June 1, 2015

**MEMORANDUM FOR** Paul Zielinski

Director, Technology Partnerships Office

**From:**  Howard A. Harary

Director, Engineering Laboratory

**Through:** Jason D. Averill

Chief, Materials & Structural Systems Division

**Subject:** Proposed New Consortium Named Service Life Prediction Methodologies and Metrologies for Commercial Polymers Consortia

**I wish to enact the CRADA based on the following SOW**.

The formation of this consortium has been requested by a group of industrial members that have been meeting sporadically over the past three years. The focus of this consortium will be on developing the measurement science to support changes to the Underwriters Laboratory 746 family of polymer degradation standards.

An important purpose of a CRADA is to improve U.S. competitiveness to provide substantial benefit to the U.S. economy. I have considered the preference for businesses which agree to manufacture substantially in the United States any product embodying CRADA inventions, or produced through the use of such inventions, for sale or use in the United States by the Collaborator and/or affiliates.

1. **Please complete the following statements:**
2. The NIST PI, Christopher White is / is not currently the PI on any other CRADA. *The Sealant Consortium.*
3. To the best of my knowledge, there is / is not any overlap between the proposed SoW, the SoW of any other CRADA, or other formal collaboration. *If so, please explain:* Click here to enter text.
4. NIST will / will not be receiving equipment, software, etc. from the collaborator for use beyond the term of the CRADA. *If so, please identify the equipment/software and indicate the duration of use beyond term of the CRADA:* Click here to enter text.
5. The PI  does /  does not have a potential invention which could lead to a NIST invention disclosure, or possible patent, and which will be used in under this CRADA. *If so, please identify:* Click here to enter text.
6. NIST is / is not engaged in discussions with Collaborator concerning a NIST Background Invention/patent that is related to the work under this CRADA. *If so, please identify:* Click here to enter text.
7. The Statement of Work research will / will not involve the use of [human material, data or subjects](http://www-i.nist.gov/director/IRB/grants.htm) or animal materials. *If so, please contact TPO at (301) 975-2209 or by email at* [*ipp@nist.gov*](mailto:ipp@nist.gov).
8. The Collaborator is / is not a foreign-controlled entity, either directly or via a parent company. ***If so, please identify parent/country: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****.* I have determined that working with a foreign collaborator is in the best interests of the United States. As per NIST policy, TPO will request approval of the collaborator from the US Trade Representative before the CRADA can be executed.
9. **If Collaborator is foreign:** The Division Chief has reviewed the [Commerce Control List](http://beta-www.bis.doc.gov/index.php/regulations/export-administration-regulations-ear) and has identified that the technology (i.e., any equipment, material, software or data) being shared under the Statement of Work is categorized under the following Export Control Classification Number(s): N/A

*For more information TPO’s website on export control:* [*http://inet.nist.gov/tpo/export\_compliance.cfm*](http://inet.nist.gov/tpo/export_compliance.cfm)

1. **Please provide the information below:**
2. **Collaborators’ Legal Name and Address:**

Legal name, city, state, zip, DUNS#.

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1. **Signatory Contact (e.g. contracts officer, legal, person responsible for having the CRADA signed):**:

Name, street address (note UPS will not deliver to PO Box), phone and e-mail.

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The Statement of Work (SoW):

Project Objectives: Develop the underlying polymer science to support the modification of UL standards that address testing and certification of polymeric materials, especially the standards under the direct supervision of the UL 746 Standard Technical Panel (STP). The opportunity is to provide the technical support to align the latest scientific knowledge on polymer science with the UL standards that relate to the retention of performance properties after long term thermal aging (UL 746B) and after exposure to ultraviolet radiation and moisture (UL 746C). Working with industry and leveraging the NIST reliability-based service life prediction methodology for commercial polymers the UL standards for polymeric materials, if appropriately updated can better assess the level of protection for the consumer while potentially resulting in significant reductions in the time for evaluation and certification. Keeping the standards current with the latest knowledge on polymers and the effect of thermal, radiation, and humidity exposures will help drive innovation for applications where these conditions exist.

Technical Opportunity: There are two opportunities here relating to Thermal Indices and/or Relative Thermal Indices (TIs and/or RTIs) and UV and Humidity Ratings (f1 and f2). First, the UL certification program of polymeric materials has been very successful at increasing the safety of the use of plastic products. As it relates to thermal performance of polymeric materials, the program is based on the work of Dr. Thomas Dakin in which he proposed to treat electrical insulation deterioration as a chemical rate phenomenon (1948). This resulted in the Arrhenius analysis of data from the degradation of polymeric materials exposed to multiple temperatures and from which an estimated use temperature could be extrapolated. This method while increasing the safety has also required significant investment of time and other resources. For example, a simple formulation change to a polymeric compound may require 18 months to become recertified. The opportunity rests in working with UL and other industry partners in identifying and providing the latest available scientific knowledge for methods that reduce the time required to obtain a temperature rating while maintaining the highest level of safety. In the same way, the second opportunity is in the evaluation of polymeric materials exposed to UV radiation and humidity in an attempt to simulate the outdoor conditions where these materials could be used. UV and humidity exposures in the current certification program are done separately on polymeric materials by introducing specimens in a xenon chamber and in a water bath to evaluate the permanence of certain properties (typically mechanical and flammability) after these exposures. The specimens are not exposed to both conditions at the same time. And neither are they exposed to temperature to simulate the combination of thermal, radiation and humidity. Working with industry and UL, this consortium will provide the latest scientific knowledge to evaluate the existing methods for the practicality of the (f1) and (f2) ratings and to propose new standard test methods that increase safety while potentially reducing the time to certification.

Technical Approach: The technical approach will proceed by working with UL and industry members to optimize the process to execute modifications to the standard or the introduction of new test methods. The proposed modifications or new methods will be evaluated and the criteria for acceptance will be demonstrated. For example, instead of an 18 month four temperature evaluation, certain minor changes to formulations may be considered for recertification after 2000 hours of testing. The criteria and products that can use a shortened method will have to be demonstrated. The scientific evidence will be assembled into a proposal and put before the UL 746 Standard Technical Panel (STP). This approach will be followed with thermal exposure (TI and/or RTI) and UV and humidity exposures (f1 and f2). Also, by leveraging the expertise at NIST with multicomponent exposure (UV light, temperature, humidity and mechanical loading) a new reliability-based method for certification can be developed and proposed for standardization to the UL 746 Standard Technical Panel (STP).

The technical approach will proceed in several stages: The first stage will focus on thermal only exposures to support TI and/or RTI testing. The second stage will focus on UV and humidity exposures to support (f1) and (f2) ratings. The third stage will include simultaneous exposure to UV light, temperature, and humidity. These stages will follow the same research plan outlined below with a methodology that involves these five steps:

Identify critical polymeric materials and important chemistries.

Establish the characterization methods for performance tracking.

Generate thermal decomposition data and weathering data indoor and outdoor.

Develop thermal decomposition models.

Develop weathering models based on the indoor data and validate the model against the outdoor data.

Establishing characterization methods

Leveraging previous accelerated weathering efforts at NIST allows for the use of standardized characterization methods for photo-oxidation and mechanical performance. Performance characterization methods that will be used in this study will be selected based on consultation with our industry partners.

Generating the indoor and outdoor data for a multicomponent exposure model

The most time consuming aspect of this project is generating the validation data from outdoor exposures. Outdoor exposure will occur in at least two locations as soon materials are identified. It is important for validation that there be at least two locations. Gaithersburg Maryland and a commercial exposure site in Florida are current possibilities. Additional sites could be added as the need arises. A larger number of exposure sites increases the validation of the model predictions for the entire United States. Gaithersburg and Florida could be selected due to the easy access and milder weather in Gaithersburg and the availability of commercial weathering sites in a site that has higher temperature, UV intensity, and humid weather in Florida. The SPHERE (indoor exposures) will continue throughout the life of the project.

Developing models and validating data.

The project will work with the Statistical Engineering Division (SED) at NIST to provide the statistical models and validation of thermal exposures, UV and humidity exposures, and multicomponent exposures (UV light, temperature, humidity and mechanical loading). There is a long standing cooperative relationship with SED that has led to predictive models for sealants. Continued cooperation with SED is critical for model development, but the project will regularly identify new mechanisms to support the modeling effort. For example, once a validated weathering predictive model is obtained, a geographic map of validated property change will be produced.

Data Management Plan:Experimental results from thermal, UV, humidity, SPHERE and outdoor exposures will be integrated into an exposure database. Additionally, the analysis and resulting models will also be publically available. This will consist at a minimum of UV Intensity, Temperature, Relative Humidity, and Material Performance Changes. Use will not be restricted. This database will be delivered to the information technology infrastructure with our expectation that it will be publically available.

Anticipated Results: The anticipated results will be a series of scientific outputs that will start from presentations to peers, move through peer reviewed publications and then be formulated into standards proposals for the UL 746 Standards Technical Panel. Early results will include validation TI or RTI programs, round robins to evaluate the precision and bias of any proposed test methods, development of new standard test method proposals for thermal decomposition and multicomponent outdoor exposure, and transfer of this technology and methods to industry.

Roles and Responsibilities: The ultimate responsibility to modify UL standards and to introduce new test methods in the polymeric materials standards rests with the UL 746 Standard Technical Panel (STP). Thus, to be able to introduce new methods to evaluate polymeric materials or to modify UL 746A, UL 746B or UL 746C the UL 746 STP members have to achieve consensus per ANSI rules. The UL 746 STP members are responsible for reviewing any proposal that is made to modify the standards or a proposal to introduce a new test method. The STP members appreciate proposals that are based on current scientific knowledge and are more likely to support a modification if they are introduced with a strong technical rationale. The LTTA Forum and this consortium can work together to provide the STP with proposals that have the scientific rationale to drive standard modifications with a high level of probability of achieving consensus. Thus, the LTTA Forum members will be considered advisory members for work that will be funded by the members of the consortium. Since the consortium members provide the funds to conduct tests that support scientific investigations, the consortium members are ultimately responsible for approving the recommendations of the LTTA Forum. Effective collaboration between the members of consortium, the LTTA Forum members, and the STP members is what ultimately will result in new test methods or modifications to the existing test methods.

Approves new test methods or standard modifications

UL 746 STP

Consortium

LTTA Forum

Provides funding and oversees the use of funds to execute investigations proposed by the LTTA forum

Provides technical advice to guide scientific investigations

Collaboration Model

Below is an example of how this collaboration model can work. Other examples will be contemplated in this fashion as additional opportunities for collaboration arise during ongoing technical discussions.

Example for using collaboration model in the further development of IEC 60216-7:

The LTTA Forum members consult with members of IEC TC112 and other interested industry members to determine materials and methods to choose for another round robin test. The information about materials and methods chosen by the LTTA Forum is provided to the consortium. The consortium provides funding to procure materials or to formulate and compound materials for the experiment. NIST coordinates the distribution of materials to round robin participants and provides the testing facilities when available. When the testing facilities are not available at NIST the consortium provides the funding to conduct the testing at different facilities. The results of the experiments are analyzed, reviewed, and published by members of the LTTA Forum and the consortium. Proposals to modify the UL standards are drafted by members of the LTTA Forum and the consortium. The drafted proposals are presented to the members of the UL 746 STP for preliminary review. The feedback from the preliminary review from the UL 746 STP is reviewed and considered by the LTTA Forum and the consortium to make revisions to the draft proposal. A final proposal is moved to ballot by the LTTA Forum. The members of the UL 746 STP vote to accept the proposal into the UL standard.

Expected Milestones:

FY2016

* Identify and establish priority of projects related to thermal and weathering exposures.
* Complete selection of the candidate materials for thermal and combined outdoor rating (temp, UV, water) development.
* Complete characterization protocol for the candidate material.
* Hold consortium meeting to develop experimental plan.
* Support IEC 60216-7 round robin efforts for UL-IEC method improvement.
* Develop and/or identify thermal testing capabilities.
* Finalize experimental plan for thermal, UV, humidity, SPHERE and outdoor exposures.

Fy2017

* Hold Service Life Prediction meeting in Santa Fe, NM.
* Hold consortium meeting.
* Complete installation of the UV components of commercial version of the SPHERE.
* Continued support for IEC 60216-7 round robin efforts for UL-IEC method improvement.
* Initiate thermal, SPHERE and outdoor exposures for candidate material.
* Consider publication of Certification Requirement Decisions (CRDs) based on available data.

FY2018

* Hold consortium meeting in a place to be determined.
* Continued support for IEC 60216-7 round robin efforts for UL-IEC method improvement.
* Complete installation of the temperature components of commercial version of the SPHERE.
* Produce validated expanded RTI for a plastic material.
* Produce standards change proposal for approval by STP.
* Consider publication of Certification Requirement Decisions (CRDs) based on available data.