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Specifying the **National** **World War II Memorial**

by David Metzger FCSI, FAIA, CDT

It is perhaps literally once in a lifetime that one is fortunate enough to participate in a project with the significance of the National World War II Memorial in Washington, D.C. This article describes the memorial's physical design and discusses some of the more unique and interesting issues this author faced in preparing specifications for the project.

The public memorial

Located on one of most prominent sites in Washington, the National World War II Memorial sits between the

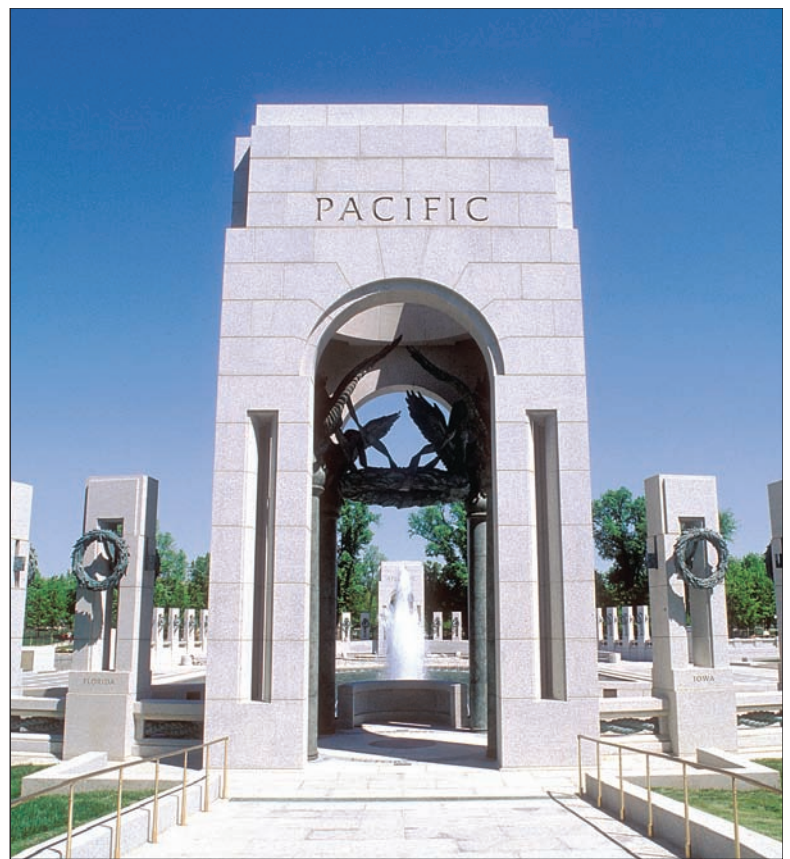
Washington Monument and Lincoln Memorial, encircling the Rainbow Pool at the east end of the Reflecting Pool. The National World War II Memorial covers almost 3 ha (more than 7 acres), more than two-thirds of which are trees, plantings, and water. The visible memorial consists of:

- the central Rainbow Pool and plaza, surrounded by a colonnade of stone pillars and arches, the Freedom Wall, and the ceremonial entrance from 17th Street;
- a small, quiet contemplation area in the northwest corner; and
- an information pavilion and comfort station.

At the north and south ends of the memorial stand two granite arches to represent the war in the Atlantic and Europe, and in the Pacific and Asia. Each contains a bronze baldachino comprising four columns on which are perched eagles holding a flowing ribbon in their beaks—the ribbons, in turn, support a laurel wreath. Extending from the base of each arch is a small pool and fountain, on whose borders are carved the major battles of its respective theater of the war.

Arrayed between the arches are 56 granite pillars in four groups of 14. Each pillar is carved with the name of one of the then-48 states, the District of Columbia, and the seven territories—Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, American Samoa, Guam, and the Philippines—that formed the nation during the war. The names on the pillars, alternating between the south and north groupings, are in the order the states were admitted into the union. Each pillar supports two bronze wreaths symbolizing the nation's home front contributions to the war effort—oak leaves for its industrial productivity, and wheat for its farm and agricultural output. They are linked within each group with a cast bronze rope, symbolizing national unity.

The west side of the memorial is focused on the Freedom Wall, with its low stone coping carved with the words,



One of the four granite structures representing the major theaters of war, this Pacific arch houses a bronze baldachino of ribbon-bearing eagles. The pillars behind represent the states and territories involved in World War II.



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Given its location between the Washington Monument and the Lincoln Memorial, there were concerns the National World War II Memorial would interrupt the area's sightlines. As such, the central portion was lowered 1.8 m (6 ft) below its previous grade.

“Here we mark the price of freedom.” The wall consists of 4048 sculpted, gold-plated, stainless steel stars mounted on 23 bronze panels, each star representing 100 American deaths during World War II (symbolic of the gold star displayed in the windows of families who had lost a member in the war). So as not to create the impression of undifferentiated deaths, there are seven subtly different star designs, each randomly rotated by a few degrees. There

are alternate mounting heights within each row, creating a sparkling pattern accentuated by the shadows cast by the stars’ projection from the bronze panels.

From 17th Street on the east side of the memorial, the site slopes gently down toward the Rainbow Pool and plaza marking the center of the site. On both sides of the entrance ramps are stone walls, each containing 12 bronze panel bas-relief sculptures depicting the impact of World War II on the United States and its citizens, both civilian and military.

Flanking the entrance on 17th Street are two bronze flagpoles on hexagonal bronze bases with an ornamental motif of olive branches and arrowheads symbolizing peace through strength. Each face of the bases is ornamented with the seal of one of the service branches that fought in the war—Army, Navy, Marine Corps, Army Air Corps, Coast Guard, and Merchant Marine. The flagpoles are topped with custom gold triglycidyl isocyanurate (TGIC)-finished finials, in a lotus flower and arrowhead design symbolizing peace over tyranny.

The bronze drainage grates around the Rainbow Pool (and elsewhere on the site) contain a star and parallel line motif based on the insignia on U.S. airplanes and tanks. This central portion of the site has been lowered 1.8 m (6 ft) below its previous grade, and the Rainbow Pool has been reconstructed in its original configuration, but approximately 15 percent smaller in size.

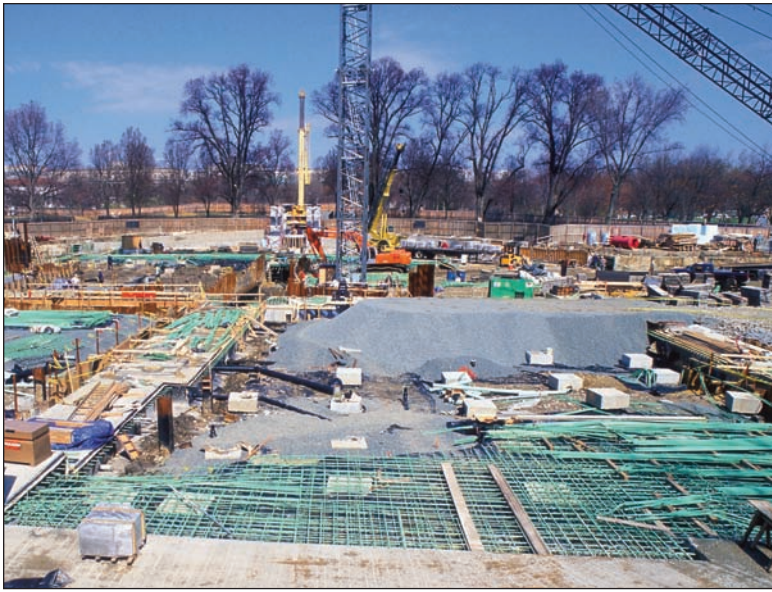
This lowering ensures unobstructed sightlines from the Washington Monument to the Lincoln Memorial. One of the objections voiced by opponents of the National World War II Memorial was it would block these views—to allay these concerns, the specifications required the construction of a plywood mockup of the west wall of the Memorial so the Fine Arts Commission and other government agencies could review the height of the wall relative to the sightlines. This way, the wall’s height and configuration could be modified prior to construction if necessary.

The Project Team

The World War II Memorial was designed by Friedrich St. Florian. The project team included:

- associated architect: Hartman-Cox;
- architect of record: Washington, D.C., office of Leo A. Daly;
- landscape architect: James van Sweden;
- general contractor: Tompkins Builders and Grunley-Walsh Construction;
- construction quality manager: Gilbane Building Co.; and
- specifications: Heller & Metzger PC.

Three federal government agencies were involved with reviewing the construction documents. The client agency was the American Battle Monuments Commission (ABMC), which administers and maintains U.S. military cemeteries and memorials overseas and establishes other memorials in the United States as directed by Congress. The General Services Administration (GSA) was the contracting agency. The National Park Service (NPS) is responsible for the memorial’s maintenance. ♡



The memorial structures themselves are granite—selected for its strength, hardness, and water resistance.

The unseen memorial

Although they are unseen by the public, underground support spaces are crucial to the design and construction of the memorial. As late as the 1880s, the area just west of the Washington Monument was the Potomac River. The land was filled in the late 19th century, and the Lincoln Memorial, Reflecting and Rainbow Pools, and adjoining gardens comprising West Potomac Park were constructed by the early 1920s. The fact this area remains in the Potomac River 25-year-flood plain had a major impact on the design of the memorial.

The memorial's entire central portion is surrounded by a 0.6-m (2-ft) thick slurry wall more than 396 m (1300 ft) in circumference. This construction keeps groundwater from seeping into the below-grade spaces, such as:

- the equipment room (housing fountain pumps, fountain lighting controls, and related equipment);
- stormwater and electrical vaults; and
- connecting tunnels.

The slurry wall also helps maintain the level of the water table outside the memorial's boundaries. Access to the equipment room is further protected by watertight doors, described later in this article.

Within the slurry wall, the memorial structures are supported on 600 steel H-piles. The central plaza paved areas are framed structural slabs reinforced with epoxy-coated reinforcing bars. This was necessitated by the aforementioned low-lying site and the difficulties of building on landfill, which would not support the weight of stone paving and a concrete slab-on-grade without settling.

Specifying stone

The primary finish materials of the public memorial are stone and ornamental metal. The subsequent sections of this article examine how design issues of appearance and workmanship,

as well as the related issue of contract responsibility, were specified.

A major difference between selecting and specifying products for the National World War II Memorial and a typical commercial or institutional project is longevity—the memorial is designed for centuries, not decades. For example:

- granite assemblies are either solid stone or, where stone-clad, the cladding is dimension stone at least 200 mm (8 in.) thick, not a typical 30-mm (1.25-in.) veneer;
- granite pavers are 100 mm (4 in.) thick;
- stone anchors and dowels are Type-316 stainless steel;
- stone arches are reinforced with stainless steel reinforcing bars and tension rings;
- framed plaza slabs are reinforced with epoxy-coated rebar; and
- stone paving setting beds are reinforced with epoxy-coated welded wire fabric (WWF).

There are six different types of granite in the memorial, along with the fieldstone cladding used for the contemplative area's retaining walls. Granite was selected because of its hardness, strength, and water resistance. The memorial structures themselves are Kershaw granite—a gray stone with pink and black graining. Green County stone—a beige and black granite—is the primary paving stone, while accent and border pavers are both green Brazilian granite, Rio Verde and Moss Green respectively. The copings around the Rainbow Pool are white Mount Airy granite from the same quarry that provided stone for the original Rainbow Pool. Finally, the pool in front of the Freedom Wall and the pools by each arch, as well as the Rainbow Pool aprons, are clad with Academy Black granite. Each stone type was given a designation code (e.g. ST-1, etc), which was used on the drawings to differentiate one from the others.

Nine stone finishes were specified:

- steeled (a fine-textured finish achieved by the use of steel shot);
- fine-pointed (with a 4-mm [0.16-in.] amplitude, achieved by a 9-point bit);
- coarse-pointed (with a 10-mm [0.4-in.] amplitude, achieved by a 4-point bit);
- honed;
- diamond 4-point (with a 6-mm [0.23-in.] amplitude);
- thermal;
- hand-rubbed;
- sawn; and
- smooth.

A unique coordination issue arose from the decision to have certain stone carvings provided by the contractor, while other carving and inscriptions were by Nicholas Benson of The



Workers lower the reinforcing cage for the slurry wall. The green color of the bars indicate their epoxy coating.

John Stevens Shop—a stone carver under separate contract with the government. The stonework specifications described the necessary responsibility and coordination procedures as follows:

Coordination of Carved Stone Inscriptions and Decoration

1. Certain inscriptions and carved decoration shall be provided by Contractor as Work of this Contract. Other inscriptions and carved decoration will be by sculptor under separate contract with the Government.
2. Drawings indicate which inscriptions and decoration shall be by Contractor, and which will be by sculptor under separate contract with Government, as follows:
 - a. Procedure IS-1: Carved inscription or decoration by Contractor.
 - b. Procedure IS-2: Carved inscription or decoration by sculptor, to be performed at stone fabricator's shop.
 - 1) Upon completion of sculptor's work, Contractor shall deliver stone to Project site and proceed with installation.
 - 2) Contractor and stone fabricator shall cooperate and coordinate with Contracting Officer's Representative [COR] and sculptor for sequencing and scheduling of Work and

use of stone fabricator's facilities. Stone fabricator shall provide for use of sculptor, without charge, interior climate-controlled space, equipment to move stone, electric power, task lighting, water, air compressors and hoses, and access to sanitary facilities and telephone.

c. Procedure IS-3: Carved inscription or decoration by sculptor, to be performed at Project site after installation of stone.

1) After stone to receive inscriptions or decoration has been fabricated, finished, and installed by Contractor, Contractor shall notify sculptor that stone is ready for sculptor's work.

2) Contractor shall cooperate and coordinate with COR and sculptor for sequencing and scheduling of Work and use of Project site and facilities.

a) During construction period, Contractor and sculptor jointly shall have use of premises (within Limit of Work) for construction operations.

b) Provide for use of sculptor, without charge, temporary utilities including but not limited to temporary power, water, and toilets; and scaffolding and work platforms for elevated work.

c) Special equipment, such as task lighting and air compressor, will be provided by sculptor.

Each location of stone on the drawings thus received a three-way designation—stone type, stone finish for each stone face, and contract responsibility procedure—linked back to the corresponding detailed description in the specifications. This was a complex coordination effort considering the memorial has more than 17,000 individual pieces of stone.

A multi-stage approval process was specified for stone. The first step was the submission of six 305-mm (12-in.) square by 19-mm (0.75-in.) thick samples of each stone type for each required finish, as this showed the range of color and finish expected in the work. From these samples, an approved range was selected by the architect. The next step was the construction of full-size, on-site mockups of pillars, paving, and certain other items. This helped confirm stone color and finishes on a larger scale than the 300-mm samples, demonstrated workmanship, and allowed the architect to make a final selection of mortar and grout colors.

As a result of the mock-up review, the design team made the decision to change the stone finish for typical exposed surfaces to the 9-point finish from the originally designed steeled finish (the 9-point finish brought out the stone highlights much more than the relatively flatter-appearing steeled finish). The mockups remained in place during construction to serve as a standard for the work; they were removed at project completion. Finally, in-place mockups (*i.e.* sample installations) were required to verify



While the stonework and ornamental metal specification sections were the most intricate to coordinate, the memorial's unique conditions also meant other challenges, ranging from demolition and soil conditions to waterproofing.

workmanship—these were the first portions of in-place work to be installed, and served as a standard by which subsequent work was judged.

Specifying ornamental metal

Ornamental metal work in the National World War II Memorial includes:

- bronze sheet cladding for doors and frames;
- extruded bronze gates, railings, and handrails;
- extruded bronze grilles;
- extruded bronze grate assemblies in stone flagpole bases;
- stainless steel grate assemblies in pools and fountains;
- gold-plated cast stainless steel stars;
- cast bronze drainage grates around the Rainbow Pool and at the base of ramps;
- cast bronze medallions, ornamental border, and text inlaid into stone paving;
- cast bronze trim, wreaths, and armatures for the stone pillars;
- cast bronze flagpole bases; and
- gold-plated flagpole finials.

All these items were the responsibility of the contractor to furnish and install.

In addition to the work provided by the contractor, other ornamental metal work was provided by sculptor Raymond Kaskey, FAIA (Kaskey Studio), who was under separate contract with the government. Kaskey also designed the cast ornamental fabrications provided by the contractor, including:

- the stars for the Freedom Wall;
- the wreaths and armatures for the stone pillars;
- the ornamental border around the medallions;
- the bronze drainage grates; and
- the ornamental flagpole bases and finials.

Models for these components were furnished to the contractor's foundry for its use in casting.

The cast bronze medallions set in stone paving within the Atlantic and Pacific arches are an enlarged version of the World War II Victory Medal given to each returning veteran. The specifications called for the strike for the Victory Medal to be loaned to the contractor by the Institute of Heraldry at Fort Belvoir, Virginia, for use as a guide in fabricating the medallions.

The cast bronze items, fabricated from silicon bronze (Unified Numbering System for Metals and Alloys [UNS] C87300), were the most complex fabrications to specify because these had to be cast and finished in the same way as the baldacchino sculptures and bas-relief panels provided by Kaskey.

Sand-casting is a process in which molten metal is poured into a cavity, formed by using a wood pattern duplicate of the real part, within a sand mold. Sand-cast fabrications require additional finishing to remove the sand-like texture imparted by the mold. This process was specified for the following:

- stainless steel stars;
- bronze armatures; and
- bronze medallions, ornamental border, and text to be inlaid in paving.

The bronze wreaths and ornamental flagpole bases were fabricated by the lost wax casting method (also known as 'investment casting'), an ancient process dating back to the time of the Pharaohs. Intricate shapes can be made with high accuracy because of the close tolerances that can be achieved. The mold is made by creating a pattern using wax or some other material that can be melted away prior to pouring the molten material.

As for stone, multiple finishes were required for the ornamental metal fabrications. All stainless steel was Type 316. Stainless steel grates were acid-etched and cleaned before receiving a polyester TGIC powder coating. The stainless steel stars were given a copper flash undercoat, followed by a nickel bath, then a plating of 24-karat gold that was 1×10^{-3} mm (40 millionths of an inch) thick, and finally a clear



The Freedom Wall's low stone coping is carved with the words, "Here we mark the price of freedom." The wall has 4048 sculpted, gold-plated, stainless steel stars mounted on 23 bronze panels. Each star represents 100 American deaths during the war.

electrophoretic finish for wear resistance. After completion of plating, each star was tested using X-ray fluorescence to confirm the gold plating's thickness.

The ornamental metal section also specified a custom bead-blasted finish for stainless steel light fixture housings, ground hydrant covers, and the exposed electrical boxes/covers provided under the mechanical and electrical sections of the specifications.

Bronze sheet cladding (UNS 28000 Muntz Metal, color matched to the extrusions) and the bronze extrusions for

the gates, railings, handrails, grilles, and grate assemblies (UNS 38500 architectural bronze) received a medium satin directional textured finish, followed by a protective coating of a corrosion inhibitor, an air-dry acrylic lacquer, and three coats of wax. The wax coating, consisting of a custom blend of four different types of wax, is a formulation used by the National Park Service (NPS) for the maintenance of bronze statuary.

The bronze castings received a verdigre patina finish, followed by the same protective coating given to extruded and sheet bronze fabrications. The specification for this finish was coordinated with Kaskey to match the finish of the baldacchinos and bas-relief panels. The specified chemicals, proportions, and finish procedures were noted as 'suggestive,' allowing the fabricator and finisher to vary them as necessary to achieve the matching verdigre patina finish.

The approval process for ornamental metal differed somewhat from that for stonework. Small 305-mm (12-in.) square samples were specified only for bronze cladding and the bead-blasted finish for stainless steel. Workmanship samples for brazing and subsequent finishing of cast bronze were also required, as the wreaths were cast in four sections and then brazed.

For cast ornamental work, full-size fabricated samples were required after approval of shop drawings; approved fabricated samples were returned to the contractor for use in the work. As for stone, sample installations to verify in-place workmanship were required for wreaths and armatures, railings, inlaid text in stone paving, drainage grates, and the stars.

Other specifications issues

While the stonework and ornamental metal specification sections were the most intricate to write and coordinate, the unique conditions of the memorial design meant there was no shortage of other challenges to resolve.

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One of the early steps in the site preparation process was the demolition of the original Rainbow Pool. To address concerns the tiles and coping stones might be sold for commemorative purposes, the removed items were required to be crushed and recycled for use as aggregate or fill, or otherwise disposed of without advertising their origins.

The poor soil conditions and flood plain location impacted not only the foundation design of the memorial proper, but also details such as support for the 19.8-m (65-ft) tall bronze flagpoles at the 17th Street entrance. Since a typical ground-set pole would not be stable, each pole is anchored to its own steel pile-supported foundation by an internal 1.8-m (6-ft) tall stainless steel mandrel anchor-bolted to the foundation.

To prevent floods from damaging the below-grade equipment room's delicate fountain controls and light dimming systems, the space can be sealed by a pair of watertight steel doors—the same type found on ships. These doors are designed to resist a hydrostatic head of 239 kPa (5000 psf) water pressure. One door is operated by a quick-acting central handwheel, the other by individual stainless steel and bronze dogs (*i.e.* lever handles to tighten the closure) and drop bolts. The doors have an aluminum flame spray finish, complying with Department of Defense (DOD) MIL STD 2138 A, *Metal-sprayed Coating Systems for Corrosion Protection Aboard Naval Ships*.

The two ancillary buildings southwest of the site—the NPS information pavilion and the comfort station—are clad in the

Further Reading

- Thomas B. Grooms' *World War II Memorial* (U.S. General Services Administration [GSA], 2004)
- Nicolaus Mills' *Their Last Battle* (Basic Books, 2004) ♥

same Kershaw granite used for the memorial, and are roofed with factory-pre-patinated copper standing seam roofing. This finish was chosen because it relates to the verdigre patina aesthetic of the bronze ornamentation in the memorial, without having to wait years for the roofing to weather to a naturally formed copper patina. ♥

Author's note

Writing the specifications for the National World War II Memorial has been the most rewarding experience of this author's career, and it is the project of which he is the most proud. Those who worked on the design and construction of the memorial had the opportunity to sign the back of one of the last stones placed on the project, and it is both satisfying and humbling to know one's association with the memorial will last beyond one's own lifetime.

Additional Information

Author

David Metzger, FCSI, FAIA, CDT, is a principal at Heller & Metzger, and has more than 20 years of experience in architecture and specifications. He was an associate with Hellmuth Obata & Kassabaum (HOK) and Perkins & Will, and served as the director of production for Swanke Hayden Connell's Washington, D.C., office. Metzger has taught at London, England's Thames Polytechnic School

of Architecture and Oklahoma State University School of Architecture. He was a contributing author to the seventh edition of the *Architectural Graphic Standards*, and served as chair of the American Institute of Architects (AIA) Masterspec Architectural Review Committee. Metzger is treasurer of Specifications Consultants in Independent Practice (SCIP). He can be contacted via e-mail at davem@hellerandmetzger.com.

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Abstract

This article examines the design, specification, and construction of the National World War II Memorial

in Washington, D.C. It explores both the physical and 'hidden' monument, delving into the delicate coordination of stonework, ornamental metal, and other aspects.