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# Asphalt Research Consortium

## **Responses to Feedback**

Models ETG – Chicago, June 2008

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# Background

- FHWA compiled inputs provided by the ETGs during the February 2008 meetings in Tampa, Florida
  - A two part document was transmitted to ARC in the last week of March requesting modifications / clarifications to the year 2 work plan
  - Part 1 contained aspects related to the management of ARC activities and Part 2 contained technical clarifications that were requested based on the year 2 work plan
  - A summary of these responses is as follows
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# Part 1, Items 1 & 2

## Review, Reporting, and Project Management

- ETG members had indicated that preparation and review of the reports were onerous for both ARC and ETG members
  - Also due to the volume of these reports, there was a lack of technical details
  - To resolve this issue FHWA has recommended that ARC provide only summary progress reports and separate detailed technical reports as deliverables
  - ARC has provided FHWA with a tentative schedule of deliverables including detailed technical reports
  - Sub-working groups from the models and binder ETGs have been identified to focus on elements of the research to be coordinated through the AOTRs and ETG secretaries
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# Part 1, Items 1 & 2

## Review, Reporting, and Project Management

|                            |   | Year 2 (4/08-3/09) |      |      |        | Year 3 (4/09-3/10) |    |    |       | Year 4 (04/10-03/11) |    |    |       | Year 5 (04/11-03/12) |       |        |      | Remarks | % Complete  |  |
|----------------------------|---|--------------------|------|------|--------|--------------------|----|----|-------|----------------------|----|----|-------|----------------------|-------|--------|------|---------|---|--|
|                            |   | Q1                 | Q2   | Q3   | Q4     | Q1                 | Q2 | Q3 | Q4    | Q1                   | Q2 | Q3 | Q4    | Q1                   | Q2    | Q3     | Q4   |         |   |  |
| <b>Material Properties</b> |   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         |   |  |
| <b>F1a</b>                 | <b>Cohesive and Adhesive Properties</b>   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         |   |  |
| F1a-1                      | Critical review of literature   |                    |      | JP   |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | JP: On the comparison of SFE and mechanical fracture energy       |  |
| F1a-2                      | Develop experiment design   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         |   |  |
| F1a-3                      | Thermodynamic work of adhesion and cohesion   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | Ongoing effort. Results will be incorporated in P, JP, D, F of ot |  |
| F1a-4                      | Mechanical work of adhesion and cohesion  |                    |      |      |        | JP                 | D  | F  |       |                      |    |    |       |                      |       |        |      |         | JP: On the comparison of mechanical and thermodynamic wor         |  |
| F1a-5                      | Evaluate acid-base scale for surface energy calculations                                      |                    |      |      |        |                    |    |    |       |                      |    |    |       | JP                   |       |        |      |         | JP: On the use of acid base scales to determine surface free en   |  |
| <b>F1b</b>                 | <b>Viscoelastic Properties</b>  |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         |   |  |
| F1b-1                      | Separation of nonlinear viscoelastic deformation from fracture energy under cyclic loading    |                    |      | D,JP | M&A, F |                    |    | JP |       | JP                   |    | P  |       | JP,M&A,D             |       | F      |      |         | JP and F: On the use of Schapery's model with DMA; On the us      |  |
| F1b-2                      | Separation of nonlinear viscoelastic deformation from fracture energy under monotonic loading |                    |      | D,JP | M&A, F |                    |    | JP |       | JP                   |    | P  |       | JP,M&A,D             |       | F      |      |         | JP and F: On the use of Schapery's model monotonic ; On the       |  |
| <b>F1c</b>                 | <b>Aging</b>  |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         |   |  |
| F1c-1                      | Critical review of binder oxidative aging and its impact on mixtures                          |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | Ongoing effort. Results will be incorporated in P, JP, D, F of ot |  |
| F1c-2                      | Develop experiment design   |                    | D, F |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | D & F: Aging Experiment Design                                    |  |
| F1c-3                      | Develop transport model for binder oxidation in pavements                                     |                    | P    |      | P, JP  |                    | P  |    | P, JP |                      | P  |    | P, JP |                      |       | D, M&A | F    |         | P, JP: improved calculations of pavement temperatures; P oxi      |  |
| F1c-4                      | Effect of binder aging on properties and performance  |                    |      | JP   | P      |                    | JP | D  | F     |                      |    |    |       | JP                   | D     | F      |      |         | JPs: Using forward/back analysis to quantify aging effect; Effec  |  |
| F1c-5                      | Polymer modified asphalt materials  |                    |      |      |        |                    | P  |    |       |                      | P  |    |       |                      |       | D      | F    |         | Ps: polymer-binder interactions; durability of PMA                |  |
| <b>F1d</b>                 | <b>Healing</b>  |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         |   |  |
| F1d-1                      | Critical review of literature   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | Ongoing effort. Results will be incorporated in P, JP, D, F of ot |  |
| F1d-2                      | Select materials with targeted properties   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | Ongoing effort. Results will be incorporated in P, JP, D, F of ot |  |
| F1d-3                      | Develop experiment design   |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | Ongoing effort. Results will be incorporated in P, JP, D, F of ot |  |
| F1d-4                      | Test methods to determine properties relevant to healing                                      |                    |      | JP   |        |                    |    |    | JP    | D                    | F  |    |       |                      |       |        |      |         | JP, F: On the use of molecular modeling, DSR and other techn      |  |
| F1d-5                      | Testing of materials  |                    |      |      |        | JP                 |    |    |       |                      | JP |    |       | M&A,D                | JP, F |        |      |         | JP, F: On the quantification of healing in binders, mastics, mixt |  |
| F1d-6                      | Evaluate relationship between healing and endurance limit of asphalt binders                  | DP                 |      |      | P      | D,JP,F             | P  |    | D,F   |                      | P  |    | DP,JP |                      | P     | D      | F    |         |   |  |
| F1d-7                      | Coordinate with AFM analysis  |                    |      |      |        |                    |    |    |       |                      |    |    |       |                      |       |        |      |         | Ongoing effort. Results will be incorporated in P, JP, D, F of ot |  |
| F1d-8                      | Coordinate form of healing parameter with micromechanics and continuum damage models          |                    |      |      |        |                    |    |    |       |                      |    | JP |       |                      |       |        | JP,D | F       |   |  |

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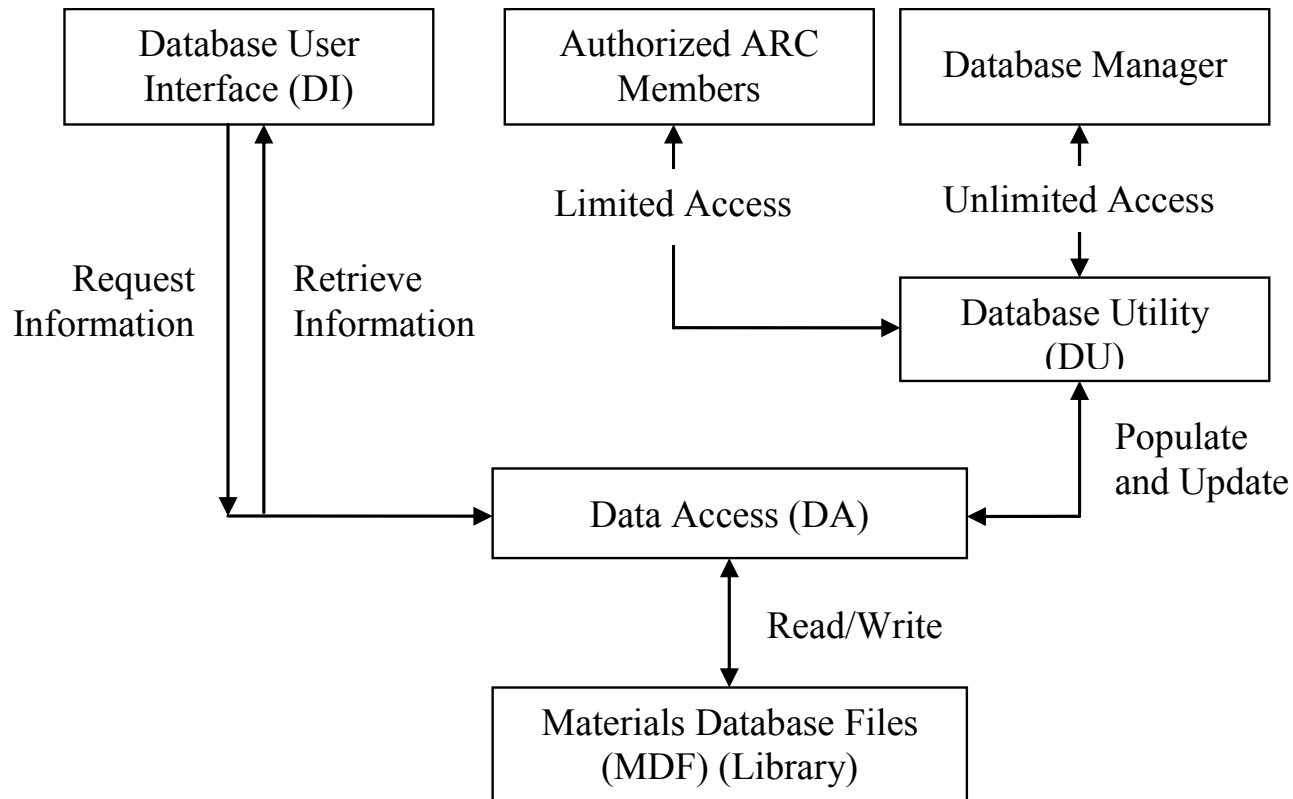
## Part 1, Item 3

### Materials Selection and Management

- FHWA and ETG members have highly recommended a common set of materials to the extent possible for various tasks in this research
  - A material selection and management plan was developed in task TT1d (UNR) and submitted for review
  - The detailed plan that identifies the use of core and non core materials that will be used in the research as well as procedures for sharing, labeling and handling these materials was prepared and submitted to FHWA
  - The plan also includes the basic structure for a database that will be developed and used to catalog the materials and their properties as these are accumulated during the course of this project
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# Part 1, Item 3

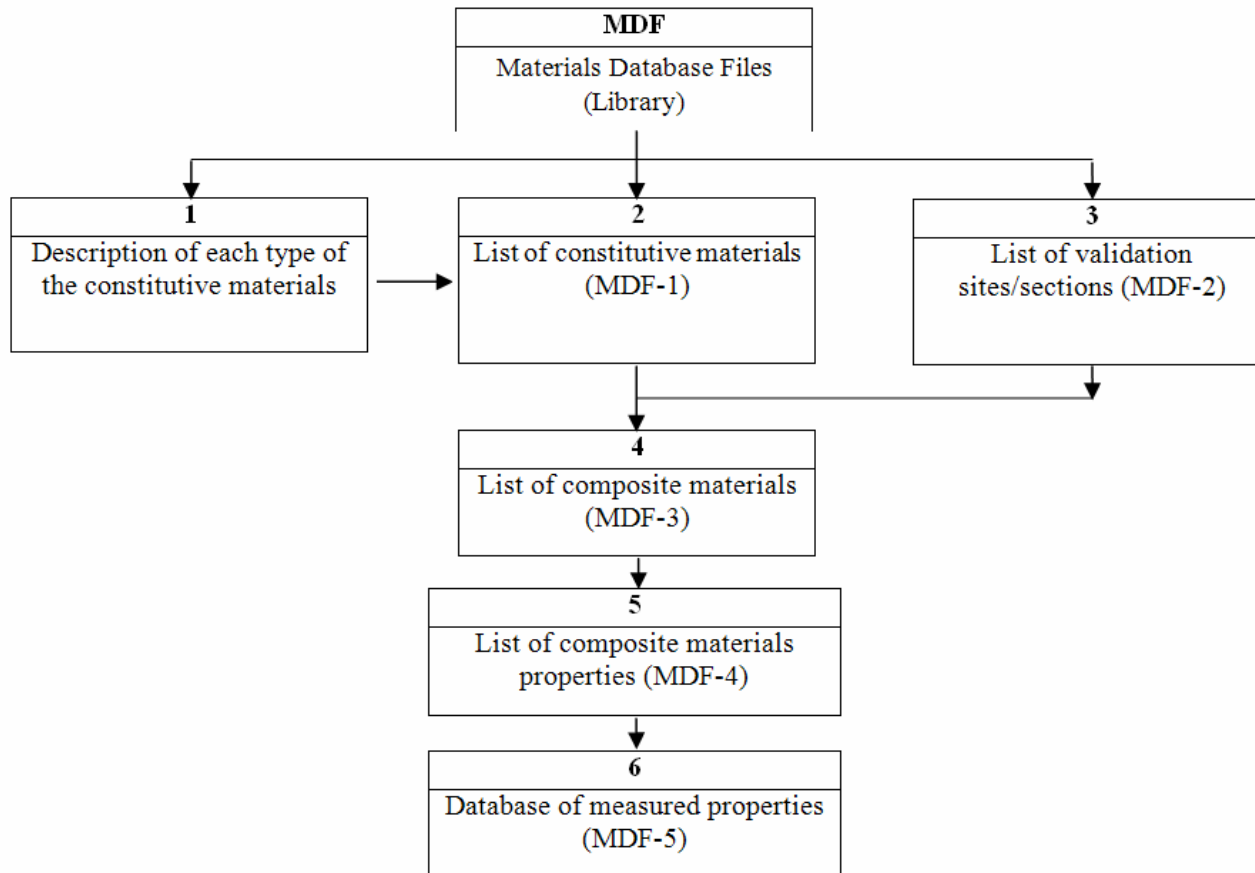
## Materials Selection and Management



**Illustration of the materials database structure**

# Part 1, Item 3

## Materials Selection and Management



**Illustration of the flow chart for materials database files**

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# Part 1, Items 4 and 5

## Research References

- The references used in the work plan were all documented with information on availability in a single location to facilitate review

## Validation Site Materials

- Availability of materials from SPS 9 test sections was physically verified at MRL to assess availability for use in this project. SPS-9 binders were delivered to ARC by MRL. Other SPS original materials need to be identified and utilized where appropriate in the validation efforts.
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# Part 1, Item 6

## Coordination with Other Research

- Reviewers had indicated potential duplication of ARC research with other major research efforts
  - A tabulated document that highlights similarities and differences in some of the work areas in ARC vs. other similar major national level research efforts was prepared to clarify this
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# Part 2, Items 1 and 2

## Missing work plans

- Work plans for certain tasks were missing
- The work plans were delivered June 12 and are under review by FHWA

## Engineered materials

- E2a: There was some concern that responsibility for research in certain tasks rested with the industry and some clarification for this was required
  - A teleconference with a selected group of experts from binder ETG was arranged to discuss revision of plan.
    - It was agreed that suppliers of additives will provide base binders and modified binders at multiple levels of modification.
    - Performance related testing will be conducted on these binders.
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## E2a Revised Plan

- Modifiers selected:
    - SBS, Elvaloy, PPA, EVA, Binary modification
  - Grades:
    - Unmodified (base) binder PG58-XX
    - Low level of modification PG64-XX
    - High Level of modification PG76-XX
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# Testing Matrix – E2A

|  |  |
|--|--|
| <b>Rheology and Damage Resistance</b><br>(In addition to PG grading and PG+ testing) | MSCR   |
|  | G* and $\sin\delta$  |
|  | Frequency Sweep<br>Master curve                            |
|  | SNEB/BBR   |
|  | Fatigue (BYET)   |
|  | viscosity and phase angle<br>(@mixing and compaction temp) |
| <b>Storage stability and storage separation @ High Temperature</b>                   | 0 hours  |
|  | 24 hours   |
|  | 72 hours   |
| <b>Adhesion Dry/wet</b>  | DSR – Tackiness with 2 aggregates                          |
| <b>Cohesion Dry/wet</b>  | DSR- Tackiness with metal plate ( full adhesion)           |

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# Part 2, Items 3 and 4

## Validation Sites

- WRI is evaluating the possibility of accelerated testing on certain test sections to reduce the time required to obtain the relevant information
- ARC is contacting states with LTPP sections that are going out of service for possible new field sections

## Technology Development

- Five test methods were nominated by ARC and FHWA to ETGs for further development in the technology development area
  - Positive feedback was received from ETG members and FHWA has requested ARC to proceed with the development of all the nominated test methods
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# Part 2, Item 5

## Moisture Damage

- Concerns related to moisture diffusion:
    - Measurement of moisture diffusion in asphalt binders, mastics and full asphalt mixtures is one of the critical tasks in ARC research (M2b: Impact of moisture diffusion)
    - Researchers will utilize the information from this task to correct for the differences in moisture concentrations for the specimens that are being tested
    - The detailed approach for the methodology used for this correction will be presented in the forthcoming detailed technical reports
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# Part 2, Item 5

## Moisture Damage

- Concerns related to torsion test, differences between failure modes, and use of DSR and PATTI tests:  
Some of the concerns were due to the misinterpretation of the intended purpose of the torsion test (this will be clarified in detail in a white papers)
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# Part 2, Items 6 and 7

## Modeling approaches

- A document describing the three basic types of approaches was presented earlier
- Another white paper that presents a more detailed comparison of the modeling approaches is under preparation

## Aging

- Aging has an important role in several different work elements of the ARC research
  - A document was prepared to illustrate the research tasks that involve aspects of aging amongst different researchers
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