DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
ARMY RESEARCH LABORATORY
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REPLY TO
ATTENTION OF RDRL-WMM-C

2 AUG 2013

MEMORANDUM FOR NATIONAL CAPITAL PLANNING COMMISSION (NCPC)

SUBJECT: Eisenhower Memorial Corrosion Resistant Materials Findings Follow-up

1. Accelerated corrosion in accordance with ASTM G85 A4 SO_2 salt fog: The decision to run welded specimens under load and contaminated with lamp black carbon was wise. The ASTM G85 A4 SO_2 salt fog is one of the harshest accelerated corrosion methods in use and is often the only manner possible to determine any corrosion susceptibilities of inherently corrosion resistant alloys such as stainless steels. After exposing the welded stainless steel alloys 316L, 317L, and 321 in the SO_2 salt fog environment and demonstrating excellent corrosion resistance of both the 316L and 317L wires, even with the carbon black added to simulate city soot, I confidently recommend either alloy. The 316L may be more favorable due to its wider usage, greater variety of wrought products, and lower cost. If possible, it is recommended that the SO_2 salt fog exposure for the 316L and 317L samples be continued and run to failure or at least to 3000 hours to distinguish differences between the 316L and 317L alloys. If no further degradations occur under the longer exposures the confidence level for the tapestry base material to endure will increase.

2. Alloy selection admonition: Whether 316L or 317L is ultimately selected, **under no circumstances should undesignated 316 (no "L") or undesignated 317 (no "L") EVER be used** for construction of the tapestry. The "L" stands for low carbon and it is critical that the carbon content is minimized for the maximum lifespan and durability of the welds. The greatest of care and diligence must be maintained at all times to ensure that the undesignated versions of either of these alloys are never procured. Furthermore, if two or more different sources for 316L or 317L products are presented for purchase contract consideration, the individual statements of compositions should each be referenced and the vendor having the lowest carbon content within their wires preferentially selected.

3. Post-assembly pickling and passivation: My prior recommendation for this procedure remains unchanged. In order maximize the lifespan of the stainless steel tapestry panels, it is recommended that the individual tapestry panel assemblies are each pickled and passivated prior to placement at the memorial site. The pickling will remove the discolored areas from high heating on and adjacent to the welds where chromium levels are sometimes reduced. Pickling is done through immersion in hydrofluoric and nitric acid mixtures per the ASTM A380 specification that is already included in Section 6.1 of the Eisenhower Memorial Tapestry Engineering and Technical Data Summary Notebook. After pickling, a final passivation step through immersion in nitric acid once again in accordance with ASTM A380 will build and optimize the passive layer thus maximizing the corrosion resistance.

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4. Design and operational strategies for long-term memorial durability:
In my prior memorandum dated 17 SEP 2012, it was suggested that a set of duplicate tapestries be considered as part of an interchangeable modular system. This suggestion is definitely a major consideration, however my strong recommendation for this remains. The use of an interchangeable system of tapestry panels would minimize unsightly disruptions at the memorial site by having "new" panels immediately available for fast onsite exchanges in the event of unforeseen damage from an accident or the elements. The ability to then refurbish and repair the degraded or damaged tapestry panels under ideal controlled conditions at an offsite location would ensure the highest quality and would enhance overall memorial safety versus the alternative of onsite in-situ repairs of single copy tapestry panels. When exchanged, the weathered panels could easily be refurbished to near new conditions via spot re-welding to reattach missing or damaged wires followed by pickling, and passivation at minimal cost levels and could be stored in reserve until the twin panel is ready for its cycle of maintenance. The extra panels are a wise investment in the event of any unforeseen catastrophic events such as vehicle collisions, crane accidents, tree falls, or accidents during maintenance. President Eisenhower, greatly admired for his mastery of planning and preparing for complex operations once quoted: *"You will not find it difficult to prove that battles, campaigns, and even wars have been won or lost primarily because of logistics"*. Using the tapestry panel rotation method would extend the lifespan of individual panels and would reflect well upon President Eisenhower's legacy.

5. Falling ice issues: Through the due diligence of the Ice Loading calculations in section 3.3.2 of the 8 July 2013 Technical Data Summary I am confident in the tapestry's ability to bear the loading of all but the most extreme of ice storms. Unanswered questions however remain. One issue is partial releases of melting ice could lead to large bending moments leading to much greater localized stresses than anticipated in section 3.3.2 that could possibly twist and tear the wire spot welds apart. Further engineering studies are needed to determine the strength of single, twisted, and braided wire spot welds and to establish process controls for the construction and assembly phase to ensure consistent integrity of the welds. I also remain concerned over what is to be done as ice melts and inevitably falls from the structure. In the event of a full ice release, care must be taken to ensure the safety of memorial visitors and the regular passing pedestrians. Engineering workarounds for inherently safer designs for bulk ice falls or an established safety procedure from the National Park Service for ice buildup are recommended.

6. Summary: The additional measures taken during the last year by Gehry Partners, LLP have increased my confidence that a tapestry base alloy such as 316L or 317L stainless steel can satisfy the durability criteria of the Commemorative Works Act. In particular, the ASTM G85 A4 SO_2 salt fog results were helpful. If my remaining

recommendations including post assembly pickling, the duplicate tapestry panel set, and strong admonishment to **NEVER** use undesignated 316 or 317 stainless steel wire products minus the “L” are followed, my increased confidence will be further boosted. It has been a distinct honor for me to participate in this important project honoring Dwight D. Eisenhower’s legacy as our President, our General, and his greatness as a fellow American citizen. I look forward to providing additional assistance as additional durability analyses are conducted on the tapestry welds as well as additional samples of the base material alloy.

7. The point of contact for this action is Mr. Brian Placzankis, brian.e.placzankis.civ@mail.mil, 410-306-0841.

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