledger, must be recognized as reducing or meeting the load serving entity's (LSE's) resource adequacy (RA) requirement (RAR). Supply-side resources meet the RAR as supply resources, while demand-side resources reduce the RAR by modifying the load shape. Without the continued recognition of DR resources meeting or reducing the RAR, the value of DR resources would be greatly diminished.[2]

This same view was supported by several parties, including utilities and large energy consumers.[3] For the reasons stated in these and the Joint Response, EnerNOC/Comverge therefore, strongly disagree with the position stated by the Direct Access Customer Coalition and the Alliance for Retail Energy Markets (DACC/AReM) that supply-side resources are more valuable, and recommend that this position be disregarded.[4]

However, before nomenclature is even defined or determined the Commission must establish a foundational policy reason to make any changes.[5] There is an assumed desire to increase DR participation and a desire to ensure that DR resources meet the needs of the California Independent System Operator (CAISO). Yet, it is not clear exactly what the needs of the CAISO are at this time because several of those "needs" are under development. For example, resource requirements in order to meet flexibility needs are being developed in the CAISO's Flexible Resource Adequacy Criteria Must-Offer Obligation (FRACMOO)

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[2] Joint DR Parties Opening Response, at p. 4.
[3] California Large Energy Consumers Association (CLECA) Response, at p. 3; Southern California Edison Company (SCE) Response, at p. 3; Pacific Gas and Electric Company (PG&E) Opening Response, at pp. 4-5; San Diego Gas and Electric Company (SDG&E) Opening Response, at p. 5.
[4] DACC/AREM Opening Response, at p. 2.
[5] Joint DR Parties Opening Response, at pp. 5-6; Center for Energy Efficiency and Renewable Technologies (CEERT) Opening Response, at pp. 3-5.

Stakeholder Process, including requirements for use-limited resources. However, CAISO has just introduced a new version of that proposal that has not been fully vetted.[6]

Similarly, CAISO has introduced a proposal for DR resources to qualify as a local capacity resource for meeting local reliability needs in the CAISO's transmission planning process (TPP). Yet, there has not been any recent activity and the discussion has not been part of any Commission process.[7]

Long-term and short-term resource needs are being developed that give limited recognition to DR resources. Nonetheless, the CAISO states that it is not enough to determine whether resources are retail or wholesale programs, but that these resources "1) reduce the need for conventional resources by reducing the amount of net load or 2) act as a supply-side substitute that can replace conventional generation and transmission assets."[8]

There are several problems with these statements. First, CAISO did *not* include *any* demand response, either supply side or demand side, in the long-term procurement plan (LTPP) proceeding (R.12-03-014 (Track 1)) to modify the load shape or act as a supply resource and only included a portion of the amount of DR resource directed by the Commission to be included in Track 4 of the LTPP.

DR cannot displace the need for additional, traditional generation resources *if* it is *not* included as either a load-modifier or a supply-side alternative in the forecasts and analysis that result in the determination of need for new resources. This concern was also voiced by The Utility Reform Network (TURN) in its Response. DR should be displacing the need for adding

[6] CAISO FRACMOO Stakeholder Meeting on December 13, 2013.
[7] CLECA Opening Response, at p. 6.
[8] CAISO Opening Response, at p.2.

resources.[9] However, that cannot occur unless the DR resources are included in the long-term planning analysis either for transmission or generation resources.

While EnerNOC/Comverge agree that DR resources should be included in forecasts for determining short- and long-term resource needs, DR may not necessarily displace all peaking resource dispatches.[10] Such circumstances raise the issue of whether the Loading Order is a procurement and planning tool or an operational tool. This distinction may need to be explored more fully.

While the previous paragraphs discuss the problem associated with the CAISO's failure to include DR in long-term forecasts, the same concern exists relative to the inclusion of DR resource availability for short-term purposes. CAISO receives information from the investor-owned utilities (IOUs) on a daily basis as to the amount of DR capacity available for dispatch. In addition, the IOUs indicate the programs they intend to call and the amount of capacity associated with those dispatches, by sub LAP or local capacity area. But, CAISO does not adjust its daily load forecasts to reflect DR availability before they run through their residual unit commitment (RUC) process,[11] which results in committing generation resources in the day-ahead that would displace the need for day-of DR resource dispatches. So, from either a long-term or short-term perspective, the CAISO may need to adjust its processes to give due recognition to DR resource availability.

In terms of DR acting as a supply-side resource, CAISO is setting DR up to fail if CAISO requires DR resources to meet all of the operating characteristics of a conventional generator.[12] Instead, CAISO should match the operating characteristics of DR resources with the system

[9] TURN Opening Response, at p. 3.
[10] TURN Opening Response, at p. 2.
[11] CLECA Opening Response, at p. 3; PG&E's Opening Response, at p. 12,
[12] Joint DR Parties Opening Response, at pp. 8-9; CLECA Opening Response, at p. 4.

needs. The most beneficial application of DR resources is for it to be dispatched if more economic than other resources and if that dispatch displaces the need for an incremental generator, whose operations would be limited to a few hours.

Flexible capacity resource definitions are being discussed in a CAISO Stakeholder Process and include definitions for use-limited resources like DR. However, those discussions are not final. No such process is yet underway for "generic" resources. Defining the resource characteristics of a local capacity resource has begun at the CAISO, but there has not been any recent activity.[13] It is difficult for any resource to qualify as a supply resource if the product parameters are not established.

The fundamental problem that needs to be addressed is to answer the question: What do DR resources need to do to be recognized as a resource by the CAISO? But, that discussion is not happening as directly as it needs to be. Without that conversation, parties are left to guess at the purpose, direction, and outcome of bifurcation and wholesale market integration. Uncertainty is antithetical to growing a DR resource.

Several parties expressed concern about the lack of a fully developed DR opportunity in the wholesale market due to either (1) remaining barriers to entry, such as telemetry; (2) the lack of certainty around product definitions, like flexible or local capacity resources; (3) the lack of economic incentives in an energy-only market with low energy prices prevailing; or (4) the possible degradation of value for DR resources that cannot participate in the wholesale market.[14] Without a real policy reason, an objective, or a vision for making changes, EnerNOC/Comverge share the concerns expressed by other parties that more harm than good will be done to the existing DR resource base if changes are made without reference to or support from a strong

[13] CLECA Opening Response, at p. 6.
[14] SDG&E Opening Response, at pp. 3-5; Olivine Opening Response, at pp. 3-5, 8; SCE Opening Response, at p. 5; TURN Opening Response, at pp. 5-7.

policy direction. EnerNOC/Comverge are skeptical that integration will expand DR opportunities beyond those that exist at the retail level or that the wholesale market provides an economic opportunity to grow resource participation beyond present levels, unless coupled with continued utility funding for capacity payments. EnerNOC/Comverge, therefore, remain concerned that integration may result in the reduction or collapse of the DR resource base that exists today.[15]

However, EnerNOC/Comverge are willing to engage in a discussion as to how integration may better align the DR resource characteristics with the system needs. Those system needs must be vetted and well defined and must not be developed so that only generation can meet the requirements. Without such a discussion, the policy foundation for change will remain vague and uncertain and fail to support any proposed changes.

II.
BACK-UP GENERATION IS REGULATED BY LOCAL, STATE AND FEDERAL AGENCIES; THE COMMISSION SHOULD NOT REGULATE AIR EMISSIONS.

Sierra Club California (Sierra Club), Natural Resources Defense Council (NRDC), and the Office of Ratepayer Advocates (ORA) oppose the use of back-up generators (BUGs) for DR RA purposes.[16] DACC/AReM support the use of BUGs for DR RA purposes, so long as those BUGs are permitted and compliant with the air emissions regulations.[17] EnerNOC/Comverge support the position taken by DACC/AReM.

NRDC's position is based on the Environmental Protection Agency (EPA) regulations that limit BUG use for emergency purposes that are defined as North American Electricity Reliability Council (NERC) energy emergency alert, level 2 (EEA-2) conditions for 50 hours,

[15] Joint Parties Opening Response, at pp. 5-6.
[16] Sierra Club Opening Response, at p. 8; NRDC Opening Response, at pp. 3, 10; ORA Opening Response, at p. 7.
[17] DACC/AREM Response, at p.12.

with up to 50 hours of testing, for a total of 100 hours.[18] NRDC also contends that state and local air emissions requirements would apply to BUGs.[19] The regulations applicable to BUGs, however, were specifically addressed in the Joint Response.[20]

At page 3 of its opening Response, NRDC displays a chart that identifies the number of BUGs in California, but the chart does not offer any information as to the participation of those BUGs to DR programs. In fact, it appears that NRDC's concerns regarding BUGs extends beyond the participation of such generators in DR programs. Not only are such broader concerns well beyond the scope of this rulemaking, but even if a percentage of the permitted BUGs in California are located on customer sites that participate in DR programs, there is no evidence to show that the generators are used in place of load reductions.

The IOUs' responses indicate that they do not record information related to back-up generation (BUG) use for DR purposes.[21] BUG use information is collected by the customer and reported to the air regulators. It is the jurisdiction of the air regulators to ensure that BUG operation is compliant with air emissions regulations.[22]

In its Response, ORA references a report entitled "Reliability and Emission Impacts of Stationary Engine-Backed Demand Response in Regional Power Markets" prepared by Paul Hibbard of the Analysis Group in August 2012 for Calpine Corporation.[23] ORA claims that the use of BUGs could "increase emissions of hazardous air pollutants relative to the same capacity needs being met by alternative market resources."[24]

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[18] NRDC Opening Response, at pp. 5-6.
[19] Id., at pp. 6-7.
[20] Joint DR Parties Opening Response, at pp. 13-14.
[21] PG&E Opening Response, at p. 17; SCE Opening Response, at p. A-9; SDG&E Opening Response, at p. 10.
[22] SCE Opening Response, at p.A-9.
[23] ORA Opening Response, at p. 6.
[24] ORA Opening Response, at p. 7.

However, EPA has already responded in the NESHAP/NSPS[25] engine proceeding that "there is no guarantee that this would be the case." [26] As noted by an analysis conducted by NERA Economic Consulting entitled "Evaluation of the Calpine Report on the Reliability and Emission Impacts of RICE-Based Demand Response in PJM," EPA determined:

> "The decisions made by ISO are based on price, not emissions. There is no reason to believe that the absence of emergency generators would lead to the use of new natural gas turbines, as opposed to other types of generation like older coal plants. In addition, the commenters do not take into account the fact that emergency generators can be turned on fairly quickly and do not need to be in idle or standby mode, which can cause emissions." [27]

NRDC offers some suggestions to address its concern with BUGs, such as using bio-fuels in place of diesel.[28] EnerNOC has researched the use of bio-fuels in BUGs in place of diesel fuel. In some cases, use of bio-fuels will invalidate the generator warranty. (See, Appendix A hereto.) Bio-fuels, in a stationary application, congeal and may require stirring, heating or other apparatus and increased maintenance. Bio-fuels in a mobile application are agitated and the agitation prevents congealing. Further, mobile applications use the fuel more rapidly, which prevents the fuel from degrading. Bio-fuel in a stationary application may degrade since the BUG does not consume the fuel on a regular basis.[29]

Therefore, the fuel may not be of a consistent quality to ensure the generator will operate when needed, which is why the warranty is invalidated by using bio-fuels for emergency purposes. Since BUGs are considered emergency resources, the failure of a unit to operate during an emergency could be catastrophic.

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[25] National Emission Standards for Hazardous Air Pollutants/New Source Performance Standards (as per 40 CFR 63 Subpart ZZZZ and 40 CFR 60 Subparts IIII and JJJJ)
[26] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2008-0708-1491
[27] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2008-0708-1484
[28] NRDC Opening Response, at p. 5.
[29] Appendix A: Cummins Engineering Application Report for Bio-Diesel Fuel Usage, May 2008.

In addition to EnerNOC's research, Comverge has researched the overall emissions impacts of bio-fuels in electric generation. (See, Appendix B hereto.) The emissions benefits of bio-fuels are questionable at this point in time; the term "sustainable bio-fuels", as used by NRDC, is poorly defined and open to broad interpretation. In some cases, bio-fuels may be developed and harvested through a "closed-loop" system in which the carbon dioxide (CO2) emissions resulting from bio-fuel combustion is compensated for by an equal (or greater) amount of CO2 consumption needed to grow new biofuel stock. In these cases the bio-fuel source may be said to be "carbon neutral" or even "carbon negative." However, many bio-fuel sources may be termed "sustainable" without being a closed-loop system, and thus combustion may lead to a net increase in CO2 emissions, although those emissions may be lower than emissions from diesel fuel combustion.[30]

In its response, NRDC also suggests that the utilities demonstrate that no DR programs are using BUGs.[31] However, as stated by the IOUs themselves, they do not collect such data. The data is collected by the customer and shared with the air resources regulators. If the customer is not operating the BUG in compliance with those air emissions restrictions, then, the air resources regulators will address the situation with the customer. If a unit is meeting all air resources regulations, however, removing the BUG from participation in DR programs would be erecting an unreasonable barrier to relying on the BUG as an emergency resource.

The Commission can decide that only BUGs that are compliant with local, state and federal air emissions requirements are permitted to participate in DR programs. The Commission, however, should not consider actions or decisions that would preempt or conflict with state and federal air quality regulatory authority or air quality regulations. Compliance with

[30] Appendix B: Climate Action Registry, Biodiesel Emissions, March 2007.
[31] NRDC Opening Response, at p. 10.

federal EPA regulations would limit BUG operation to 100 hours/year for testing, maintenance and defined emergency conditions. In addition, BUGs must comply with the requirements of the California Air Resources Board (CARB) and local air quality management district (AQMD), which may be stricter than EPA regulations.

In these circumstances, it would seem prudent to maintain DR resources that are available for emergency purposes, especially when BUGs could be instrumental in keeping the lights on and, potentially, displacing the need for other central station generation from being developed, so long as those resources are compliant with air emissions regulations. In any event, regulation in this area should be left to the appropriate regulatory authorities with the requisite jurisdiction and competence regarding emissions and air quality matters.

Finally, EnerNOC/Comverge note that the EPA spent over three years analyzing, in detail, the effects of engines in demand response programs and found that "[t]he use of stationary engines as part of emergency demand response programs can help prevent grid failure or blackouts, by allowing these engines to be used for limited hours in specific circumstances of grid instability prior to the occurrence of blackouts."[32] Numerous states such as Connecticut, Massachusetts, Rhode Island, Vermont, New Hampshire, Maryland, Ohio, and Virginia modified its air regulations so that emergency engines can participate in emergency demand response programs. Other states such as Maine, New York, Pennsylvania, Illinois, West Virginia, Florida, and Texas allow the use of engines to participate in emergency demand response programs under its existing air regulations. These states and the federal EPA all understand the importance of grid stability and keeping the lights on.

[32] Federal Register, Volume 78, No. 20, January 30, 2011, at p. 6679.

III.
CESA'S RESPONSE INCLUDES A PROPOSAL THAT IS OUTSIDE OF THE SCOPE OF THIS RULEMAKING.

The Scoping Memo issued in this Rulemaking on November 14, 2013, fully accounted for the OIR and the notice and opportunity provided to all parties, including a Prehearing Conference (PHC), on the issues to be included within the scope of this rulemaking. Based on that full and complete record, the Scoping Memo identified four phases for this rulemaking – a first phase on DR bridge funding, a second phase on DR foundational issues, a third phase on DR competitive procurement mechanisms, and a fourth phase on future DR programs designed to increase DR participation.

With respect to the "foundational questions" that are the specific topic of these responses, those issues were included in Phase Two and defined as follows:

> "T]he foremost issue in this rulemaking is whether the Commission can and should bifurcate. In addition, we will address the foundational issues of cost-effectiveness, cost allocation, and the use of back-up generators. In order to begin to create the record for phase two, we ask parties to file and serve responses to the questions in Attachment 1 of this Ruling."[33]

Attachment One of the Scoping Memo specifically defines the questions that will be considered in this "foundational" Phase Two, rejecting others that were otherwise discussed or proposed.

At no point in any pleading submitted to the Commission or argument made at the PHC (held on October 24, 2013) was there any request to have the issue of energy storage as a demand response resource included in this Rulemaking or any phase of this Rulemaking. The term "energy storage" is never used in the Scoping Memo and not included in Attachment One. Thus, no notice was provided nor record established for including that issue within the scope of this Rulemaking.

[33] Scoping Memo, at p. 9.

Nevertheless, in its Response filed on December 13, the California Energy Storage Association (CESA) seeks to expand the scope of Phase Two of this rulemaking to include consideration of storage resources as both demand- and supply-side DR resources.[34] While EnerNOC/Comverge do not object to exploring the concept that CESA has raised in its Response in some proceeding, this issue is not within the scope of this Rulemaking, and certainly no basis exists today to consider it as part of the Phase Two foundational questions.

IV.
CONCLUSION

Based on the Joint Response and Joint Reply here, EnerNOC/Comverge renew and further the recommendations made in the Joint Response to the Phase 2 Foundational questions as follows:

- Bifurcation should be the result of a policy directive that will result in increased DR opportunities and incremental benefits beyond those provided by the current retail programs.
- The Commission should acknowledge that energy market revenues, alone, will not be enough to encourage wholesale market participation, much less result in an expansion of DR beyond the current retail programs.
- If the Commission proceeds with bifurcation, bifurcation between wholesale and retail programs probably makes the most sense.
- Not all retail programs will be bid into the wholesale market; however, maintenance of the value of retail DR for resource adequacy purposes is critical.
- Differences in operating characteristics of different resources must be reflected in the resource adequacy requirements, relative to generation, or risk collapse of other resource types.
- Back-up generators (BUGs) are subject to federal, state and local air emissions regulations. These regulations are extremely complex and it has taken years for them to be developed. The Commission should not attempt to regulate air quality and allow the current agencies with the responsibility to do their jobs.

[34] CESA Opening Response, at pp. 3-4.

- BUGs do not represent a large percentage of EnerNOC/Comverge services.
- BUGs are not dispatched frequently; but, may provide protection against outages. EPA and other states have determined that it is better to use a subset of generators for a short period of time to avoid a blackout, rather than waiting for a blackout to occur when it could take hours or days for the electric grid to be restored, during which time every generator whether properly permitted or not will be operating.
- Because aggregators will incur the risk of non-payment for any capacity that will not meet an LSE's resource adequacy obligation, bifurcation does not increase the likelihood that aggregators will increase BUG use.
- The proposal by CESA to include energy storage resources as either demand- or supply-side resources is beyond the scope of this rulemaking, including Phase Two.

Respectfully submitted,

December 31, 2013

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APPENDIX A

Cummins Engineering Application Report for Bio-Diesel Fuel Usage
May 2008

BIODIESEL EMISSIONS

Biodiesel is the first and only alternative fuel to have a complete evaluation of emission results and potential health effects submitted to the U.S. Environmental Protection Agency (EPA) under the Clean Air Act Section 211(b). These programs include the most stringent emissions testing protocols ever required by EPA for certification of fuels or fuel additives. The data gathered complete the most thorough inventory of the environmental and human health effects attributes that current technology will allow.

EPA has surveyed the large body of biodiesel emissions studies and averaged the Health Effects testing results with other major studies. The results are seen in the table below. To view EPA's report titled "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" visit www.epa.gov/otaq/models/biodsl.htm.

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL, ACCORDING TO EPA

Emission Type	B100	B20
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
Nox	+10%	+2% to -2%
Non-Regulated		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

*** Estimated from B100 result**
**** Average reduction across all compounds measured**
***** 2-nitroflourine results were within test method variability**

(more)

This document provides detailed calculations, assumptions, input values and other information required to calculate the energy use and GHG emissions for the ULSD pathway. Although the original GREET model developed by Argonne National Laboratory forms the core basis of this analysis, it has been appropriately modified to reflect California specific conditions. Examples include electricity generation factors, crude transportation distances, etc. which have been used to replace to the original GREET input values. A detailed list of all input values is provided in Appendix B.

Table A provides a summary of the Well-To-Tank (WTT) and Tank-To-Wheel (TTW) energy use and GHG emissions for this pathway. Energy use is presented in unit of heat content Btu per million Btu and GHG emissions are reported as gram CO_2 equivalent per Mega Joules (CO_2e/MJ) where non-CO_2 gasses (i.e., methane and nitrous oxide) are converted into CO_2 equivalents. Details of converting non-CO_2 gasses to CO_2 equivalents are detailed in Appendix A in this document.

Note: The energy inputs are presented in mmBtu because the calculations in the GREET model use mmBtu.

Table A. Summary Energy and GHG Values for the ULSD Pathway

	Energy Required (Btu/mmBtu)	**% Energy Contribution**	**Emissions (gCO_{2e}/MJ)**	**% Emissions Contribution**
Crude Recovery	80,345	6.30%	6.93	7.31%
Crude Transport	16,265	1.28%	1.14	1.20%
Crude Refining	172,588	13.55%	11.41	12.11%
ULSD Transport	4,721	0.37%	0.33	0.35%
Total WTT	**273,919**	**21.50%**	**19.81**	**20.97%**
Total TTW	1,000,000	78.50%	74.90	79.08%
Total WTW	**1,273,919**	**100%**	**94.71**	**100%**

Note: percentages may not add due to rounding

From Table A above, the WTW analysis of ULSD indicates that **1,273,919** Btu of energy is required to produce 1 (one) mmBtu of available fuel energy delivered to the vehicle. From a GHG perspective, **94.71** gCO_2e of GHG are released during the production and use of 1 (one) MJ of ULSD. Note that this analysis uses average crude recovery which takes into consideration crude extracted in California as well as crude recovered overseas. The transportation of crude via ocean tanker from overseas locations and pipeline from Alaska is also weighted to reflect average crude available in California.

The values in Table A are pictorially represented in Figure 2, showing specific contributions of each of the discrete components of the fuel pathway. The charts are shown separately for energy use and GHG emissions. From an energy use

- Process Efficiency for any step in GREET is defined as:
  Efficiency = energy output / (energy output + energy consumed)
- Note that rounding of values has not been performed in several tables in this document. This is to allow stakeholders executing runs with the GREET model to compare actual output values from the CA-modified model with values in this document.

Table A. Summary of Energy Consumption and GHG Emissions per mmBtu of Biodiesel Produced

	Energy Required (Btu/mmBtu)	**Share of Total Energy (%)**	**GHG Emissions (gCO_2e/MJ)**	**Share of Total Emissions (%)**
Well-to-Tank (WTT)				
Soybean Farming	67,180	4.9%	5.10	18.9%
Agricultural Chemicals Production	50,358	3.7%	3.73	13.9%
N_2O Emissions from Fertilizer Use	N/A	N/A	3.9	14.5%
Soybean Transport	14,907	1.1%	1.15	4.3%
Soyoil Extraction	119,080	8.7%	6.96	25.8%
Soyoil Transport	19,688	1.4%	1.48	5.5%
Biodiesel Transesterification	72,091	5.3%	2.29	8.5%
Biodiesel Transport & Dist.	19,754	1.4%	1.54	5.7%
Total WTT	**363,058**	**26.6%**	**26.15**	**97.1%**
Tank -to- Wheel (TTW)				
Carbon in Fuel	1,000,000	73.4%	N/A	N/A
Fossil Carbon in Fuel	0	0	0	0.0%
Vehicle CH_4 and N_2O	N/A	N/A	0.780	2.9%
Total TTW	**1,000,000**	**73.4%**	**0.780**	**2.9%**
Total Well-to-Wheel (WTW)	**1,363,058**	**100%**	**26.93***	**100%**

From Table A above, a WTW analysis of biodiesel indicates that **1,363,058** Btu of energy is required to produce 1 (one) mmBtu of available fuel energy delivered to the vehicle. From a GHG perspective, **26.93** gCO_2e of GHG are released during the production of 1 (one) MJ of biodiesel.

*Note that land use change analysis by staff at this time for soy based fuels is estimated to be **42.0 gCO_2e/MJ**. This is a preliminary estimate using the GTAP[3] analysis. Using

this preliminary value, the total carbon intensity for soybean derived biodiesel derived from soybeans is estimated to be **68.93 gCO_2e/MJ** which is inclusive of a preliminary land use change value of 42.0 gCO_2e/MJ. This value will be refined and updated when an updated analysis is available for this feedstock based biofuels. Details of the Land Use Change analysis is available in Chapter 4 of the staff report.

The values in Table A are pictorially represented in Figure 2, showing specific contributions of each of the discrete components of the fuel pathway. The charts are shown separately for energy use and GHG emissions. From an energy use viewpoint, carbon in fuel (73.4%) dominates the pathway energy use. For GHG emissions, the largest contributions are from soybean production (includes soybean farming, use of agricultural chemicals and consequent N_2O release) (47.3% combined) and soyoil extraction (25.8%).

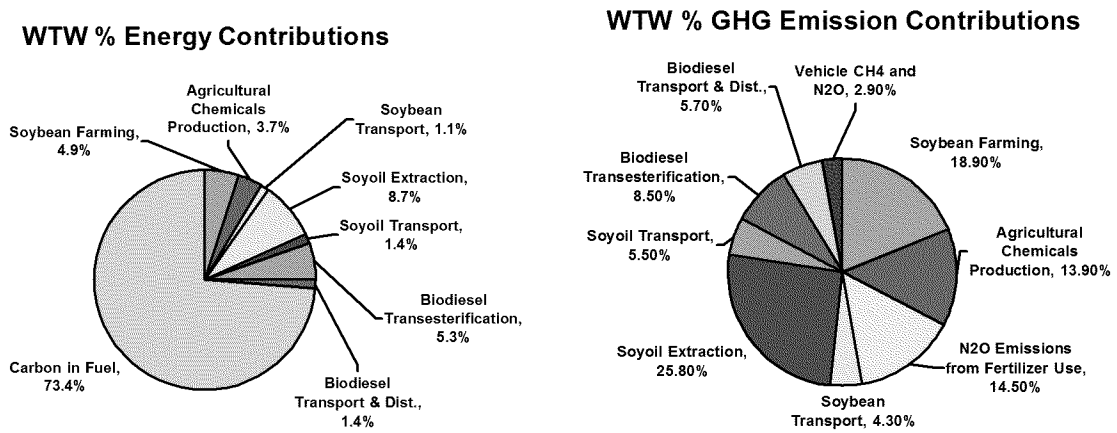

Figure 2. Percent Energy Contribution and Emissions Contribution from Well-to-Wheel (WTW).

The following sections provide a summary of all the components that form part of the biodiesel pathway. Complete details are provided in Appendix A.

WTT Details

Soybean Farming

The biodiesel (esterified soyoil) production process starts with soybean farming. Table B provides a breakdown of energy use needed for soybean farming. The table shows values for various fuels used on a per bushel basis. Table B also shows the total energy for soybean farming on a Btu/mmBtu basis with all adjustment and allocation factors applied. Appendix C shows the details of adjustment and allocation factors for the biodiesel pathway. In a similar manner, GHG emissions associated with the soybean farming are shown in Table C below. Complete details are provided in Appendix A.

Table C.3: Carbon Dioxide Emission Factors for Transport Fuels (kg CO_2/gallon)

Fuel	kg CO_2/gallon
Aviation gasoline	ffiffl┘|
Biodiesel	–ffl●┘
CA Low Sulfur Diesel	–ffl–◘
CA Reformulated gasoline, 5.7% ethanol	ffiffl●•
Crude Oil	ffl |
Non-CA Diesel / Diesel No.2	ffl●
Ethanol (E85)	◘ffl
Fischer Tropsch Diesel	–ffl ♂
Jet Fuel, Kerosene (Jet A or A-1)	–ffl| ◘
Jet Fuel, Naphtha (Jet B)	–ffl┘ |
Kerosene	–ffl◘ ◘
Liquefied Natural Gas (LNG)	|ffl♂◘
Liquefied Petroleum Gas (LPG)	•ffl─┘
Methanol	|ffl
Motor Gasoline (Non CA and off-road)	ffiffl┘ffi
Propane	•ffl◘ ◘
Residual Oil	ffl◘ ◘
Fuels With Other Units Of Measure	
Natural Gas (CNG) per therm	•ffl┘ffi
Natural Gas (CNG) per gasoline gallon equivalent	◘ffl ffi◘
Hydrogen per kg	ffl

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Emission Factors for Stationary Combustion

Table C.5: Carbon Dioxide Emission Factors and Oxidation Rates for Stationary Combustion (kg/MMBtu or kg/gallon)

Fuel	kg CO_2/ MMBtu (CA.)	kg CO_2/ MMBtu (U.S.)	kg CO_2/ gallon	Fraction of Carbon Oxidized	Adjusted kg CO_2/ MMBtu (CA.)	Adjusted kg CO_2/ MMBtu (U.S.)	Adjusted kg CO_2/ gallon
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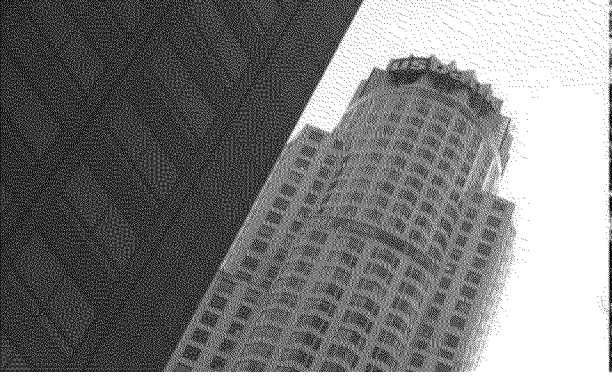

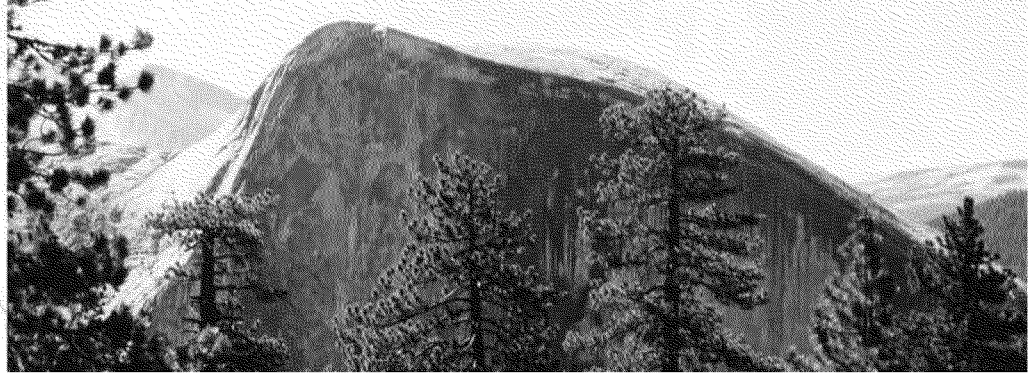

California Climate Action Registry
515 S. Flower Street, Suite 1640
Los Angeles, CA 90071

California Climate Action Registry General Reporting Protocol

Reporting Entity-Wide Greenhouse Gas Emissions

Version 2.2 | March 2007

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Note: Visually apparent phase separation, sediment, suspended matter, or undissolved water should not be present in biodiesel and biodiesel blends.

Biodiesel and biodiesel blends should not contain any constituent, additive or other substance that makes them unacceptable for use in diesel engines.

"EN 14078" is the recommended test method for determining the volume percent biodiesel in a biodiesel blend.

NOTICE
Failures that result from the use of any fuel are not Caterpillar factory defects. Therefore, the cost of repair would NOT be covered by the Caterpillar warranty for materials and/or the warranty for workmanship.

Recommendation for the Use of Biodiesel in Caterpillar Commercial and Machine Diesel Engines

For Caterpillar Series C175 Series diesel engines, consult the Caterpillar Application & Installation Group or consult your Caterpillar dealer before using biodiesel or biodiesel blends.

For Caterpillar off-highway ACERT Technology diesel engine model numbers C7, C9, C11, C13, C15, C18, C27, and C32 and also for Caterpillar 3114, 3116, 3126, 3176, 3196, 3208, 3306, C-9, C-10, C-12, 3406, C-15, C-16, C-18, 3456, 3408, 3412, Series 3500 Series, Series 3600 Series, Series C280 Series, CM20, CM25, and CM32 engines, biodiesel that meets the requirements that are listed in the "Caterpillar Specification for Biodiesel Fuel", "ASTM D6751", or "EN 14214" are acceptable blendstock. Biodiesel may be blended in amounts up to a maximum of 20 percent (B20) with an acceptable diesel fuel. This blend is acceptable provided that the biodiesel constituent meets the requirements that are outlined in Table 9 prior to blending. In addition, the final blend must meet the requirements for distillate diesel fuel that are listed in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines", Table in this Special Publication, "Distillate Diesel Fuel" article. Biodiesel that meets "ASTM D7467" (B6 to B20), or biodiesel that meets "ASTM D975-08a" or "EN 590" requirements for B5 and lower biodiesel blends are also acceptable for use in the listed engines.

C0.5-C2.2, C4.4, and C4.4 ACERT Technology diesel engines and C6.6 ACERT Technology diesel engines compatible with up to B20 biodiesel as described above have been released as follows:

- C0.5-C2.2 Tier 4 Interim/Stage IIIB, at model introduction, starting April 2007
- C4.4 (Mechanical) Tier 3/Stage IIIA, at model introduction, starting Nov 2007
- C4.4 ACERT Technology Tier 3/Stage IIIA electronic diesel engines manufactured after 1 July 2008, Serial numbers:

- Cat Machine Group - C4E05524-UP

- Cat Industrial - 44404304-UP

- C6.6 ACERT Technology electronic diesel engines built after 1 July 2008, Serial numbers:

- Cat Machine Group - CE614624-UP

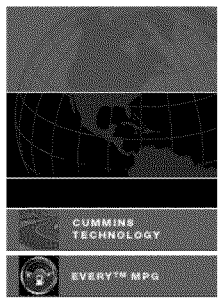
- Cat Industrial - 66609016-UP

Note: Diesel fuels that meet the requirements of the most current versions of the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines", the "Caterpillar Specification for Distillate Diesel Fuel for On-Highway Diesel Engines", the National Conference on Weights and Measures (NCWM) Premium Diesel definition, "EN 590" and/or "ASTM 975 (No.1-D, No.2-D)", are examples of fuels that are acceptable for creating biodiesel blends. These biodiesel blends must meet the Caterpillar recommendations and requirements for biodiesel blends.

Note: Crankcase oil fuel dilution may be much higher when biodiesel and/or biodiesel blends are used. This increased level of fuel dilution when using biodiesel and/or biodiesel blends is related to the typically lower volatility of biodiesel. In-cylinder emissions control strategies utilized in many of the industries latest engine designs may lead to a higher level of biodiesel concentration in the sump.

The long-term effect of biodiesel concentration in crankcase oil is currently unknown, but some potential issues are:

- A higher risk of corrosion
- A higher risk of wear
- A higher risk of piston deposits
- Either increased or deceased oil viscosity
- Shortened aftertreatment device ash service intervals (more frequent) and/or shortened aftertreatment device life
- Shortened oil life (more frequent oil drain intervals)



Frequently Asked Questions.

The Use of B20 Biodiesel Blends in Cummins Engines.

1. What Cummins engines can be used with B20 biodiesel?

The current approved engine models are as follows:

On-Highway: ISX, ISM, ISL, ISC and ISB engines certified to EPA '02 and later emissions standards, ISL, ISC and ISB engines certified to Euro 3.

Off-Highway: QSX, QSM, QSL, QSC, QSB6.7, QSB4.5 and QSB3.3 engines certified to Tier 3/Stage IIIA, QSM Marine, QSM G-Drive.

High Horsepower Off-Highway built after January 1, 2008: QSK78, QSK60, QSK50, K2000E, K50, QSK45, QSK38, K1500E, K38, QST30, QSK23, QSK19 and K19. Also Marine QSK60, QSK50, K50 QSK45, QSK38, K38 QSK19, K19.

Cummins has approved B20 for the high horsepower engines listed above with the following fuel systems: Pressure Timed, High-Pressure Injection, Modular Common Rail Fuel Injection System and BOSCH Pump-Line-Nozzle.

2. What are the general fuel specification requirements?

Biodiesel must conform to the American Society of Testing Materials (ASTM) specifications. B100 must conform to ASTM D6751 prior to blending, and the finished B20 blend must conform to ASTM D7467.

ASTM D6751 specification for B100 has been revised to now include a cold soak test. The B100 fuel is cold soaked and filtered in order to catch impurities or incomplete reactions resulting from the production process. As mentioned in previous communications, the stability requirement is still in effect and is a critical requirement when B100 is blended with petrodiesel to produce a B20 blend.

ASTM D7467 is a new specification which applies to biodiesel blends of B6 – B20 and includes an oxidation stability requirement. This specification replaces Cummins' previous Engine Manufacturers Association (EMA) B20 specification requirement.

In Europe, specifications for biodiesel are issued under EN 14214. EN 14214 is published by CEN, the European Committee for Standardization or Comite Europeen de Normalisation. http://www.cen.eu/cenorm/index.htm.

Equivalent biodiesel specifications are required internationally.

Customers are required to purchase the biodiesel blend from a BQ9000 Certified Marketer. The B100 fuel used in the blend must be sourced from a BQ9000 Accredited Producer. BQ9000 Certified Marketers and Accredited Producers can be found at www.bq-9000.org.

3. Where can I find further information as it relates to the use of biodiesel in Cummins engines?

Cummins has recently updated the Fuels Requirements – Service Bulletin 3379001. It can be obtained on Cummins QuickServe website at quickserve.cummins.com. Customers can also contact their local distributor and certified dealers for the bulletin.

4. Are there any special requirements for fuel filters?

Cummins requires the use of a StrataPore™ fuel filter media, and strongly recommends using Cummins Filtration™ filters equipped with StrataPore™ media. If StrataPore media is not used, then an equivalent filter that meets specific performance standards must be used. For more information, please visit www.cumminsfiltration.com.

Cummins also requires high horsepower marine applications to use a centrifuge filtration system to safeguard against water contamination as water intrusion is common in vessel fuel storage tanks. Cummins recommends all commercial marine applications to use centrifuge filtration systems as well. For more information please review the Fuel Requirements - Service Bulletin, number 3379001.

5. Do I need to modify any service intervals when switching from petrodiesel to B20?

Due to the solvent nature of B20, and the potential for 'cleaning' of the vehicle fuel tank and lines, new fuel filters must be installed when switching to B20 on used engines. Fuel filters will need to be replaced at half the standard interval for the next two fuel filter changes. After this initial period, you may revert to the intervals specified in your O & M manual.

For EPA 2007 on-highway midrange engines only, oil sampling will be necessary for the first 6 months of operation with B20 to monitor fuel dilution of the lubricating oil.

For high horsepower engines equipped with the Eliminator™ oil filter option, oil sampling will be needed to determine the appropriate oil change interval. Oil samples should be taken every 250 hours of operation and analyzed according to the Cummins Engine Oil Recommendations Bulletin 3810340 which can be found on quickserve.cummins.com or through local distributors and certified dealers. This process should be repeated for at least three oil change intervals to ensure consistent oil behavior.

6. Are there any biodiesel fuel storage guidelines?

Use biodiesel fuel within six months of its manufacture date. Biodiesel has lower oxidation stability compared to petrodiesel. Avoid storing equipment with biodiesel blends in the fuel system for more than three months.

7. What materials are incompatible with biodiesel?

Natural rubber, butyl rubber and some types of nitrile rubber (depending on chemical composition, construction and application) may be particularly susceptible to degradation. Also, copper, bronze, brass, tin, lead and zinc can cause deposit formations. The use of these materials and coatings must be avoided for fuel tanks and fuel lines. Fuel fittings and connectors are acceptable due to the small surface area in contact with the fuel.

Note: Contact your vehicle manufacturer to determine if any of the OEM supplied components are at risk with biodiesel in order to prevent engine or vehicle damage.

8. Why didn't Cummins include engines prior to 2002?

The main reason not to include engines earlier than 2002 is due to materials compatibility concerns. Some fuel systems in pre-2002 engines contain components that are not compatible with a B20 biodiesel blend. EPA 2002 and later engines contain fuel system components that are compatible.

9. Why didn't Cummins include high horsepower engines prior to January 1, 2008? Some seals and gaskets had to be changed on the engines to allow compatibility with biodiesel.

10. How does using biodiesel affect the engine warranty?

Cummins engine warranty covers failures that are a result of defects in material or factory workmanship. Engine damage, service issues, and/or performance issues determined by Cummins to be caused by the use of biodiesel fuel not meeting the specifications outlined in the Fuels Service Bulletin (3379001) are not considered to be defects in material or workmanship and are not covered under Cummins engine warranty.

This is no different from Cummins position with regular diesel fuel. Cummins does not cover the damage caused by non-Cummins products that are of insufficient quality. It is important to ensure when using diesel fuel or a B20 biodiesel blend with a Cummins engine that the fuel meets industry acceptable quality standards.

11. What are the implications of emission certification?

It should be emphasized that Cummins, in common with all other engine manufacturers, only certifies engines to meet the prescribed EPA (or other local regulatory agency) registered fuels. It is the customer's responsibility to use the correct fuel prescribed by these regulations and as recommended by the engine manufacturer.

The EPA has regulated the United States' highway diesel fuel quality since 1993 to ensure it is compatible with engine emissions standards and air quality goals. It is the responsibility of the customer to obtain the proper local, regional, or national exemptions required for the use of biodiesel in any emissions-regulated Cummins engine.

12. Will Cummins support the use of B20 biodiesel in engines not listed in this document?

Cummins fully supports the use of environmentally beneficial alternative fuels. All of our automotive and industrial engines are compatible with B5 biodiesel to help encourage the greater use of renewable, domestically grown fuel.

Only engines listed in this document are approved for B20 use. Cummins is continuing the evaluation of biodiesel concentrations higher than 5%. All future products will be compatible with biodiesel B20. We are aware of the growing interest in B20 fuel blends and fully support this interest in renewable fuels. As we reach conclusions and the completion of these evaluations, we will modify our position on engine compatibility accordingly.

Some OEMs using Cummins engines not listed in this bulletin may have specific releases regarding the use of biodiesel that apply only to their application. All customers wanting to use biodiesel should also contact their OEM to ensure all supplied components are compatible, including fuel tanks and lines.

13. Is B20 approved for the Dodge Ram Turbo Diesel?

Cummins approves the use of up to B20 in the Dodge Ram trucks for municipal, government, and commercial fleets only. This applies to selected model year vehicles. Please consult Chrysler for specific requirements and approved vehicle models.

Top of Page

Terms of Use and Disclaimers

AUTOMAKERS' AND ENGINE MANUFACTURERS' POSITIONS OF SUPPORT FOR BIODIESEL BLENDS

Company	Biodiesel Blend Approval	Notes	Reference / Source	Last Updated
Acura	TBA	Honda and Acura are working in tandem to introduce the new i-DTEC clean diesel engine to the North American market, but this is now delayed (see links for delay notification). The i-DTEC engine meets the ultra-stringent U.S. EPA Tier II Bin 5 emission standards without the on-board storage of urea.	Click Here for more Info Click Here for more Info	8/13/2009
Arctic Cat	B20	B20 Approved for use in Arctic Cat twin cylinder diesel ATVs. Biodiesel fuel must meet ASTM D6751 spec.	Click Here for more info	8/13/2009
Audi	B5	Audi has introduced 2 new diesels into the US market in 2009: the Audi A3 TDI Sedan and Audi Q7 3.0L TDI SUV. Audi supports the use of up to B5 biodiesel blends.	Click here for more info	8/13/2009

Blue Bird	B5 / B20	Biodiesel blend level approval depends upon school bus model / engine. Those equipped with Cummins engines support B20; those equipped with Ford / GM engines support B5. NBB is working with Bluebird to post biodiesel approval information by model on their website.	http://www.blue-bird.com/product.aspx	8/13/2009
BMW	B5	BMW has introduced 2 new diesels into the US market in 2009: the BMW X5 xDrive 35d and the BMW 335d sedans. BMW supports the use of up to B5 biodiesel blends.	Click Here for more Info	8/13/2009
Buhler	B20	B20 Approved for use in Buhler 4WD tractors powered by Cummins Tier 3 QSM and QSX engines.	Click here for more info	4/18/2007
Case Construction Equipment	B20 - Approved for more than 85% of Case Construction Equipment; B5 is approved for the remainder	Biodiesel fuels approved for use must comply with the North American Standard ASTM D6751. Biodiesel should be purchased from a trusted supplier who understands the product and maintains good product quality. Case recommends that you only use biodiesel from BQ 9000 accredited	Click here for more info	6/11/2008

		suppliers to maintain the quality and the consistency of the fuel.		
Case IH	B100 - Approved for nearly half of the Case IH models sold globally B20 - Approved for more than 90% of Case IH models sold in US and Europe B5 - Approved for every Case IH engine sold globally	Visit www.caseih.com for biodiesel approval levels on specific products and equipment by model	Click here for more info	1/21/2009
Caterpillar	B30 / B20 / B5	Tiered biodiesel blend approval structure based on equipment type and model. On-Highway Truck Engines (SEBU6385-07) - See page 31 for biodiesel recommendations. Caterpillar Commercial Diesel Engines Fluids Recommendations (SEBU6251-12) - See page 54. Visit www.cat.com for more information.	Caterpillar Commercial Diesel Engine Fluids Recommendations Caterpillar On Highway Diesel Engine Fluids Recommendations	3/1/2009
Chrysler LLC	B20 approved on Dodge Sprinter and on Dodge Ram for approved Government, Military and Commercial Fleets - B5 approved for all other diesel applications	B5 Factory Fill in place for Dodge Ram. Biodiesel fuel must meet ASTM D6751 or ASTM D7467 and fuel should be used within 6 months of production.	Click here for more info	8/13/2009
Cummins	B20	B20 Approval is for 2002 and later emissions-compliant On-Highway ISX, ISM, ISL, ISC and ISB engines. B20 is also approved for Off-Highway engines including:	Click here for more info Click here for info on Cummins 2010 diesel engines	5/4/2009

		engines		
		QSX, QSM, QSL, QSC, QSB6.7, QSB4.5, QSM Marine, QSM G-Drive. All 2010 Cummins engines will be B20 compliant.		
Detroit Diesel	B5	Biodiesel must meet ASTM D6751 and petroleum diesel must meet ASTM D975. Biodiesel should be sourced from a BQ-9000 Accredited Producer. Detroit Diesel is currently conducting research that may allow future B20 acceptance.	Click here for more info	8/13/2009
Fairbanks Morse	B100	B100 approved for use in Opposed Piston (OP) Model 38D 8 1/8 diesel and dual fuel engines for continuous operations. Biodiesel must meet ASTM D6751.	Click here for more info	2/1/2007
Ford Motor Co.	B5	Any recent-model Ford truck with a diesel engine can run on a mixture including up to 5 percent biodiesel (B5), but higher amounts are not recommended at this time. Ford is currently conducting research that may enable future B20 acceptance.	Click here for more info Ford 2008-09 Sustainability Report on Biofuels	8/13/2009
		Freightliner is a division of Daimler Trucks North America.		

- The engine should be well maintained and not consume lubricating oil at a rate greater than that specified by the engine manufacturer.
- The other terms and conditions specified below.

Table 1: Conditions for the EnviCat-DPF™

Parameter	Value
Application	Stationary Prime and Emergency Standby Power Generation and Stationary Prime and Emergency Standby Pumping
Engine Type	Diesel, with or without turbocharger, without Exhaust-Gas Recirculation(EGR), mechanically or electronically controlled, certified off-road engine with particulate matter (PM) emission levels less than or equal to 0.2 g/bhp-hr.
Minimum Exhaust Temperature for Filter Regeneration	The engine must operate at the load level required to achieve 400 degrees Celsius (°C) for a minimum of 30 minutes. Operation at lower temperatures is allowed, but only for a limited duration.
Maximum Consecutive Minutes Operating Below Passive Regeneration Temperature	300 Minutes
Number of Cold Start and 30 Minute Idle Sessions before Regeneration Required	10
Number of Hours of Operation Before Cleaning of Filter Required	1,500 when using diesel with up to 500 ppm sulfur, 2,000 when using Low Sulfur Diesel(<15ppm Sulfur).
Fuel	California diesel fuel with less than or equal to 500 ppm* sulfur or a biodiesel blend provided that the biodiesel portion of the blend complies with ASTM D6751 (15 ppm sulfur), the diesel portion of the blend complies with Title 13 (CCR), sections 2281 and 2282 and the blend contains no more than 20 percent biodiesel by volume.
PM Verification Level	Level 3 Verification: At least 85% reduction of PM.

* The 500 ppm diesel fuel sulfur limit required by this Executive Order shall be superseded by a 15 ppm diesel fuel sulfur limit as of September 1, 2006, as required by Title 13 CCR, section 2281.

The EnviCat-DPF™ consists of a catalyzed passive diesel particulate filter and a Dwyer 3000, Series AN 14, backpressure monitor.

This Executive Order is valid provided that installation instructions for the EnviCat-DPF™ do not recommend tuning the engine to specifications different from those of the engine manufacturer.

Changes made to the design or operating conditions of the EnviCat-DPF™, as exempted by ARB, which adversely affect the performance of the engine's

APPENDIX B

Climate Action Registry, Biodiesel Emissions
March 2007

Application Engineering Bulletin

Subject	This AEB is for the following applications:
Biodiesel Fuel Usage - Application Requirements.	☒ **Automotive** ☒ **Industrial** ☒ **Marine** ☒ **G-Drive** ☒ **Genset**

Date: May 13, 2008		AEB Number 21.73
Engine Models included: All (Diesel) Engines / All Markets (See Exceptions List by Market)		
Owner: Keith Nolting	Approver: per Procedure 9183OPS-04-10-01	Page 1 of 9

This AEB Supercedes AEB
21.73 dated November 7, 2007

Purpose:

The purpose of this AEB is to provide Application Requirements and Recommendations for the use of biodiesel fuel above B5 and up to B20 in the new installations of certain engine models prescribed by Cummins. This AEB lists certain applications that are not approved for use of biodiesel above B5. For B5 and below, no special treatment is required, provided that all biodiesel fuel blends are comprised of petrodiesel meeting ASTM D975 and B100 meeting either ASTM D6751 or EN14214.

Introduction:

Cummins Service Bulletin 3379001 outlines a number of items related to the use of biodiesel fuel:

Biodiesel terminology
Warranty and the use of biodiesel fuel in Cummins Engines
Requirements for using biodiesel fuel in Cummins Engines
Acceptable biodiesel fuel standards and biodiesel fuel supplier requirements.

The requirements and recommendations given in this AEB are specific to the use of biodiesel. It is assumed that all other fuel system installation requirements are being met as well, as described in the following AEBs:

AEB 24.10 - Fuel System - Industrial Application Installation Recommendations
AEB 21.33 - Automotive and Bus Installation Requirements - Fuel Systems
MAB 0.05.00-3/24/2004 - Engine Fuel System Installation - Marine
AEB 70.28 - Generator-Drive HPI-TP & PT Fuel System Installation Requirements

Installation Requirements:

For biodiesel blends above B5 and up to B20 the following requirements must be met:

- The engine model must be approved and listed in Cummins Service Bulletin 3379001, and the application must not be listed as disapproved in the market appendices of this AEB.

- All fuel wetted components should not contain the following materials, natural rubber, butyl rubber and some types of nitrile rubber (depending on chemical composition, construction and application). These materials may be particularly susceptible to degradation.

- Fuel tanks must be made from the following materials; aluminum, steel, fluorinated polyethylene, fluorinated polypropylene or Teflon. Large contact areas of copper, bronze, brass, tin, lead and zinc can cause deposit formations. The use of these materials and coatings should be avoided for vehicle fuel tanks. Fittings and connectors are acceptable.

- Fuel line tubing: Large contact areas of copper, bronze, brass, tin, lead and zinc can cause deposit formations. The use of these materials and coatings should be avoided for vehicle fuel lines. Fittings and connectors are acceptable.

- All OEM supplied fuel filter seal material must be comparable to Cummins Filtration (Fleetguard) fuel filters. See Appendix A for Details.

- Cummins is not in a position to evaluate the wide variety of non-metallic compounds with BioDiesel. If in doubt, contact your equipment vendor or OEM and ask if the equipment is compatible with BioDiesel.

Installation Recommendations:

ffi For adequate water separation, Cummins Filtration, StrataPore$_{TM}$ synthetic fuel filter media should be maintained as provided with the engine. If local conditions require additional water separation capacity, reference Table 1 for auxiliary filtration/water separation. Fuel flow rates can be found on the engine data sheet

ffi It is highly recommended that Water in Fuel sensors be installed on electronic engines.

ffi A fuel heater is recommended in applications where ambient temperatures are below -5 deg C (23 Deg F) and no cold weather fuel additives are available or will be used.

ffi Use biodiesel fuel within 6 months of its manufacture.

- Biodiesel has poor oxidation stability, which can result in long term storage problems. The poor oxidation stability qualities can accelerate fuel oxidation in the fuel system, especially at increased ambient temperatures. This is especially true in engines with electronic fuel systems, because they operate at higher temperatures. Biodiesel fuel should be used within 6 months of its manufacture. For this reason, Cummins Inc. does not recommend using biodiesel for low use applications, such as standby power or seasonal applications. Consult your fuel supplier for oxidation stability additives.
- If biodiesel is used for seasonal applications, the engine must be purged before storage by running the engine on pure diesel fuel for a minimum of 30 minutes.
- Care must also be taken when storing biodiesel in bulk storage tanks. All storage and handling systems must be properly cleaned and maintained. Steps should also be taken to minimize moisture and microbial growth in storage tanks. Consult your fuel supplier for assistance in storing and handling biodiesel.

ffi Due to some of the properties of biodiesel fuel blends, such as cold weather operation, long term storage, material incompatibilities and other effects on engine operating characteristics it is highly recommended that specified market applications are avoided or extra care be exercised. These include low duty cycle, intermittent operation applications. This AEB provides appendices by market which lists applications to avoid and other recommendations.

Appendix B: Industrial / Mining / Agriculture

Appendix C: Power Generation

Table 1. Auxiliary/Supplemental Filtration and Water Separator Products

Fuel Filter and Water Separator Recommendations based on Maximum Fuel Flow Requirements of the Engine.

The recommended product is a filter head that can be equipped with filter options (micron rating) depending on application requirements. Micron rating requirements can be found in the fuel system related AEB's listed in the Introduction section of this AEB. This is not a replacement for current filtration, rather a recommendation for auxiliary remote mounted filtration

	Gal/Hr	Lb./Hr.*	Recommended Cummins Filtration Product
Flow Rate	40	284	FH232
	50	355	FH230
	60	426	FH230
	80	568	FH230
	100	710	FH230+
	120	852	Dual FH234
	150	1065	Dual FH234
	180	1278	Dual FH234
	200	1420	Dual FH234

*Lb/Hr based on No. 2 Diesel fuel density of 850 g/liter [7.10 lb/U.S. gal] @ 25 Deg. C. [77 Deg F]

Recommended Product Cummins Filtration Part Number	**Filter Options**	**Micron**
FH232	FS19730	7
	FS19731	10
	FS19785	25
FH230	FS19624	7
	FS19727	10
	FS19728	25
FH234 and FH230[+]	FS19763	7
	FS19764	10
	FS19765	25

Appendix A: Compatibility for B20

Purpose:

The purpose of this document is to ensure that seal compatibility requirements are met for applications using B20 biodiesel. If an inappropriate seal material is used in biodiesel applications, accelerated material degradation leading to potential fuel leakage issues can occur. Cummins Filtration seals have been tested extensively in B20 to ensure there are no compatibility issues.

Introduction:

This specification establishes the approval requirements for filters used in B20 applications. Specifically, this document sets the testing criteria and requirements for filter seal materials in B20 applications.

Discussion:

ffi Laboratory Testing

- ffl Rubber materials will degrade with time, temperature and fluid environment. ASTM testing as specified by ASTM D 2000 callouts is for quality control information and shall not be used to determine long-term performance. The desired test method is outlined in the document.

- ffl Table A1: Aging Test Requirements for Rubber Seals and Table A2: Aging Standard Test Temperatures on page 3, outline the test requirements relevant to long-term performance at applicable temperatures and fluid environments.

- ffl Testing per Table A1 should be tested on the actual Filter Seal.

- ffl Table A2: Aging Standard Test Temperatures, specifies the temperature at which common materials shall be tested.

- ffl When source approving a new material, a control sample (a Cummins Filtration seal material) shall always be tested at the same time (side-by-side) as the proposed new material.

- ffl Test data for a new material shall be from three filters for all of the characteristics specified in Table A1: Aging Test Requirements for Rubber Seals.

- ffl Seal materials shall be heated at the given temperatures in the above given fuel for the specified time interval. Test methods referenced in table A1 shall be performed on seal samples both before and after heating at the given conditions in the given fluid.

- ffl Weight loss following aging in dry heat per ASTM D 573 in Table A1 shall be determined from specimens that have been desiccated for 24 ± 0.5 hours, before and after

air aging. Specimens shall be weighed immediately after each desiccation period. Results shall be calculated as follows:

- % Weight Loss = {(W1-W2)/W1} x 100 (EQ 1)

where: W1 = weight before age
W2 = weight after age

- Test Fuel Requirements

  - B20 Fuel – The test fuel must be composed of 20% fatty acid methyl ester. The fatty acid methyl ester must be of a base stock that meets ASTM D6751 (Examples are soy bean methyl ester or rape seed methyl ester). The fatty acid methyl ester base stock must also be produced by a BQ9000 accredited supplier. The final B20 blend must meet ASTM D975. This will allow for all types of biodiesel used globally but will drive consistency of the test fluid by requiring minimum quality specifications.

- Acceptance Criteria

  - Approving Filter Seal Material

    - New materials shall be tested in accordance with Table A1: Aging Test Requirements for Rubber Seals. The results of the new materials tests shall be comparable to a current Cummins Filtration Fuel Water Separator seal material.
      - Hardness change shall be + or – 5 % that of the Cummins Filtration seal material
      - Compression set shall be + or – 5 % that of the Cummins Filtration seal material
      - Volume change shall be + or – 5 % that of the Cummins Filtration seal material

Appendix A: Tables

B20 SME Fuel (ASTM D 471)	Hardness (ASTM D 2240)	Compression Set(1) (ASTM D 395)	Volume Change (ASTM D 471)	Weight Change (ASTM D 573)
168 hrs ± .5	X	X	X	

Table A1: Aging Test Requirements for Rubber Seals

Dry Heat	B20
125°C± 2	100°C± 2

Table A2: Aging Standard Test Temperatures

References:

a. FES 1544: Seals, Static, Rubber (Supplier Requirements, Fuel Applications)
b. ASTM D 297, Standard Test Methods for Rubber Products – Chemical Analysis
c. ASTM D 395, Standard Test Methods for Rubber Property – Compression Set
d. ASTM D 412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
e. ASTM D 471, Standard Test Method for Rubber Property – Effect of Liquids
f. ASTM D 573, Standard Test Method for Rubber – Deterioration in an Air Oven
g. ASTM D 975, Standard Specification for Diesel Fuel Oils
h. ASTM D 2000, Standard Classification System for Rubber Products in Automotive Applications
i. ASTM D 2240, Standard Test Method for Rubber Property – Durometer Hardnes

Appendix B: Industrial / Mining / Agriculture Recommendations

Due to some of the properties of biodiesel fuel blends, such as cold weather operation, long term storage, it is highly recommended that extra care be exercised in the following applications:

Application	Approved for Biodiesel	Recommendations	Comments
Cold Weather Equipment	Approved with Recommendations	Extra caution recommend for fuel handling and fuel conditioning.	Examples include snow blowers, ski-lift, logging equipment and snow groomers.
Seasonal Equipment	Approved with Recommendations	Flush fuel system with petroleum diesel prior to seasonal storage. Engine should be purged before storage by running the engine on pure diesel fuel for a minimum of 30 minutes.	Examples include crop harvesting equipment, agricultural sprayers, mowers and irrigation pumps.

Appendix C: Power Generation Recommendations

Due to some of the properties of biodiesel fuel blends, such as cold weather operation, long term storage, it is highly recommended that extra care be exercised in the following applications:

Application	Approved for Biodiesel	Recommendations	Comments
Emergency Standby	Disapproved	Use petroleum diesel only.	Low fuel usage and critical start nature of Emergency Standby make Biodiesel impractical.
Limited Time Prime	Approved with Recommendations	Use fuel within 6 months of manufacture. Flush fuel system with petroleum diesel prior to seasonal storage.	Biodiesel is suitable for constant high load operation (e.g. Peak Shaving) with proper precautions.
Unlimited Time Prime	Approved with Recommendations	Use fuel within 6 months of manufacture. Flush fuel system with petroleum diesel prior to storage/transport.	Biodiesel is suitable for variable load operation with proper precautions.
Continuous	Approved with Recommendations	Use fuel within 6 months of manufacture.	Biodiesel is suitable for base load operation with proper precautions.

Change Log

Date	Author	Description	Page(s)
May 13, 2008	K. Nolting	Clarification on Installation requirements regarding the materials used for fuel fittings and connectors.	Page 1-2
November 5, 2007	K. Nolting	Fuel wetted requirements changed to match Fuel Services Bulletin Changes. Requirements have been relaxed from must not contain to should not contain for some materials.	Page 1-2
July 3, 2007	K. Nolting	Added new Requirement and Appendix section for seal compatibility requirements	2, 4-6
March 21, 2007	K. Nolting	Initial Release of Document	All