

From: <rainsbjl@songs.sce.com>
To: <nxx@nrc.gov>
Date: 8/15/2006 3:03:38 PM
Subject: Evaluation of change to Ultra Low Sulfur Diesel Fuel Oil

Kaly

For your information, below is the technical evaluation that looked at the acceptability of the ULSD fuel. It looked at the effect of ULSD on the various aspects of the diesel generators. The conclusions of this evaluation supported the 50.59 screen that was prepared to support the Engineering Change Package for the fuel oil change.

Jack

1) PURPOSE

The purpose of this technical evaluation is to justify the acceptability of using Ultra Low Sulfur Diesel (ULSD) fuel oil in the Emergency Diesel Generators at SONGS Unit 2 and 3. This evaluation also covers all the identified technical issues resulting from the addition (mixing) of ULSD fuel to existing California Air Resources Board (CARB) diesel fuel.

2) BACKGROUND

SONGS converted to CARB fuel in 2002 to meet State of California emissions requirements (Ref #2, AR 011101320). CARB fuel was formulated to have a lower aromatic content, which has the effect of reducing the sulfur content in the fuel and increasing the API gravity (reducing the specific gravity). In June 2006, the State of California will require all diesel engines operated in the state to be using ULSD fuel as required by California Code of Regulation Section 2281-2285. ULSD as the name implies is reduced in sulfur content (nominally 150ppm for CARB to ≤ 15 ppm for ULSD) so that emission particulates can be reduced.

3) PROCESS DESCRIPTION

There will be no deviation from normal diesel fuel filling and storage operations. State regulators only require that ULSD diesel fuel be in use by June 2006 and does not require existing inventories to be replaced. As a result, the ULSD fuel will be added to the storage tanks as needed during normal fuel inventory management activities.

4) TECHNICAL CONSIDERATIONS

4.1) ULSD fuel energy content

The conversion over to CARB fuel required a change to Technical Specification 3.8.3 (PCN-531) for increased fuel inventory requirements due to the reduced Lower Heating Value (LHV) of the CARB fuel. Fuel specifications provided by our current fuel vendor, ARCO, indicates that ULSD fuel has the same typical specific gravity (American Petroleum Institute, API 38) as CARB fuel. Per Att 1 in calculation M-0016-008 "DG Onsite Fuel Oil Requirements," diesel fuels with the same specific gravity have the same heating values. Per our current fuel vendor ARCO, the current chemical formulation of ULSD and CARB are identical with the only different property being a reduced level of sulfur content in ULSD (Ref 1).

Variations in specific gravity or variations in fuel quality, thermally induced volumetric changes, atmospheric conditions, engine wear etc. and their effect on diesel fuel consumption are captured in the 10% additional fuel margin maintained in the storage tanks per ANSI N195-1976/ANS 59.51. Based on the heating value similarities of CARB and ULSD fuels, changes to EDG fuel consumption rates will not happen and changes to fuel inventory requirements are not required.

4.2) ULSD fuel chemistry

SONGS is required to meet the criteria of Tech Spec 3.8.3.3 for establishing whether diesel fuel to be used in the EDGs is of the appropriate grade and does not contain contaminants that could be detrimental to engine performance. Tech Spec Basis 3.8.3.3 basis criteria for fuel chemistry are based on the fuel properties specified in Table 1 of ASTM D975-81, API gravity per ASTM D287-82, and particulates per ASTM D2276-83.

ULSD fuel, treated (with stabilizer and biocide) and untreated used in the liner soak test (see section 4.5) was tested at Saybolt Labs for compliance with SO123-III-6.6, "Diesel Fuel Oil Testing Program". All of the fuel test results were within the specifications of SO123-III-6.6, and the results were consistent with new CARB fuel currently delivered to SONGS. Results also indicate that there is no difference between treated and untreated fuel (stabilizer and biocide added by SONGS). Comprehensive results on ECD fuel (ECD is Emission Control Diesel and is a trademark name for ULSD from ARCO our current fuel supplier) as tested at Saybolt Labs are in AR 030600847-03. The table below is a comparison of a typical sample of CARB fuel (see ref 1) and treated ULSD after being used in the liner soak tests and indicates that no changes to the SONGS current diesel fuel oil program are warranted.

Test Limit	Method	CARB fuel				
ECD Fuel	Limit					
Water and Sediment	ASTM D1796	0%	0%	#0.05%		
Kinematic Viscosity	ASTM D445	2.458	2.642	1.9 - 4.1		
Particulate Contamination	ASTM D2276-83A	0.6 mg/L	<1mg/L	#10		
API Gravity	ASTM D287-82	38.5	39.7	27 - 42		
Flash Point	ASTM D93	144EF	150 F	\$125EF		
Cloud Point	ASTM D2500	+14EF	20 F	#25EF		
Distillation Temperature	ASTM D86	614.7EF	624 F	540 - 640EF		
Ash	ASTM D482	<0.001 wt%	<0.001%			
#0.010 wt%						
Carbon Residue (10% bottoms)	ASTM D524	0.08%	.11%	#0.35%		
Sulfur	ASTM D4294	0.017 wt%				
<0.015%	#0.50 wt%					
Copper Strip Corrosion	ASTM D130	1A	1A	#No. 3		
Cetane Index	ASTM D976 (calc)	52.0	52	\$40		
Accelerated Stability (not T.S.)	Octel F21-61	1	1	<7		

4.3) ULSD fuel lubricity and effects on engine components

Diesel fuel in the fuel system of the EDGs is used to lubricate moving parts within the fuel system and provide cooling to the fuel injectors. The

lubricity of a given diesel fuel is directly related to the amount of sulfur contained in the fuel with lubricity decreasing with lower amounts of sulfur. Although sulfur content of ULSD is ten times lower than CARB fuel, the lubricity characteristics of the fuel remains comparable due to a lubricity additive being added to the fuel during the refining process. California Code of Regulations Section 2284 Title 13 gives minimum lubricity requirements for ULSD. In particular, the code specifies a maximum wear scar diameter of 520 microns when performing lubricity tests per ASTM D 6079-2 the High Frequency Reciprocating Rig (HFRR) test. Per ref 2, Southwest Research Institute performed this test with CARB fuel and obtained larger wear scars (.605 and .550 microns) that were evaluated by SONGS personnel and found acceptable for SONGS EDGs. Per ASTM D975-01a, wear scars above 600 microns might not prevent excessive wear.

ARCO has added a lubricity specification to their ULSD fuel. This specification is provided to assure compliance with minimum lubricity requirements in the California regulations. ARCO's specification is a minimum of 3100g, according to ASTM test method D 6078, scuffing load ball-on-cylinder lubricity evaluator (SLBOCLE) which also allows their ULSD to meet the state requirements of 520 microns per ASTM D6079-2. The 3100g value is also recognized in ASTM D 975-01a (standard specifications for diesel fuel oils) as providing sufficient lubricity in all cases. All ULSD that SONGS will purchase is going to provide lubricity that meets or exceeds the lubricity requirements of SONGS EDGs.

Nitrile elastomer seals in the fuel system can be affected by a reduction in sulfur content in diesel fuel. The associated problems with sulfur reduction in the fuel oil are hardening and subsequent loss of sealing capability. This issue was addressed in Ref 2, AR 011101320, and an action to remove nitrile seals in the fuel system and replace them with Viton was performed. Viton is not affected by changes in fuel sulfur content and all seals in the SONGS EDG fuel system are Viton.

ULSD fuel will not have a substandard lubricity quality due to the requirements in California state law, nor can it have an adverse affect on engine elastomer seals. As a result, internal engine components in the EDGs will not be adversely affected and no further testing of the fuel is required for use in SONGS EDGs.

4.4) Conductivity of ULSD fuel

Diesel fuel conductivity as stated in ref 2 is primarily an issue in colder climates where ambient air humidity is low, typically below 50% relative humidity. Fuel blends in colder climates tend to be blended with kerosene to improve low-temperature handling which increases volatility and propensity to form mist or vapor that can be detrimental in a electrostatic discharge. Such cold weather conditions will not happen here and such fuel blends are not available here at SONGS and are not a concern related to use of ULSD fuel. Even though ARCO has a conductivity fuel additive in their ULSD, fuel specifications for ULSD fuel on the West Coast do not have conductivity specifications or pour point specifications (temperature at which wax precipitates out of the fuel-typically minus 30F) like ULSD fuel blends have in the Midwest and East Coast (this is a change since the issuance of ref 2). Fuel refiners process ULSD fuel to meet handling requirements in their respective marketing areas.

Other fuel characteristics that have an effect on the safe handling of

diesel fuel are consistent with existing fuel characteristics of CARB fuel. Such properties like distillation temperature, which effects volatility, and flash point that can affect safe handling of diesel fuel, are unchanged from existing SONGS diesel fuel. Furthermore, SONGS diesel fuel and storage system is designed to ANSI N195 -1976 standard, which is referred to in Reg Guide 1.137. Paragraph (g) section 7.5 of the Reg Guide 1.137 clearly states that the "... cathodic protection system should be designed to prevent the ignition of combustible vapors or fuel oil present in the fuel oil systems..." Fuel transfer operations at SONGS are performed with the use of grounding cables between the fuel truck and a station ground. The fuel transfer connection point is a metal-to-metal contact, which prevents the possible electrical potential build-up between our equipment and the delivery equipment. The acceptable ULSD fuel chemistry properties that can affect fuel handling and design of SONGS fuel system makes the introduction and use of ULSD acceptable for use in SONGS EDGs.

4.5) Compatibility of ULSD fuel with underground storage tank liner

SONGS underground fuel oil storage tanks have a 125 mil thick interior lining made of Bridgeport Glass Armor GA 27, two-part epoxy coating. This lining was an environmentally mandated tank upgrade. The compatibility of the tank lining with ULSD fuel was assessed in AR 030600847. Liner soak testing by the coating test vendor (PO 8D023922) was performed in the same manner as the liner testing in ref 2. This testing was done as specified in American Petroleum Institute (API) Recommended Practice 1631 which includes:

ASTM D790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Insulating Materials

ASTM D2794: Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) Testing

ASTM D2583: Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

ASTM D543: Standard Test Method for Resistance of Plastics to Chemical Reagents

ASTM D4541: Standard Test Method for Pull-Off Strength of Coatings using Portable Adhesion Testers

The final results of the testing indicates that "the immersed Glass Armor 27 showed no significant change or degradation following immersion in either treated or untreated (with stabilizer and biocide) ECD-1". Since the chemical formulation of ULSD and CARB are the same, with the same coating testing results, a mixture of the two fuels will have the same properties of either fuel individually and will not adversely affect the tank liner. ULSD or a mixture of ULSD and CARB will not have an adverse effect on SONGS underground storage tank liner and is therefore acceptable for use and storage in the underground fuel oil storage tanks.

4.6) Fuel transfer system components

The fuel oil transfer system is constructed primarily of carbon steel (ASME SA-106 Grade B) schedule 80 material. The fuel transfer pumps are made of primarily the same grade of carbon steel, with some of the pump internals constructed of bronze (ASTM-B-584-937), which is used for pump shaft bushings and cast housings. The wetted metallic surface areas of the fuel transfer pump and piping are not subject to any type of credible attack from the diesel fuel itself.

Fuel transfer pumps do contain some nitrile seals, at the suction bell housing and in the pump columns (2 joints). The nitrile seal in the suction bell housing is well below the usable fuel level in the storage tank, so its failure could never affect pump suction. The two nitrile AO@ rings in the pump column joints are within a machine-fit flange and see very low to no pressure. Failure of these AO@ rings is unlikely due to low pressure in the pump column and static nature of the column joint. Any leakage at these joints would be captured in the pump performance monitored in the IST program. As a result, these seals were not replaced in preparation for the introduction of CARB fuel and the introduction of ULSD fuel does not warrant their replacement. The redundancy of the fuel transfer system, robust design and individual pump scrutiny provided by the IST monitoring program makes the fuel oil transfer system extremely reliable and fully capable of transferring ULSD fuel or any other mixture of fuel oil consisting of CARB and ULSD. ULSD fuel will not hinder the ability of the fuel transfer system to transfer fuel oil.

4.7) ULSD compatibility with engine lubricating oil

An important function of engine lubricating oil is to provide chemical protection to vital engine components exposed to engine combustion byproducts. Internal combustion byproducts in the form of ash deposits in the combustion chamber can be generated by the use of lubricating oil that is not compatible with the fuel oil. In particular, lubricating oil with large alkaline reserves or Total Base Number (TBN) used in conjunction with low sulfur fuels can form ash deposits in the combustion chambers.

The engine manufacturer, Electro Motive Diesel (EMD), has assessed compatibility issues with the wide variety of fuels and lubricants available on the market. The results of this compatibility study are captured in Maintenance Instruction 1760 which provides guidance on acceptable fuel sulfur content and TBN levels in lubricating oil when used in the same engine. The use of ULSD fuel, or a mixture that includes CARB fuel, with our current lubricating oil Mobilgard 450 NC, meets the compatibility criteria in MI 1760. ULSD fuel is therefore acceptable to use with SONGS current lubricating oil.

4.8) EDG performance with ULSD fuel

As stated previously in section 4.1 the API specific gravity for ULSD fuel has a nominal value of 38. This API 38 value is typically the same as that of our currently used CARB fuel. The EDG performance issues in Ref 2, AR 011101320, addressed the change in heating value of CARB diesel fuel. As the heating value is proportional to the API gravity, the ULSD fuel has an equivalent heating value to that of CARB fuel. As a result there will not be any anticipated changes to engine performance from the introduction of ULSD fuel.

4.9) Long-term storage of ULSD/CARB fuel

Long-term storage properties of ULSD fuel are substantially similar to that of CARB fuel. As stated in section 4.2, ULSD fuel meets all the requirements in SO23-III-6.6 "Diesel fuel oil Testing Program". The current fuel oil testing program includes a test that is an accelerated fuel oil stability test (Analytical Method F21-61) which is used to determine fuel stability, a critical fuel quality for long-term storage. Program limits are to obtain a value less than 7. Testing results per AR 030600847 indicate that treated and untreated ECD (ULSD) fuel tested both to a value

of 1. Per ref 2 this is the identical test value obtained for both treated and untreated CARB fuel.

For the purpose of determining the compatibility of ULSD and CARB fuel when mixed together, a series of tests were performed. Per AR 050300024-02, Southwest Research Institute (SWRI) performed ASTM Method D6468-Standard Test Method for High Temperature Stability of Distillate Fuels. This test was recommended by SWRI as the test that would provide the best indication of fuel compatibility. Samples of ECD (ULSD) and CARB were prepared for testing in the various stated combinations below with the following results:

Sample	%
Reflectance, filter pad rating	
ECD - Untreated	100
ECD - Treated	99
CARB - Untreated	99
CARB - Treated	100
50/50 ECD - CARB - Untreated	99
50/50 ECD - CARB - Treated	99
90/10 CARB - ECD- Untreated	99
90/10 CARB - ECD- Treated	100

The fuel samples were aged for 180 minutes at 150 deg C; Samples were then filtered and the average amount of filterable insolubles was estimated by measuring the light reflectance of the filter pads. The results indicate no difference (within the precision of the method) between any of the results. This would indicate no differences in thermal stability or possible storage stability of the raw fuels vs. a 50/50 mixture or 90/10 mixture of the fuels. This test information supports concurrence by the fuel vendor that CARB and ULSD are fully compatible because they are the same fuel formulations. This information supercedes information previously on the subject of mixing fuels that is contained in AR 040301409. As a conservative measure, the first ULSD fuel addition will be into a single fuel storage tank and accelerated testing performed on the fuel to assure their will be no complications with mixing of fuels. The use of ULSD or a mixture of ULSD and CARB will not have an impact on fuel storage practices here at SONGS and poses no new diesel fuel ageing issues that are not monitored in the diesel fuel oil testing program. ULSD or a mixture of ULSD and CARB is acceptable for use at SONGS.

5) CONCLUSION

This evaluation of ULSD fuel with or with out the presence of CARB fuel and the past evaluation performed for the use of CARB fuel indicates that there will be no negative impact on the SONGS EDGs with the introduction of ULSD fuel. SONGS EDG will be able to perform their design basis function using ULSD fuel or a mixture of CARB and ULSD.

Critical issues that could have affected SONGS EDG have been analyzed and determined to have no negative impact on the engine or the fuel storage and transfer systems. The fuel chemistry meets all fuel oil requirements and in particular the energy content is the same as the currently used CARB fuel. The similarities of the ULSD to CARB and preventative measures performed on the engine to allow the use of CARB, apply equally to the use of ULSD. As a result, there are no new required actions needed to make the EDG system ready for the introduction and use of ULSD. Based on past experience with CARB fuel, the similarities of ULSD and CARB, and the evaluations performed

on ULSD and various mixtures of CARB and ULSD, the introduction and use of this fuel has been found acceptable for use at SONGS.

CC: <rainsbjl@songs.sce.com>, <mcgawnmm@songs.sce.com>

Mail Envelope Properties (44E21A7A.2A3 : 12 : 8867)

Subject: Evaluation of change to Ultra Low Sulfur Diesel Fuel Oil
Creation Date 8/15/2006 3:00:53 PM
From: <rainsbjl@songs.sce.com>

Created By: rainsbjl@songs.sce.com

Recipients

nrc.gov
OWGWPO04.HQGWDO01
NKK (N. Kaly Kalyanam)

songs.sce.com
mcgawnmm CC

Post Office
OWGWPO04.HQGWDO01

Route
nrc.gov
songs.sce.com

Files	Size	Date & Time
MESSAGE	19445	8/15/2006 3:00:53 PM
Mime.822	21143	

Options

Expiration Date:	None
Priority:	Standard
ReplyRequested:	No
Return Notification:	None

Concealed Subject:	No
Security:	Standard