AB679 Diesel Fuel Comparison Study Meeting – September 25, 2009

Panel Members Present: Thomas Durbin/UCR CE-CERT, Michael Tunnell/ATA, Roger Gault/EMA, Ken Kimura/WSPA, Dean Simeroth/CARB; Paul Wuebben/SCAQMD (Wuebben arrived after the start of the meeting, when test fuel properties were being discussed)
Teleconference: Charles Schleyer/ExxonMobil, Fred Cornforth/ConocoPhillips

Air Resources Board (ARB) Staff Present: Floyd Vergara, Jim Guthrie, Dean Simeroth, Aubrey Sideco, Robert Okamoto, Stephen d'Esterhazy

Public Present: Nick Economides/Chevron, Kim Waggoner/AIAM, Michael Berg/Innospec
Teleconference: Steve Howell/MARC-IV, Rasto Brezny/MECA, Jim Uihlein/Chevron, Morris Brown/TCEQ, George/NBB, Jordon Thaeler/NBB, Gina Grey/WSPA (Grey joined by phone, about 11:15 am, with the meeting in progress)

Handouts

- Federal Diesel Research Study Presentation – Tom Durbin, Sept 25, 2009
- Draft AB 679 Test Program Test Fuel Properties Spreadsheet
- Draft March 13, 2009 Meeting Minutes

Meeting and Presentation

Meeting started at 10:08 a.m.

Vergara opened the meeting with administrative announcements. All attendees and phone participants introduced themselves. Vergara made roll call of the Panel and a quorum was present.

The Panel reviewed the draft minutes from the previous meeting on March 13, 2009. Two changes were made as requested by Cornforth and Wuebben via email. Vergara asked for approval of the minutes with changes. Kimura stated that his name is Ken, not Kenneth. The minutes would be revised accordingly. Vergara asked for approval of the minutes with the correction to Kimura's first name, from Kenneth to Ken. Voted 7-0. Minutes approved.

Durbin began the presentation with an overview of the overall program plan (slide 2). The three fuels, CARB, Federal A, and Federal B, have been identified and obtained. Two of the three engines, 2007 MBE4000 and 2006 Cummins ISM, are part of the biodiesel program. The third engine is a 1991 DDC 60. These engines would be a part of the engine test program. The other part of the program would consist of chassis dynamometer testing of ten trucks, which includes three CARB vehicles. Testing will utilize the 50 mph Cruise cycle. Based on comments received, more replicates are preferred. Gault asked if the chassis driving cycle would be the same as the engine dynamometer testing. Durbin replied that chassis testing would focus on the 50 mph Cruise cycle. Tunnell then asked if Durbin and CE-CERT staff are focusing on that test cycle because it allows for more replication as opposed to other test cycles. Durbin

responded they wanted to test on the most aggressive testing condition to see larger variations. Tunnell asked about current testing under the biodiesel program and if assumptions are still valid. Durbin said he did observe smaller differences in the Cruise cycle compared to the certification cycle and that this will be shown later in the presentation.

Cornforth recommended using a driving cycle that would be representative of typical or average driving in California. Simeroth asked Cornforth what would be representative. Cornforth said that tests are developed using a series of test cycles and he has seen various test cycles in other forums. Gault asked for clarification on engine cycles. Durbin explained the Cruise and FTP cycles. He continued saying that the test sequence would be discussed later in the presentation. Tunnell requested for further clarification. Durbin said that the Cruise cycle would be conducted for both the chassis and engine testing programs.

Durbin continued discussing the status of the engine tests (slide 3). The fuel analyses are near completion. They are still waiting for cetane number results. Testing was complete on the first engine, MBE4000. Durbin stated that the results would be discussed later in this presentation. Testing on the second engine, 2006 Cummins, was completed a couple of days ago and the data are still being analyzed. Durbin stated there were complications and in some cases, the engine was operating in different modes.

Gault asked how testing could be done when the fuels have not been approved yet. Durbin replied that they would discuss the fuels in a couple slides. He said that testing on the third engine, DDC, would follow. They anticipate completion of testing and memorandum in the December timeframe.

Guthrie continued the presentation (slide 4) by discussing the analysis of the test fuels. Referring to the test fuel properties handout, he explained that the properties that the Panel approved in terms of determining the test fuels are on the left side of the handout. They selected specific properties, which happen to be the same properties as the EPA model for NOx and PM. The Panel approved the ranges to find the test fuels along with a backup range for the Fed A fuel.

Panel members asked where staff obtained the fuels. Guthrie stated the CA fuel was loaded from a refinery terminal and taken to a fuel distributor, drummed, and transported to Southern California. The Fed A fuel was a certification fuel, shipped from a refinery in drums. The Fed B fuel was drummed by a contractor at a service station.

Guthrie explained the handout and discussed the initial analysis of each fuel. Referring to the handout, the properties that are not within the approved ranges are highlighted. Guthrie said they do not have the cetane analyses yet. Based on the other properties they have, he believes the results will be within the range.

The Panel continued to discuss the fuels. They observed that the CA diesel fuel is slightly heavier than the Panel wanted. Guthrie said the tables on the right are ARB's fuel analyses. Original analyses were done at the refinery terminal. The Fed B fuel properties were not out of range. Cornforth stated that the sulfur content in CARB fuel is more representative of current supply when compared to historical data since pipelines have changed their regulations. Cornforth said that he could oversee another set of testing on the Federal diesels if ARB wanted more comparative analyses. Guthrie asked to send samples to Fred and that analyses would include cetane number. Durbin said he would send three samples of each fuel so each analysis would be done in triplicate.

Motion (Tunnell): Motion to send sample to replicate ARB analysis, 6 properties. Seconded (Gault). Unanimous approval. Motion carried.

Guthrie explained that the fuels obtained were reasonable, considering various obstacles and knowing the properties before buying them. Four properties, aromatic hydrocarbon content, API gravity, cetane number, and T50 (slide 5) work together. Other than the fact that they do not have cetane numbers for Fed B, the test fuels they have follow this ordering. They are consistent and have the properties that most strongly affect NOx emissions. There are consistent fuel correlations specifically with NOx. Guthrie believes the three fuels are acceptable even outside some fuel property ranges.

Gault stated that in the minutes from last meeting, they talked about the properties for the Fed A fuel. Guthrie responded that the Panel looked at the California fuel and the fuel they obtained was the California fuel. Both of the Federal fuels were from out of state. Gault clarified that the CA fuel, with discrepancies, reflects what the Panel approved in the previous meeting. Floyd answered yes and Guthrie added that they did not pursue Fed A fuel because they did not feel it was representative.

Cornforth said that Fed A is a certification fuel and that there are more properties typically listed for a cert fuel than the public fuels. He requested to see the whole list of properties of that cert fuel. Cornforth continued that he has qualms using cert fuel over a regular production fuel. When a company makes a cert fuel, certain blendstocks are available and may not naturally fit all of the specification parameters, thus modifications are needed to meet specifications. For example, if sulfur is low, it may be added but composition would not fit a natural makeup. Similar processes may be used to meet other parameters. He continued and asked if cetane was natural or an improver. Guthrie answered that he knows 95% of volume is straight refinery diesel blends. Simeroth asked if the table (analyses from El Monte lab) is confidential. The analyses would be shared among the Panel members.

Guthrie said the nitrogen content was extremely low at 4 ppm. Gault asked if the fuel came directly from the refinery and a participant asked if there were any additives. Guthrie responded yes to Gault and probably to the participant if the fuel is a cert fuel.

Wuebben arrived.

Economides said that the three deltas of API gravity, T90, and cetane concern him the most. He explained that they do not have a delta for cetane but have properties. Worse case, they should have deltas for two. If the fuel were to be tested without knowing cetane, they may end up with useless results. Bottom line: how do you proceed with testing until some of these issues are resolved? Until we see the cetane numbers, Economides suggested waiting before more tests are done. Guthrie said that three samples of each fuel would be tested at Southwest and three at Conoco Philips. Economides said they would get the results but testing would already been done. Tunnell stated another issue is the wide variations in aromatics. This was a concern.

Analyzing Fed A and Fed B, Guthrie said that since the test program looks at CA versus Fed, the Fed fuels are much closer to a representative Fed fuel. He believes the fuel is representative.

Simeroth stated management's decision to keep moving forward and that they were aware of the risk they were to take. Testing may need to be redone if necessary. Durbin explained that the first engine was tested only on the CARB and Fed B fuel. Time constraints were an issue with the 2007 engine because MTA had more testing to do on the vehicle. Tunnell said Fed A had been procured and some testing had already been done, but the Panel had not approved the fuel. Simeroth asked the Panel their impression of T90 for the Fed A fuel, assuming cetane is reasonable and sulfur issues are resolved. Gault was confused by its value and that it seemed strange. Economides felt that it was a tailored fuel and that the boiling range had been artificially weighted. It indicates a greater level of control than one would have. Kimura stated that for cert fuel it is expected. Economides said this creates additional questions and requires further thought. The Panel continued to discuss their concerns and that if CARB was compared to EPA fuel, Fed B fuel, it may not be fair on the EPA side. Simeroth stated that was not occurring. Guthrie explained T90 is lower and T10 is higher, but T50 is between CARB and Fed B so it appears reasonable. Simeroth explained that they simply were not successful in finding a perfect average fuel. Economides said he has been asking about the fuels but heard they already had candidates. He said they informed ARB that he would try to locate more fuels but was informed that the fuels were already obtained.

Simeroth explained it was struggle finding the fuels and taking this off the ground. Management was also faced with legislative pressure. Economides said if they do testing, and don't view a difference between CARB and Fed A fuel or observe a percent NOx increase from Fed B fuel, testing will need to be redone. Schleyer stated that he does not think Fed A is biased to be cleaner than originally designed. T90 is less while aromatics and cetane are higher, indicating it probably would not be cleaner. Wuebben stated that for Fed A, T90 is lower than planned but that fuels have varied above and below the range so this fuel might actually be the right average test Fed fuel. Gault stated it is within fall-back range. Guthrie said that they have the 1319 data on Fed B and both analyses on Fed A.

Economides reminded the Panel that they do not have cetane numbers and that the deltas are the important factor. If cetane numbers do not turn out and deltas narrow, there might not be enough differentiation, which is the objective of the program. Tunnell asked why the fuels were obtained when the Panel took time developing the specifications. The fuels are obviously not within the developed specs. It appears the fuels have already been chosen, even though it has not been presented to the group. Durbin stated they did not test the 91 series engine and that he does not expect to see complications with the cetane analyses.

The Panel continued to discuss the fuel and testing. Tunnell asked the Panel if they found the fuels acceptable or if new, more representative, fuels should be found within specs. Simeroth said they took a lot of time finding this fuel. They can check back with the suppliers. Economides said they could certainly proceed with testing. Tunnell wondered if this would take out the possibility of looking for and obtaining a better, more representative fuel.

Guthrie asked the Panel if the Fed A fuel seems too clean. Tunnell reminded the Panel that they spent a lot of time thinking of properties. Wuebben believed that ARB was careful in choosing the fuels. Wuebben said ARB demonstrated an abundance of caution and that the properties are certainly reasonable and balanced. Kimura continued stating that if sequencing were an important part of the test program, any new fuel obtained would require redoing all the tests and not just some. Simeroth stated that if the Fed A is unacceptable, they would need to repeat testing.

Economides asked how quickly they would receive the cetane analyses. Durbin explained the confusion within the lab and stated that the timeframe is uncertain. He said he would contact them on Monday or Tuesday for that information. Simeroth stated that they would acquire the cetane data for Panel consideration. Durbin said all re-testing might have to be conducted with fewer vehicles. Simeroth explained that additional funds might be available from lower priority programs. He reiterated the choice management made to move forward and explained the benefit even with the risk of repeating tests.

Wuebben asked the Panel if they perceive Fed A to be cleaner than in reality. Simeroth said if a good spread were apparent, he would not be worried. If something else looks unreasonable, however, Simeroth stated there would be a problem with the fuel and that it would need to be corrected. Durbin said it seems that ARB, through their process, vetted through all the possibilities and this was the best choice. He asked the Panel if ARB could find better fuel and explained that the task could be extended out to the Panel members. Simeroth said that an alternative is to go back to suppliers for more acceptable fuel or ask for help. They have two options.

Wuebben asked what would happen if Fed A and Fed B were blended in equal parts since in the real world blending occurs. The Panel answered that the fuel is closer to some properties but further from others. Guthrie said they focused on T90 that is lower

but T10 is much higher. PAH content is higher and so it may balance out. Guthrie said the Panel decided to look at T90 and therefore focused on T90. There are other properties as well.

Simeroth reiterated that the Panel needs the cetane numbers and list of properties. Gault asked Durbin if they would have the cetane numbers in two weeks and Durbin believed it was possible. A participant over the phone asked if ARB could set up a conference call to discuss the cetane results (**Action Item**). Simeroth acknowledged the request and said an informal conference call meeting would be arranged. Gault asked if they should approve a range to help facilitate everything and ensure certainty as the test program continues forward. Simeroth responded that they can feel confident going forward and that an informal conference call with the Panel is reasonable.

Gault asked if the Panel should approve deviations in the table, assuming the cetane results are within the expected range. The Panel can approve the rest of the numbers in the handout in front of them. Gault directed a question to the fuel experts, asking if they can make the determination or if a low T90 is a concern. Economides said they would have to see the cetane numbers but would not be concerned unless the deltas shrank by half. Wuebben said less than four would be the minimum delta, given everything else.

Motion (Gault): Motion that the Panel approve the Fed A fuel if the cetane number is within the range previously identified, 45 – 48.3 ppm. If not, the Panel will need to discuss further. Seconded (Kimura). Further discussion and clarification needed.

Economides explained they would need to see all cetane numbers and deltas. The Panel discussed the differential being at least four. Gault proposed amending the motion to include the differential for cetane number to a minimum of four and for the cetane numbers to be within their respective ranges. It is more restrictive than the original but is still in line with the preliminary data. Gault was concerned that there may be too big of a separation if the values went above eight. The initial range was from two to eight. Within these ranges, they would still have to approve the fuel but the delta constraint would support what was needed. Tunnell asked if cetane would be a concern or if sulfur and T90 would be an issue. Kimura did not believe so.

Tunnell asked for clarification regarding the last meeting and discussed the fall-back values and ranges. Guthrie said that the fall back range is based on the actual properties from the test fuel. Referring to the tables on the left side of the handout, the deltas ranged from four to eight while the previous deltas ranged for two to eight. Economides stated the need to narrow the range to four to eight. Tunnell asked for clarification on the handout from the last meeting. He was not sure how the fall-back minimum and maximum line up. Guthrie said to take the fall-back ranges and apply it to the CA test fuel analysis to get the fallback range. That is why the range is from four to eight.

Amended Motion (Vergara): Motion that if delta and cetane between CARB and Fed A is at least four and the cetane values are within their respective ranges, then ARB proceeds with testing. Seconded (Kimura). Voted 8-0. Motion carried.

Gault requested for an informal discussion on cetane. Simeroth said that ARB would take it upon themselves to set up the conference call. Simeroth reiterated that they had to start testing and make a decision. They took the risk.

Wuebben asked if refiners would ever need to spike the fuel to meet T90. Simeroth said the information is confidential and would need to be discussed individually offline.

Durbin continued the presentation (slide 6). He discussed the status of the chassis dynamometer testing. Almost everything is in place and meets current plans for the Nov/Dec timeframe, with commissioning in Jan 2010. Complications arose from campus involvement. It has taken some time to get through processing and is currently working on the bid. The dynos have all the motors so they are waiting for UC Riverside to move forward with that. They are looking at ten vehicles to magnify the number of replicates. Two trucks are part of the biodiesel program while a third is CE-CERT's in-house truck. A matrix would need to be developed for the other seven vehicles. They are working with the ports and have started communication with the carriers. The carriers would be able to provide a couple of vehicles for the study. Cornforth asked if most ports have rules requiring vehicles to be updated with aftertreatment systems in the near future. Durbin responded yes and said he is communicating with the carrier companies. Cornforth concluded that the same rule does not apply to non-port vehicles. Durbin responded yes and said they would have a broad spectrum of vehicles. Simeroth said many trucks that have aftertreatment are natural gas fired. Gault stated that it is not a part of this program and suggested a vehicle list. Durbin will work with Guthrie on the list of vehicles (**Action Item**).

A phone participant commented that the general population of trucks modeled in the program should be reflective of trucks present on roadways in the next two to ten years. Simeroth said they would honor the comment to the extent they can. Gault stated, as the Panel, the makeup of the remaining seven is reasonable, and that a certain number should conform to 07-09 standards while other should reflect 02-06 standards. It should not be all 2002 and earlier model year vehicles, for example. Simeroth acknowledged the recommendation and stated that together they would start discussion on the test vehicles. Simeroth added that at the end of the day, the vehicles included in the program would be representative of what would be seen in the next ten years. Maybe they can get a vehicle that is retrofitted. Grey (joined the meeting via telephone after 11:00am) said that looking into the future, if they are trying to determine what might be used, based on the LCFS, the types of fuels would include biodiesel, renewable diesel, etc. She asked if testing would still be relevant. Simeroth responded yes because these fuels would be the fuels blended into petroleum diesel.

Durbin continued the presentation (slide 7). The Panel discussed the engine parameters for the 2007 MBE4000, 2006 Cummins ISM, and the 1991 Detroit Diesel.

Wuebben asked if the engines are all passive regeneration traps. Durbin said that the 2007 is active but that the test sequence forces regenerations between tests to minimize factor. Durbin further clarified that testing on the 2007 engine is only during non-regenerative periods.

Durbin continued to discuss the engine dynamometer test-matrix (slide 9). For the 2007 engine, regeneration occurs between each fuel change. Wuebben asked if there would be differences. Simeroth said they could get these ranges to MSCD and have them design how to resolve the regeneration issue. Gault stated regeneration is a bigger concern in the biodiesel program than in this fuels program. Gault said regeneration is specific to the 2007 engine, and that if they try to characterize regeneration with industry, everyone has their own methodology. The Panel is unsure if 2010 vehicles will improve or decline. Kimura said they could do what was done in the biodiesel program, address regeneration as an issue, but they cannot do address regeneration in this program. Economides said they have done everything they can do. Gault mentioned another possibility of measuring regeneration emissions with CERT but it is expensive and time consuming. Wuebben added that there is a resource limit to the testing. They cannot address this issue but can highlight this as test data that does not include any information about regeneration impacts and recognize that there is uncertainty. Regeneration is an important limitation of the study that needs identification so the reader is aware of that limitation. Simeroth expressed appreciation for the comments.

Durbin continued discussing the 2007 MBE4000 results. He said that the results were as what they would expect. NOx is higher for Fed B fuel compared to CARB fuel. PM, THC, and CO is low. CO2 showed a slight increase for Fed B (tailpipe emissions) but fuel consumption was slightly lower. Wuebben answered it may or may not be statistically significant and Durbin agreed. Simeroth stated that the slides need to be labeled as draft. Durbin continued explaining the NOx results (slide 11) and pointed out the small error bars. He continued to slide 12 and presented the actual values from slide 11. The table is blank for Fed A because they did not test the fuel yet. Simeroth stated they are not ready to make conclusions on this data yet. Durbin continued to discuss the CO2 emissions, corresponding graph and actual results (slides 13 and 14). On slide 13, there were some distinguishable differences. Durbin explained his observation that the higher aromatic fuel has higher CO2 emissions.

Durbin discussed the BSFC results (slide 15). The results show lower fuel consumption from Fed B. He notes that the BSFC units are gal/bhp-hr. Tunnell said when an engine is certified, it is certified with FTP. He asked if they looked at how it stacked up with the cert fuel. Durbin said it is higher than cert values, which show 1.1 while they results show values closer to 1.2 gal/bhp-hr. He said he could not remember the exact numbers but were slightly higher. Tunnell asked if he has any idea regarding the others. Durbin responded they have CO2 emissions and he thinks it is within 10%.

Durbin asked the participants if they had any further questions. Gault asked when they would have the Cummins data. Durbin responded, the end of October.

Before the close of the meeting, Vergara announced the following action items:

1. Distribute ARB lab analyses of test fuels (include all properties)
2. Send fuels to Cornforth, who agreed to do testing to confirm results
3. ARB will set up a conference call to discuss cetane numbers if results are outside the approved ranges
4. Will start makeup of what the fleet should look like for the vehicle testing.

Simeroth added that for the selection criteria for the vehicles, they would look for newer vehicles to represent the future as best they can. Vergara thanked the Panel and meeting participants for attending the meeting and stated that they will follow up with the action items listed.

Meeting adjourned at 12:04 PM.