PARSONS ENGINEERING SCIENCE, INC.

MEMORANDUM

June 14, 1995

To: Phil Nixon

From: Michael Glade

Subject: Asphalt Materials for the OU4 IM/IRA

Due to the concern raised by EG&G regarding the performance of "refined" asphalt materials in the OU4 engineered cover, I have conducted some research into the use of "natural" asphalts as a substitute. I have had phone conversations with the following people regarding the products available and the expected performance of these products in the asphalt concrete or as the top seal coat on the asphalt concrete.

Dr. David Jones (PRI Asphalt Technologies: 813-621-5777)

Dr. Jones informed me that the mass loss and volatilization of the asphalt cement are a function of the processing of the asphalt cement and not the exposure of it to the elements. Hence, the only degradation mechanism after placement is oxidation, not volatilization.

Dr. Jones was personally involved with the $150 Million Strategic Highway Research Program (SHRP). He specifically investigated the aging of asphalt materials. Dr. Jones stated that temperature will be the primary factor controlling oxidation. He believes that a constant temperature of 58 °F is so low that little oxidation will occur. He also stated that the SHRP found that oxidation is exponentially affected by temperature.

When asked his opinion of the performance of a blended asphalt as the liner, Dr. Jones responded "in my opinion, will it last for 1000 years...yes, will it crack...no." Dr. Jones recommended that a refined high quality Venezuelan crude oil based asphalt be blended with Trinidad Lake Asphalt (TLA). In this case, a workable and durable hot mix can be obtained. Dr. Jones expressed no concern in using either a high quality "refined" or "natural" asphalt in our design.

Dr. Jones also stated that he had detailed discussions with a Mr. Bob Romine of Battelle regarding the use of asphalt materials for their prototype cover at Hanford. He said he would be surprised if the Hanford people did not support the use of asphalt materials for a long-term cover system.

In subsequent conversations with Dr. Jones, he recommended that we purchase the SHRP document SHRP-A-368 entitled Binder Characterization and Evaluation, Volume 2: Chemistry. Dr. Jones again emphasized the importance of considering that the aging process of the asphalt will be highly temperature dependent. Dr. Jones also stated that he believes a SAMI (Stress Absorbing Membrane Interlayer) is not required. Dr. Jones also reemphasized that an air void ratio of 0 percent may be desirable, but is highly unlikely due to field and mix conditions. He stated that an air void ratio under 4 percent should be more than acceptable.

Parsons ES has purchased document SHRP-A-368. Some general findings of SHRP-A-368 include the fact that asphalts contain varying amounts of natural oxidation inhibitors, probably phenols; the aging characteristics of asphalts are a function of their physical state and therefore aging is temperature dependent; the relative strength of chemical associations within the asphalt are temperature dependent; and the effects of accelerated reactions to simulate aging on asphalt properties must resemble the effect of years of service under the same properties. Further review of documents SHRP-A-367, 368, 369, and 370 will be conducted in the future. It is hoped that these documents can reduce the amount of research required under this project, or at least direct the scope of any additional supporting research or testing programs.

Rick Bird (Petro-Source: 801-322-4750 X223)

Petro-Source is a supplier of TLA. Rick believes that the TLA must be blended with a "refined" asphalt in order to produce a workable asphalt that will not be overly stiff at low temperatures. Rick stated that a high quality "refined" asphalt must be obtained for blending. Rick confirmed that TLA consists of 38 percent silica sand. However, he also stated that 90 percent passes the No. 200 sieve (making that portion a silt or clay material).

Rick stated that he had worked with Battelle on the Hanford project and that they were in agreement that a high quality "refined" asphalt should be added to the TLA.

Ron Barbetta (Zigler Chemical: 800-883-4959)

Zigler Chemical is a supplier of Gilsonite asphalt. Gilsonite is a "natural" asphalt with a very low penetration number (very stiff at lower temperatures). Ron believes that Gilsonite should be blended with a "refined" asphalt in order to create a workable hot mix that can be constructed in the field.

Ron stated that his company has supplied "refined" asphalts to the nuclear power industry for the encapsulation of radioactive materials. He stated that extensive research and review went into determining the resistance of the asphalt to salt water and general aging processes. He said it was determined that the asphalt was expected to have a long life expectancy, while sufficiently containing the radioactive materials.

Larry and Tom (Conoco: 303-288-6861)

The Conoco representatives first pointed out that all "refined" asphalts are not created equal. They indicated that it is important to determine the characteristics of each asphalt prior to utilizing it in a mix.

Larry and Tom recommended a polymer modified asphalt. A polymer modified asphalt (such as Deery Oil's Membrane 6) is stiffer than a normal asphalt, yet still offers excellent workability. They believed that the durability of a polymer modified high quality asphalt would be as good as TLA.

Dr. Scott Schuler (Colorado Asphalt Paving Association: 303-741-6150)

Dr. Schuler indicated that the penetration numbers would be too low for the TLA to be used as the sole asphalt source. The stiffness of the material would make the mix unworkable. Dr. Schuler stated that the primary factors that would lead to the degradation of the asphalt concrete would be exposure to air, sunlight, and water. He suggested that the cutting-edge age testing we should investigate would be the SHRP.

Dr. Schuler believes that temperature and thermal changes are one of the leading problems in the breakdown of an asphalt concrete. He stated that we will not see any significant temperature changes and, therefore, will be under a constant stress. Dr. Schuler stated that the chances of significant cracking are very low. Dr. Schuler also stated that in order to reduce the impacts of air and water, he would suggest sealing the top of the asphalt concrete.

Bob Romine (Battelle)

Bob Romine of Battelle contacted Parsons ES after Dr. Jones had talked with him regarding our questions and concerns. Mr. Romine has worked with both Dr. Jones and Mr. Mancini during the prototype cover design and construction at Hanford. Mr. Romine indicated that he believed a refined Venezuelan crude would be difficult to find. In fact, he stated that the SHRP had a difficult time finding a Venezuelan crude. Mr. Romine stated that, in his opinion, we would gain little by substituting a Venezuelan crude derived asphalt. Mr. Romine indicated that he has extensively investigated the types of and uses for different asphalt types. He stated that the performance and physical properties of the asphalts converge over long periods of time and also converge when under low temperature conditions. Figure 8.16 (attached) from SHRP-A-368 supports this trend. Mr. Romine believes that some air voids are needed in order for the asphalt concrete to effectively disperse stresses that may develop due to loading or slumping of the layer. Mr. Romine agreed that a test pad and further testing could be effective in supporting the research performed for the prototype cover at Hanford.

John Mancini (Deery Oil, Inc.: 1-800-495-4637)

Mr. Mancini has conducted his own research since the June 1 meeting and has indicated that Deery Oil, Inc. can incorporate a Venezuelan grade crude asphalt into their asphalt membrane. However, research on optimizing the membrane mixture to meet project requirements would be necessary. Mr. Mancini also indicated that Venezuelan crude costs more and will ultimately raise the cost of the Membrane 6. John also believes that it may be difficult to get a processed Venezuelan crude in the United States.

In order to confirm that the asphalt materials used in the asphalt membrane and asphalt concrete will meet both aging and constructability criteria, a number of areas should be more fully investigated. A "natural" asphalt can not be simply substituted for a "refined" asphalt due to the need to consider constructability, hydraulic conductivity, and stability issues.

It is recommended that SHRP Report A-368, "Binder Characterization and Evaluation, Vol. II-Chemistry", by the National Research Council, Washington, D.C. be reviewed prior to conducting future research.

If it is believed that a "natural" asphalt must be either used in the Membrane Six material or must be completely substituted for Membrane Six, several issues must be investigated. These issues include:

1) determining if a "natural" asphalt can be blended and applied as a fluid applied asphalt;

2) determining if a "natural" asphalt can be hand applied (by trowel or spreaders) while retaining low hydraulic conductivity, and quality control; and

3) determining if a "natural" material will excessively creep under the imposed loads of the cover.

If it is believed that a "natural" asphalt must be used in the asphalt concrete mix design, several issues must be investigated. These issues include:

1) determining the mix design characteristics through performing a Marshall Analysis;

2) determining if the mix meets stability criteria; and

3) determining if the designed mix is constructable.

If a "natural"/"refined" blended asphalt must be investigated due to constructability purposes, several issues must still be investigated. These issues include:

1) determining if the material has the required durability by performing age testing on the material mixtures;

2) determining the mix design characteristics through performing a Marshall Analysis; and

3) determining if the material is constructable.

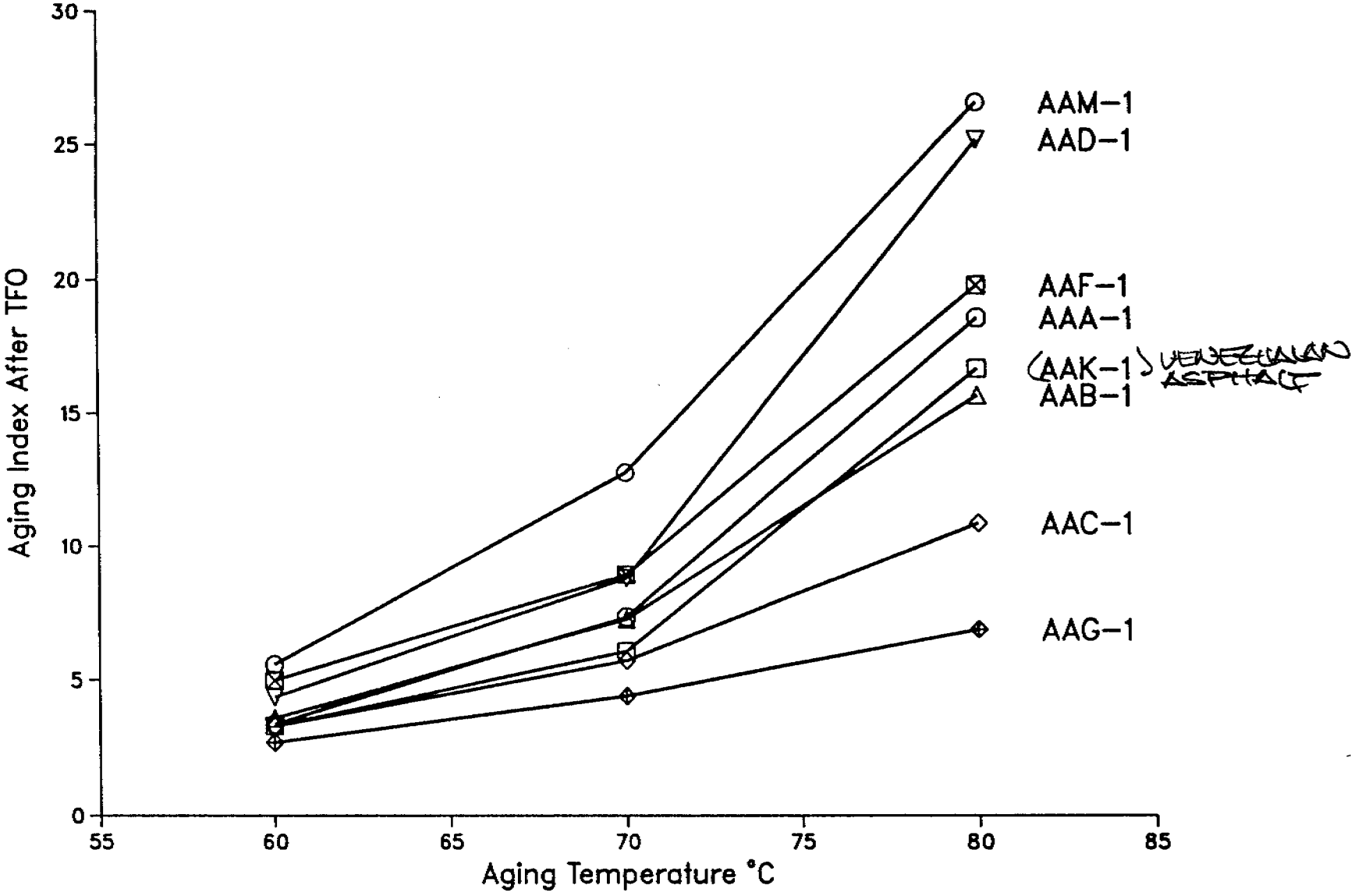

Figure 8.16 Aging Indices After TFO of Core Asphalts Aged by the PAV Method at Different Temperatures

SHRP-A-368 (1993) BINDER CHARACTERIZATION AND EVALUATION VOLUME 2: CHEMISTRY