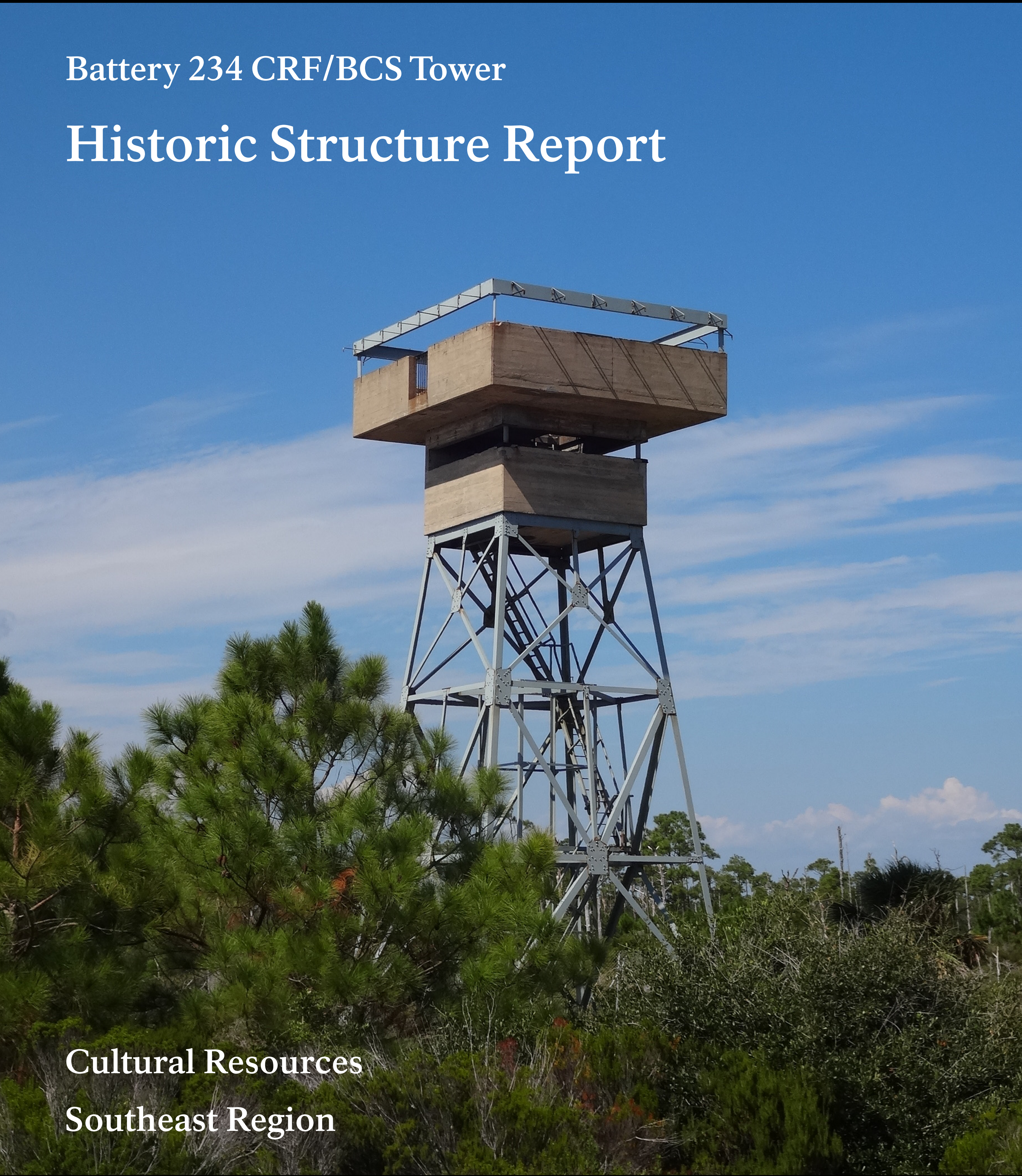
National Park Service
U.S. Department of the Interior

Gulf Islands National Seashore
Florida

Battery 234 CRF/BCS Tower

Historic Structure Report



Cultural Resources

Southeast Region

Gulf Islands National Seashore
Battery 234 CRF/BCS Tower

Pensacola Bay, Florida

Historic Structure Report

May 2015

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About the front cover: View of the Battery 234 Tower looking northeast, August 2014.

Gulf Islands National Seashore
Battery 234 CRF/BCS Tower

Pensacola Bay, Florida

Historic Structure Report

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Foreword

We are pleased to make available this Historic Structure Report, part of our ongoing effort to provide comprehensive documentation for the historic structures and cultural landscapes of National Park Service units in the Southeast Region. A number of individuals contributed to the successful completion of this work, but we would particularly like to thank the Project Team who authored the report. The authors would like to thank the staff at the Gulf Islands National Seashore who assisted with the project, including Chief of Science and Resource Stewardship Cassity Bromley, Historian/Cultural Resources Program Manager David Ogden, Historic Preservation Branch Head Jeff Halstead, and the several Park staff who assisted with the inspection of the Battery 234 CRF/BCS Tower, as well as Historical Architect Danita Brown, AIA, of the Southeast Regional Office for her assistance. We hope that this study will prove valuable to park management in ongoing efforts to preserve the buildings and to everyone in understanding and interpreting these unique resources.

Dan Scheidt, Chief
Cultural Resources, Partnerships and Science Division
Southeast Regional Office
2015

Management Summary

At the request of the National Park Service (NPS), Wiss, Janney, Elstner Associates, Inc. (WJE) has developed this Historic Structure Report (HSR) for the Coincidence Range Finder/Battery Commander's Station (CRF/BCS) Tower at Battery 234 in Gulf Islands National Seashore, Florida. Figure 1 is a map of Gulf Islands National Seashore. Figure 2 is a map of Santa Rosa Island and the Pensacola area. Figure 3 is an aerial image showing the location of Battery 234 in relation to Fort Pickens. Figure 4 is an aerial image showing the immediate area around the tower.

Although not listed individually in the National Register of Historic Places, Battery 234, including the CRF/BCS Tower, was identified as a contributing structure in the draft National Register Nomination for the proposed Fort Pickens Historic District.[1] The tower is considered to be a contributing structure in the historic district that encompasses the Endicott System and later military resources located on western Santa Rosa Island, for which a National Register nomination is currently in progress. The tower is significant for its association with World War II-era activities conducted by the U.S. Army to protect the strategically-important Pensacola Harbor. It survives with sufficient integrity to convey its historic associations. Therefore, treatment and use of the CRF/BCS Tower at Battery 234 should be considered within the context of the legal mandates and policy directives established by National Park Service Cultural Resources Management Guideline (Director's Order 28) for the protection of cultural resources.

Historical Data

The United States began development of the Third System of coastal defenses in 1816, following British attacks during the War of 1812 that indicated a need for stronger fortifications. After control of the Florida territory was transferred from Spain to the United States in 1821, the U.S. Army Board of Engineers surveyed the newly acquired coastline to identify desirable locations for defensive works. Pensacola Bay was identified as the principal Gulf Coast port, primarily because of its protected deep water harbor. To protect this harbor, the western end of Santa Rosa Island was chosen as the site for the first of the fortifications in Florida—Fort Pickens. The fort was constructed beginning in 1829 and was completed by early October 1834.

Throughout the Civil War, Fort Pickens remained under Union control. From 1862 until the end of the Civil War, Fort Pickens was used as a prison for military and political prisoners.

In the 1890s, in response to new military technology and deterioration of older fortifications, the U.S. Army began construction of the Endicott System of coastal fortifications. At Fort Pickens, this effort initially included the construction of a mining casemate in the northeast bastion of the fort in 1894–1895. Between 1897 and 1899, four reinforced concrete fortifications—

1. Anne Castellina-Dudley, Historian, Gulf Islands National Seashore, Fort Pickens Historic District National Register of Historic Places nomination form, draft, May 27, 1977.

Battery Pensacola, Battery Cullum, Battery Van Swearingen, and Battery Worth—were built in the Fort Pickens area, while a mine field was prepared for the harbor entrance. After a hurricane caused significant damage in 1906, a masonry and concrete seawall was built around the military structures in the Fort Pickens area.

Based on evolving military technology and the need to protect against attack by aircraft during World War I, new defenses were built at Battery Langdon and Battery Fixed, while anti-aircraft weaponry, searchlights, and towers were introduced in association with some of the existing batteries including Battery Worth and Batteries Cullum and Sevier between 1917 and 1919.

Beginning in the 1930s, the U.S. military foresaw the threat to coastal defenses imposed by long-range missile and carrier-born aircraft. In 1937, the military developed a prototype of a new type of battery in San Francisco that consisted of a pair of guns set within enormous casemates, between which extended a series of galleries housing ammunition magazines, power generators, storage, and operating facilities. During the next three years, similar batteries were constructed around the United States, as well as by its allies in the Western Hemisphere, to augment existing coastal defenses.

In 1940, a special War Department board prepared a master plan for coastal defenses. The plan provided a comprehensive program for the construction of standardized seacoast fortifications along the east and west coasts of the United States, as well as in allied countries in the Western Hemisphere. Two batteries were planned for the Pensacola Harbor Defense Project: Battery 233, constructed at Foster's Bank, and Battery 234, constructed at Santa Rosa Island. Both batteries consisted of a pair of 6-inch guns that had a range of 15 miles. These guns were designed to be set in a curved cast-steel protective shield, 4 to 6 inches thick, which resembled a turret. The battery's magazine, power station, communication, storage, and service rooms were located in an earth-covered concrete vault positioned between the two guns. A range section tower was constructed nearby as part of the battery complex.

After the United States entered World War II in 1941, two 90-mm anti-aircraft gun platforms were erected outside the seawall south of Fort Pickens in response to the threat posed by potential German attack. In August 1943, the planned Battery 234 was also completed outside the seawall to the east, along with a tower and range finders. Many earlier batteries were retrofitted with plotting rooms for calculating artillery ranges. Fort Pickens remained an active military installation until 1947.

In 1949, Fort Pickens opened to the public as part of the Florida State Park system. Although most steel-framed structures in the park were sold to a salvage company at this time, the tower at Battery 234 was retained as a public viewing platform. Between 1944 and 1979, the roof structure and the framing at window openings of the tower were removed. With the establishment of Gulf Islands National Seashore in 1972, public use of the fort district continued under the administration of the National Park Service. A major repair project was implemented at the tower in 1980. Due to concerns about the condition of the structure, the tower was closed to the public in 2013.

Treatment and Use

The Battery 234 CRF/BCS Tower is considered to be a contributing structure in the historic district that encompasses the Endicott System and later military resources located on western Santa Rosa Island, for which a National Register nomination is currently in progress. The tower is significant for its association with World War II-era activities conducted by the U.S. Army to protect the strategically-important Pensacola Harbor. It survives with sufficient integrity to convey its historic associations.

In recent decades, the tower has been open to visitors as an observation platform. Since 2013, however, the tower has been closed and close-up access restricted by a perimeter fence, due to concerns about its condition. As part of this HSR study, a number of potential life safety hazards have been identified; therefore, the tower should remain closed until repairs are completed. The recommended overarching treatment for the tower is determined to be *Rehabilitation*, to support returning it to use as a public observation platform while retaining and protecting historic character-defining features.

The tower is in fair to poor condition, with repairs to steel and concrete elements required to address the effects of metal corrosion. Recent maintenance work such as overcoating of the steel framing has had limited success in slowing the rate of corrosion. Therefore, more substantial repair work is recommended, including removal of all existing coatings, repair or replacement of damaged steel components (including complete replacement of the non-original stair system), and recoating with a new high-performance coating system. For the concrete observation booth, previous patching of spalls has provided limited mitigation of deterioration; corrosion of embedded reinforcing steel has continued, and cracking and incipient spalling is now apparent at both original concrete and previously patched surfaces. Concrete repairs that address corrosion of reinforcement while providing a better match to the color, texture, and form of the original concrete is therefore recommended.

Administrative Data

Locational Data

Building Name: CRF/BCS Tower at Battery 234

Location: Gulf Islands National Seashore, Florida

UTM Coordinates: 16N N: 3355313 E: 472204

Latitude/Longitude Coordinates: 30.32932 degrees north, 87.28915 degrees west

LCS Number: The CRF/BCS Tower at Battery 234 is listed in the LCS. Its LCS ID is 005395.

NPS Asset Numbers: The CRF/BCS Tower at Battery 234 asset number is 86945.

Related Studies

Bearss, Edwin C. *Fort Pickens, 1821–1895. Historic Structures Report, Historic Data Section*.

———. *Historic Structure Report and Resource Study: Pensacola Harbor Defense Project, 1890–1947, Florida Unit, Gulf Islands National Seashore, Escambia & Santa Rosa Counties, Florida*, March 1982.

Berhow, Mark A. *American Seacoast Defenses: A Reference Guide*. Bel Air, Maryland: Coast Defense Study Group Press, second edition, 2004.

Manucy, Albert. *Report on Historic Sites at Pensacola, Florida*. U.S. Department of the Interior, National Park Service, June 19, 1939.

Cultural Resources Data

The Battery 234 CRF/BCS Tower is not currently listed in the National Register of Historic Places. The tower is considered a contributing structure to the National Register-eligible district encompassing military resources located on western Santa Rosa Island.

Period of Significance: 1943–1947

Proposed Treatment: Rehabilitation

Project Scope and Methodology

The goal of the HSR is to develop planning information for use in the repair, maintenance, and preservation of this historically significant structure. First developed by the National Park Service in the 1930s, HSRs are documents prepared for a building, structure, or group of buildings and structures of recognized significance to record and analyze the property's initial construction and subsequent alterations through historical, physical, and pictorial evidence; document the performance and condition of the structure's materials and overall physical stability; identify an appropriate course of treatment; and, following implementation of the recommended work, document alterations made through that treatment.

The HSR addresses key issues specific to the Battery 234 CRF/BCS Tower, including the history and construction chronology of the structure; the existing physical condition of the materials and structural systems; and the historic significance and integrity of the tower.

The following project methodology was used for this study.

Research and Document Review. Archival research was performed to gather information about the original construction and past modifications and repairs for use in assessing existing conditions and developing treatment recommendations for the tower. Documents reviewed included maps, historic photographs, and other written and illustrative documentation about history, construction, evolution, and repairs to the structure. The research for this study built upon prior historical and archival research by the National Park Service and others, as outlined in the bibliography provided with this report. Primary reference material for this study was obtained from the Gulf Islands National Seashore collections with assistance from David Ogden, Cultural Resources Program Manager. Project team members also met with Mr. Ogden and with Jeff Halstead, Head of the Gulf Islands Historic Preservation Branch, to discuss past repair projects at the tower. Information about future planning efforts for western Santa Rosa Island within the park was provided by the National Park Service for reference in this study. Additional research material was also obtained from the National Park Service Technical Information Center (TIC) in Denver.

Condition Assessment and Documentation. Concurrent with the historical research, a condition survey of the tower was performed and observations documented with digital photographs, field notes, and annotation on existing drawings. The condition assessment included the steel and concrete elements of the tower and was conducted from the stairway and observation booth, as well as from a personnel lift parked on the loop road and parking area, providing close-up exterior access to most of the tower. As part of the condition assessment, a limited structural analysis of the tower was also conducted.

Development of History, Chronology of Construction, and Evaluation of Significance. Based on historical documentation and physical evidence gathered during the study and the concurrent National Register nomination project, a context history and a chronology of design and construction were developed. An evaluation of the significance was also prepared, taking into consideration guidelines provided by the National Register Bulletin, *How to Apply the National Register Criteria for Evaluation*.[2] This evaluation of history and significance provided the basis for the development of recommended treatment alternatives.

Guidelines for Rehabilitation. Based on the evaluation of historical and architectural significance of the structures, guidelines were

2. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: National Park Service, National Register of Historic Places, 1990, revised 1995).

prepared to assist in the selection and implementation of rehabilitation treatments.

Treatment Recommendations. The Secretary of the Interior's Standards for the Treatment of Historic Properties guided the development of treatment recommendations for the significant exterior and interior features of the buildings. Following the overall treatment approach of *rehabilitation*, which ensures preservation of character-defining features while allowing new and continued use of the structure, specific recommendations were developed to address observed existing distress conditions as well as long-term preservation objectives.[3] The tower has existing deterioration conditions that represent a potential hazard to life safety; therefore, it should remain closed to access until repairs are implemented. Overall rehabilitation of the tower is currently being planned. A scope of repairs for this rehabilitation was identified as part of treatment recommendations in this study.

Preparation of Historic Structure Report. Following completion of research, site work, and analysis, a narrative report was prepared summarizing the results of the research and inspection and presenting recommendations for treatment. The HSR was compiled following the organizational guidelines of NPS *Preservation Brief 43: The Preparation and Use of Historic Structure Reports*, with modifications to organizational structure as required for purposes of this project.[4]

3. Kay D. Weeks and Anne E. Grimmer, The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings (Washington, D.C.: National Park Service, Historic Preservation Services, 1995).
4. Deborah Slaton, *Preservation Brief 43: The Preparation and Use of Historic Structure Reports* (Washington, D.C.: National Park Service, Technical Preservation Services, 2005).

FIGURE 1. A map of Gulf Islands National Seashore in Florida and Mississippi. Source: National Park Service.

FIGURE 2. A map of Santa Rosa Island and the Pensacola area. Source: National Park Service.

FIGURE 3. Aerial photo showing the location of Battery 234 in relation to Fort Pickens at the western end of Santa Rosa Island.

FIGURE 4. Aerial photo showing the immediate area around the tower.

Developmental History

Historical Background and Context

Prehistoric Cultural Activities Associated with Santa Rosa Island

Paleo-Indian hunters and gatherers are known to have occupied and regularly traversed parts of Florida approximately 8,000 to 10,000 years before the common era (BCE). At that time, sea levels were lower than today and many areas that are now islands were thus connected to the mainland and readily accessible to early nomadic peoples.

By the beginning of the Archaic period (circa 6,500 BCE to 1,000 BCE), sea levels had begun to rise and the climate had become warmer and wetter. With this change, biological diversity within the region increased, bringing an abundance of shellfish and other food resources. Local peoples adapted by adding fishing and plant gathering to nomadic hunting activities, and populations increased significantly. Village communities are believed to have been in existence by 5,000 BCE in Florida, and watercraft are thought to have been in use for travel between regional islands and mainland areas for cultural exchange and subsistence purposes. While it is likely that peoples associated with these cultures visited Santa Rosa Island, little is known about prehistoric activities that occurred there.

The Woodland period (circa 1,000 BCE to 1,000 CE) was characterized by the introduction of the use of pottery, and increasing community development revolving around early agriculture. It was not until the Mississippian period (1,000 CE to 1,600 CE) that intensive agriculture became widespread. During a period that spanned the Woodland and Mississippian era, the Pensacola area was associated with the Deptford culture (800 BCE to 700 CE). Arising near Savannah, Georgia, the Deptford culture focused on coastal areas, spreading both northward and southward along the Atlantic shoreline as well as along the Gulf of Mexico at the Florida panhandle. Deptford culture is associated with mound burial, permanent settlements, population growth, social and political complexity, and an increasing reliance on specific crops. The Deptford culture in the Gulf region evolved into the Swift Creek and Santa Rosa-Swift Creek cultures circa 500 CE Many Deptford culture sites along the Gulf Coast may now be under water, or eroded by rising water levels, as the sea level along the coast of the Florida panhandle has risen approximately 80 inches (2.0 m) in the last 2,000 years.[5]

At European Contact during the early sixteenth century, the region was occupied by the Pensacola Indians (1,100 CE to 1,700 CE) whose territory stretched from Choctawhatchee Bay in Florida to the Mississippi River Delta near Biloxi, Mississippi. The Pensacola spoke a Muskogean language. The tribe, for which the present-day city is named, co-existed with Spanish and English settlers until the mid-eighteenth century when they assimilated into other groups.

5. Jerald T. Milanich, *Archaeology of Precolumbian Florida* (Gainesville, Florida: University Press of Florida, 1994), 115.

Early European-American History of the Pensacola Region, 1513–1821

The first recorded European visitors to the region were the Spanish. Several Spanish expeditions through the gulf during the early sixteenth century were chronicled, including that of explorer Juan Ponce de León in 1513. The first expedition to explore Pensacola Bay more extensively was recorded by Panfilo de Narvaez in 1528. An expedition led by Tristan de Luna y Arellano later tried to establish a permanent settlement in Pensacola in 1559, but the effort was short-lived. Efforts to establish colonies along the gulf shores were abandoned in favor of the eastern coast of Florida after St. Augustine was settled in 1565. Establishment of Presidio San Agustin was followed by the development of a chain of missions to its north and south that served 26,000 Christianized Indians.[6] The gulf coast did not become a focus of Spanish colonization again until the French set about controlling the region. In response, the Spanish renewed their efforts to occupy Pensacola Bay in the late seventeenth century.[7]

One of the factors contributing to Spanish interests in controlling Pensacola was its relationship to trade and shipping lanes. The Spanish regularly traveled through the gulf for trade. By the mid-sixteenth century, Spanish ships carrying silver mined in Peru and New Spain sailed across the Gulf of Mexico on their way to Spain. The Pensacola Bay area was a strategically important location along the route. As such, it became the target of Spanish occupation. The Spanish built several fortifications in the area of the bay to protect their naval interests in Florida, beginning with the fort and village of Presidio Santa Maria de Galve on the bluffs overlooking the pass into the bay in 1698.

Despite a rivalry with the French, the Spanish settlement maintained trade relations with the French in Mobile, Alabama. However, as a result of the conflict associated with the War of Quadruple Alliance (1718–1721), the French captured the Presidio of Santa Maria from the Spanish in 1719. After Spain regained control of the area in 1722 in the treaty following the conflict, they found that the presidio had been burned to the ground. Rather than rebuild in the same location, which had been subject to a series of American Indian attacks, the Spanish elected to build a new presidio on Santa Rosa Island at the mouth of the bay. Lt. Col. Alejandro Wauchope, the recently appointed governor of the area, was ordered to oversee construction of the new presidio. Wauchope chose a site for the fort located approximately one-half mile east of the western tip of the island and 240 feet south of the Pensacola Bay shoreline, where a few trees and dunes offered protection.[8] Once completed, the presidio housed soldiers, officers, and convict laborers from Mexico; women and families joined the settlement later. Hurricanes and other severe weather, however, contributed to the need for regular rebuilding of the presidio structure. A severe hurricane in 1752, which followed a series of damaging storms, destroyed much of the settlement and in response to these events, the presidio was officially abandoned in 1755.

Spain continued to control Florida until 1763, at which time it was forced to cede the territory to Great Britain as part of the treaty resulting from the Seven Years War (1754–1763). The British subsequently reorganized the territory into the

6. John W. Griffin, "Foreword," in Bonnie G. McEwan, *The Spanish Mission of "La Florida"* (Gainesville, Florida: University Press of Florida, 1993), xv.
7. William S. Coker, "Pensacola, 1686–1821," in Judith A. Bense, editor, *Archaeology of Colonial Pensacola* (Gainesville, Florida: University Press of Florida, 1996); Paul E. Hoffman, *Florida's Frontiers* (Bloomington and Indianapolis: Indiana University Press, 2002).
8. Alejandro Wauchope, Letter to Juan de Acuña, Marqués de Casafuertes, February 27, 1723. AGI Mexico 380. Translation by R. Wayne Childer on file, Archaeology Institute, University of West Florida, Pensacola.

provinces of East Florida—consisting of most of the present-day state of Florida—and West Florida, an area bounded by the Mississippi River and Lake Pontchartrain on the west, the 31st parallel on the north, and the Apalachicola River on the east. For the next twenty years, the British worked to colonize the region. Spain regained control of Florida in the 1783 Treaty of Paris resulting from the American Revolutionary War.

Control of the area was again contested during the War of 1812. In 1814, the United States Army, under the command of Gen. Andrew Jackson, waged the Battle of Pensacola against British forces and their allies—the Creek Indians—occupying the city of Pensacola, as well as the Spanish forces that controlled the city. As a result, the British abandoned the city, while the Spanish surrendered their military holdings to Jackson.

Overview History of U.S. Military Defenses, Pensacola Bay and Santa Rosa Island

United States Ownership of Florida and the Establishment of Coastal Defense Systems, 1821–1861. Spain continued to control Florida until the Adams-Onís Treaty, signed in 1819, eventually resulted in its transfer to the United States in 1821. As part of the treaty, the United States renounced any claim to Texas.

By 1821, trade activities between Atlantic and Gulf Coast ports had increased substantially, along with the number of ships passing through the Gulf. To support trade and commerce in the region, the United States government took action to protect American shipping interests in the gulf. Following his reconnaissance of the region, U.S. Navy Commodore Matthew C. Perry identified the need to establish naval bases in Florida as part of this effort.

American shoreline defenses in general had been revealed as fragmented and weak when the British burned the nation's capital during the War of 1812. Coastal defenses, comprised of the so-called Second System of fortifications, remained a haphazard assortment of batteries and outposts. In response to the dangers posed to national security during the War of 1812, a new defensive network, known as the Third System, was designed to house advanced armaments within a comprehensive collection of fortifications placed strategically along the United States coast.

In 1816, Congress appropriated more than $800,000 for establishment of the Third System coastal defenses. President James Madison appointed a Board of Engineers for Seacoast Fortifications, which visited potential sites and prepared plans for the new works. Its first report, published in 1821, suggested the creation of a chain of forts along the coast to extend from Maine to Texas.[9]

Shortly after Florida was transferred to the United States, the federal Board of Engineers initiated plans to develop the defensive system along the newly acquired stretch of coastline. Pensacola Bay was selected as the principal naval depot along the Gulf Coast due to its deep water harbor. To protect the depot, the United States determined to build several fortifications based on the Third System of coastal defense plan. The western end of Santa Rosa Island was chosen as the site for the first of these fortifications—Fort Pickens, constructed from 1829 to 1834. Later, additional forts were built at other strategic locations around the harbor and navy yard, including Fort McRee, built between 1834 and 1839, and Fort Barrancas, constructed between 1839 and 1844. Advanced Redoubt was added to Fort Barrancas in 1845–1870 to protect against landward approaches to the Pensacola Navy Yard.

Fort Barrancas was constructed on the site of the 1698 Spanish Fort San Carols de Barrancas, overlooking the entrance to Pensacola Bay north of Fort Pickens, in an area known as Warrington.

9. Coast Defense Study Group, "United States Seacoast Defense Construction 1781–1948: a Brief History," http://www.cdsg.org/cdsghis2.htm.

Fort McRee was located to the west of Fort Pickens and Santa Rosa Island, on the eastern edge of Perdido Key. Like Fort Pickens, both Fort Barrancas and Fort McRee were constructed of masonry.

Construction of Fort Pickens, named in honor of Revolutionary War hero Maj. Gen. Andrew Pickens, began in late May 1829 and was completed by early October 1834. Access to the site and delivery of construction materials occurred via the Engineers' Wharf, a structure completed on the north side of the island by 1828. The new fortification was constructed of brick and masonry in a pentagonal shape with walls 40 feet high and 12 feet thick. Other fort features included three powder magazines, protected passageways, a ditch, and flanking outerworks. Over 200 artillery emplacements were arranged to fire on all potential enemy avenues of approach. The lower walls were punctuated with openings in bomb-proof casemates for artillery, while positions were established *en barbette* (with guns elevated so as to fire over the top of a parapet rather than through embrasures) on top of the walls. Corner bastions projected forward from the fort walls to allow for cross fire.

The first garrison, Company H of the 2nd U.S. Artillery, arrived on October 21, 1834. Over time, the U.S. Army would choose not to heavily garrison the fort except during periods of military conflict, such as the Mexican-American War (1846–1848), and the Civil War (1861–1865).

The Civil War, 1861–1865. At the onset of the Civil War conflict, the fort was unoccupied. Following the passage of the secession ordinance in Florida on January 10, 1861, the U.S. Army determined that Fort Pickens was the most defensible post in the area and moved quickly to garrison the fort. Lt. Adam J. Slemmer, in charge of United States forces at Fort Barrancas, destroyed over 20,000 pounds of gunpowder at Fort McRee, spiked the guns at Barrancas, and evacuated with 51 soldiers and 30 sailors to Fort Pickens.

Despite repeated threats from Confederate attack, Fort Pickens remained in Federal control throughout the war. During the Civil War, changes in ordnance—particularly new rifled artillery—resulted in the vulnerability of masonry fortifications to destruction. This was made clear in the April 10, 1862, attack on Fort Pulaski near Savannah, Georgia, where the rifled cannon repeatedly breached the masonry walls and did extensive damage, leading to Confederate surrender of the fort. Fort Pickens, however, was not attacked by the Confederates in this way, and remained operational throughout the war.

Post-Civil War Military Use of Santa Rosa Island, 1865–1893. After the Civil War, Fort Pickens remained in use as a prison for military and political prisoners. In late October 1886, Batteries B and H of the 2nd U.S. Artillery under the command of Capt. James E. Wilson were ordered to Pensacola to guard the famous Apache warrior Geronimo; the chief, Naiche; and several other Chiricahua Apache Indians. The first group of Apache to be held at the fort consisted of fifteen men, with two more arriving a few days later. Six months later their families arrived from Fort Marion, and the number rose to forty-eight prisoners. The Apache were held at the fort for eighteen months after being captured in 1886. The prisoners attended to the routine maintenance of the grounds, and frequently entertained visitors, until their departure on May 12, 1888.[10]

During the 1880s, the only funds allocated for coastal fortifications in the United States were for maintenance, which resulted in a general decline in the defensive capacity of the structures. At the same time, changes in design of heavy ordnance suggested the need to improve coastal defensive systems and organize the armed forces accordingly.

10. Edwin C. Bearss, *Historic Structure Report, Historical Data Section, Fort Pickens, 1821–1895, Gulf Islands National Seashore, Florida/Mississippi* (Denver, Colorado: National Park Service, 1983), 766, 768–769, 770, 772–789; Thomas Muir, Jr., and David P. Ogden, *The Fort Pickens Story* (Pensacola, Florida: Pensacola Historical Society, 1989), 11–13.

In 1882, President Chester A. Arthur noted the need for heavy fixed artillery for seacoast defense in his Second Annual Message to Congress, noting "I call your attention to the recommendation of the Secretary and the board that . . . appropriations be made for high-power rifled cannon for the torpedo service and for other harbor defenses."[11]

In 1885, President Grover Cleveland convened a board, under the auspices of Secretary of War William C. Endicott, to evaluate the nation's coastal defenses and propose a program to modernize them. The Endicott Board submitted a report in 1886 recommending that twenty-three key ports, Pensacola among them, be improved through the construction of new coastal defense structures. One of the areas to be improved was Santa Rosa Island.[12]

In 1890, Fort Pickens became a U.S. Army Coastal Artillery Post, and remained under this administrative jurisdiction until the end of World War II. The new designation related to the recognition by Army leaders that heavy fixed artillery required different training programs and tactics than mobile field artillery. The role would continue to evolve; in 1901, the Artillery Corps was divided into two types: field artillery and coast artillery. The coast artillery became responsible for the installation and operation of the controlled mine fields that would be monitored, fired electrically, and protected by fixed guns, consistent with the new defensive systems that would be developed on Santa Rosa Island over the course of the next fifteen years.

Endicott System Implementation, 1893–1905. Because most of the nation's existing coastal brick and masonry fortifications were in a state of deterioration, the U.S. Army Corps of Engineers ceased funding their repair and preservation between 1891 and 1894. In January 1893, however, the Board of Engineers specifically indicated the need to begin implementing Endicott Board recommendations at Pensacola. To meet the needs of current military technology, the program, which became known as the Endicott System, would include the setting out of explosive mines in the harbor as a defense against submarines and armored warships.

The first project completed on Santa Rosa Island was construction of a mining casemate in the northeast bastion of Fort Pickens in 1894. On August 23, 1894, $8,000 was allocated to the project from appropriations for "Torpedoes for Harbor Defense."[13] To support the project, plans were made in 1894 to rebuild the Fort Pickens wharf, which had fallen into a state of disrepair. The plans included proposals for the addition of narrow gauge railroad tracks near the eastern edge of the platform that would facilitate the movement of ordnance and materials to the site of defensive improvements. Although the mining casemate was completed in 1895, work on the wharf did not begin until 1896. Together with rebuilding of the wharf, other efforts to establish the Endicott System included construction of several modernized batteries in and around Fort Pickens to accommodate newly developed rifled ordnance.

To assist in the construction of the Endicott fortifications, 7,500 feet of narrow gauge railroad track was laid on Santa Rosa Island. The wharf and railroad were effectively completed in July 1896, and readied to receive supplies.[14]

Between 1897 and 1899, four reinforced concrete fortifications—Battery Pensacola, Battery Cullum (later redesignated Battery Cullum and Battery Sevier), Battery Van Swearingen, and Battery Worth—were built in the Fort Pickens area, while a mine field was prepared for the harbor

11. The American Presidency Project, "Chester A. Arthur, Second Annual Message, December 4, 1882," Available at http://www.presidency.ucsb.edu/ws/index.php?pid=29523%7C (accessed January 12, 2015).
12. Bearss (1983), 756–759, 761.
13. Ibid., 799–804.
14. Edwin C. Bearss, *Historic Structure Report and Resource Study: Pensacola Harbor Defense Project, 1890–1947* (Florida Unit, Gulf Islands National Seashore, Escambia & Santa Rosa Counties, Florida, March 1982), 26–30, 44–46, 67.

entrance.[15] Battery Pensacola, a reinforced concrete structure, was constructed in the center of the parade ground of Fort Pickens in 1898 in anticipation of Pensacola's involvement in the Spanish American War. The railroad was used to support construction. It included two spurs that coursed south from the wharf: one led to the construction site of Batteries Cullum and Sevier, while the other extended toward the southern beach where sand could be obtained for mixing concrete. An additional spur was added in 1898 to connect the wharf with Battery Worth.

In 1898, several structures, including a torpedo (or mine) storehouse, concrete cable tank, and a loading room were constructed adjacent to the railroad between the fort and the wharf to support the mine field in the harbor. However, disaster struck on June 20, 1899, when the powder magazine in the northeast bastion of Fort Pickens exploded, sending up a shower of debris and reportedly hurling bricks as far away as Warrington on the other side of the bay. Extensive damage occurred to the mine defense facilities, which were soon rebuilt.[16] Repairs were made to the railroad track and locomotive in June 1900. Soon thereafter, the Army post was improved with new quarters, administration buildings, and maintenance facilities added to the north and west of Fort Pickens.

Development of Batteries, 1905–1945. With additional technological advances, including the development of minesweepers and torpedo boats, the coastal defenses at Santa Rosa Island were again improved with the addition of three batteries of rapid-firing cannon in 1905. These new structures included Batteries Payne, Trueman, and Cooper.

The new facilities were threatened on September 26, 1906, when a severe hurricane struck Pensacola, inflicting heavy damage on the Santa Rosa Island installation. In response, U.S. Army Corps of Engineers Chief Engineer Cavanaugh recommended erecting a concrete seawall around the installation to protect the facility from future hurricanes. Within two years, a masonry and concrete structure measuring 11 feet in height, 13 feet wide at the base, and 5 feet wide at the top had been completed. A concrete-lined ramp was constructed over the seawall to allow rail access to the wharf (Figure 5).[17] Hurricanes continued to pose a threat. On August 11, 1916, another hurricane swept away the superstructure of the wharf, leaving only the pilings.

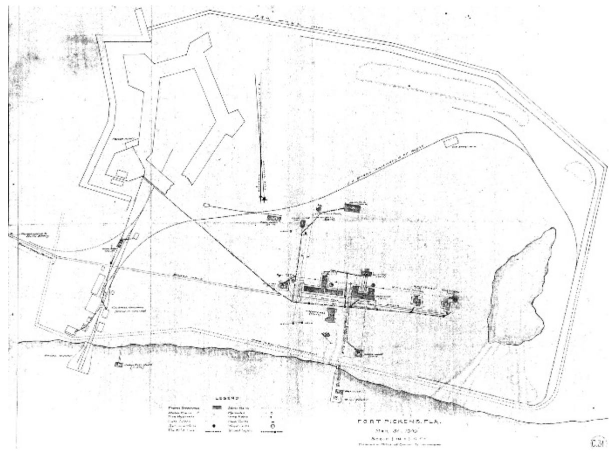

FIGURE 5. Map of the Fort Pickens area, showing the seawall under construction, 1909. Source: Gulf Islands National Seashore.

As a result of evolving military technology and the introduction of aerial bombing (from both airplanes and zeppelins) in World War I, new defenses were built at Fort Pickens, including Battery Langdon (1917–1923), the anti-aircraft Battery Fixed (1917–1918), and searchlights at several locations. Refinements in targeting led to construction of several range-finding stations and towers beginning in 1923. The 1930s saw the relocation of Battery Fixed to the east of Battery Langdon and the construction of Battery GPF to replace Battery Cooper; still more changes came with the outbreak of World War II.

When completed in 1923, Battery Langdon featured a massive casemate to protect the magazines, storerooms, and plotting room located

15. Batteries Cullum and Sevier are one structure; this structure was known as Battery Cullum until 1916. In that year, Battery Sevier was designated as such.

16. Bearss (1982), 182–196.

17. Ibid., 226–242; Muir and Ogden, 18.

between two 12-inch guns mounted *en barbette* and capable of 360-degree fire to a range of 17 miles. Responding to the effectiveness of dive-bombers in the Spanish Civil War, the German "Blitzkrieg" of 1939–1941, and the Japanese attack on Pearl Harbor, Battery Langdon's guns were casemated in 1942 (thus affording overhead protection but limiting their field of fire to 120 degrees) and a new Battery Commander's Station was built behind the battery. In 1943, two 90mm guns were located on platforms just outside the seawall south of Fort Pickens in Battery AMTB (Anti-Motor Torpedo Boat). Also in that year, Battery Trueman was relocated to old Battery Cullum, Battery Worth was converted into the Harbor Entrance Control Post and Harbor Defense Command Post, and the Harbor Entrance Signal Post was built on old Battery Sevier. In 1943–1944, improved range-finding towers were established in new locations, radar towers were constructed, and Battery 234 with its BCS/CRF tower was completed.

Fort Pickens remained an active military installation until 1947. After World War II, however, airplanes, improved sea-borne assault tactics, guided missiles, and the atomic bomb rendered the defenses at Fort Pickens obsolete. Fort Pickens was decommissioned in 1947 after 118 years of service.

In March of 1949, the War Assets Administration published a "Notice of Availability: Government Real Property for Disposal: Fort Pickens." This document noted that 87 acres had been reserved as a "Historic Monument" (the future state park), with the remaining 1,484.6 acres of land, with improvements, offered for sale as a whole. Included in the itemized list of assets were "five steel towers with steel buildings on top" and "one steel tower with concrete building on top." At the same time, the State of Florida filed an application with the War Assets Administration for all 1,571.6 acres for a park, to encompass Batteries Langdon, Worth, Cooper, and 234. As both salvage operations and land transfer proceeded, the state arranged to trade two buildings it had reserved to the salvage company in return for the tower at Battery 234. An identical tower at Fort McRee's Battery 233 on Perdido Key was dismantled, with only the concrete elements remaining today.[18]

Public Access and Park Development, 1929–1972

While the western end of Santa Rosa Island remained a military enclave, other parts of the island became the focus of preservationists and developers. Developers hoped to use the historic structure of Fort Pickens, as well as the pristine beaches of the island, to establish a tourism mecca with hotels and an amusement park, while politicians and others sought to ensure protection and open public access.

In 1929, the War Department elected to sell the majority of the island, with the exception of the Fort Pickens Military Reservation, to Escambia County, Florida, for $10,000. The land was to be used for public purposes, and the county was prohibited from further conveyance of the land except to Florida or the federal government. Escambia County later released 3 miles of the island for development at Pensacola Beach. In 1931, the first Pensacola Bay Bridge was opened, along with the bridge across Santa Rosa Sound to the island.

In the late 1930s, the National Park Service expressed interest in preserving the surviving evidence of the historic Pensacola Harbor forts. In response, Escambia County conveyed undeveloped portions of Santa Rosa Island to the Department of the Interior in 1939 based on the assumption that the National Park Service would develop the land as a park and preserve the Pensacola Harbor fortifications. In 1939, President Franklin Delano Roosevelt signed a Presidential

18. "Defense Environmental Restoration Program for Formerly Used Defense Sites, Preliminary Assessment, Fort Pickens Military Reservation, Pensacola, Escambia County, Florida, Property Number – I04FL0063," September 2007.

Proclamation establishing Santa Rosa Island National Monument.[19] Due to a lack of funding and the mobilization needs associated with World War II, the Department of Interior was not able to take action at the site for several years.

In 1941, the Department of the Interior permitted the War Department temporary use of the eastern half of Santa Rosa Island as part of Eglin Field. The U.S. Army Air Corps used the field for early rocket and missile applications and to test a replica of the German V-1. The first launch over the Gulf occurred in October 1944. In 1945 this area was assigned permanently to the War Department.

In 1946, Congress disestablished Santa Rosa National Monument based on a proposal by Congressman Robert Sikes that suggested the area be returned to Escambia County for public use.[20]

The last military garrison pulled out of Santa Rosa Island in 1947, and the U.S. Army salvaged all usable metal from the area before handing the property over to the State of Florida. An Act of July 2, 1948 (62 Stat. 1220) authorized the establishment of Pensacola National Monument, to include approximately 13 acres encompassing Fort San Carlos de Barrancas, Fort Redoubt, and Fort Pickens. In 1949, Fort Pickens became part of the Florida State Park system. The State of Florida built the first paved road on the island to access the fort in 1953–1954; the Army had relied entirely on boats to bring supplies and personnel to the island.

In 1972, the western half of Santa Rosa Island, including Fort Pickens, became part of a newly formed unit of the National Park System known as Gulf Islands National Seashore.[21]

Chronology of Development and Use

Planning and Construction of Battery 234

Beginning in the 1930s, the U.S. military foresaw the threat to coastal defenses imposed by long-range missile and carrier-born aircraft. This concern, and the rapidly growing emphasis on national defense, were further amplified by a series of victories by the German army in the spring of 1940 and the Japanese attack on Pearl Harbor on December 7, 1941.

In 1937, the military developed a prototype of a new type of battery in San Francisco that consisted of a pair of guns set within enormous casemates, between which extended a series of galleries housing ammunition magazines, power generators, storage, and operating facilities. The structure had a thick reinforced concrete roof with overhead cover and was designed to withstand direct hits from battleships and aerial attack. During the next three years, similar batteries were constructed around the United States, as well as by its allies in the Western Hemisphere, to augment existing coastal defenses.

In 1940, a special War Department board prepared a master plan for coastal defenses. The plan provided a comprehensive program for the construction of seacoast fortifications along the east and west coasts of the United States, as well as in allied countries in the Western Hemisphere. Unlike the large-scale Endicott coastal defense structures, which utilized a variety of artillery and customized equipment, the new structures had standardized equipment. Variations of the batteries consisted of 16-inch, 12-inch, or 6-inch gun batteries. The standardization of the machinery allowed for standardized plans,

19. Proc. No. 2337, May 17, 1939, 53 Stat 2542.
20. National Park Service, Bureau of Outdoor Recreation, "A report for the Proposed Gulf Islands National Seashore" (January 1968), 1.
21. Gulf Islands National Seashore was established "to preserve for public use and enjoyment certain areas possessing outstanding natural, historic, and recreational values." 16 U.S. Code sec. 459h (a) (Pub. L. 91-660.); Bearss (1982), 248–250; Muir and Ogden, 21.

simplified training and implementation, and reduced the number of staff required to man the facilities.[22]

Two batteries were allotted for the Pensacola Harbor Defense Project: Battery 233, constructed at Foster's Bank, and Battery 234 constructed at Santa Rosa Island (Figure 6). Both batteries consisted of a pair of 6-inch guns that had a range of 15 miles. These guns were designed to be set in a curved cast-steel protective shield, 4 to 6 inches thick, which resembled a turret. The battery's magazine, power station, communication, storage, and service rooms were located in an earth-covered concrete vault positioned between the two guns. A Coincidence Range Finder/Battery Commander's Station (CRF/BCS) tower was constructed nearby as part of each battery complex.[23]

Battery 234 was substantially completed by August 1943 and consisted of two gun positions spaced 210 feet apart, a battery that spanned between the gun positions, and a range section tower located approximately 200 feet northwest of the battery. The gun positions consisted of a concrete foundation with a circular plan. At the time the structure and gun mounts were completed, the 6-inch guns and barbette carriages had not arrived.

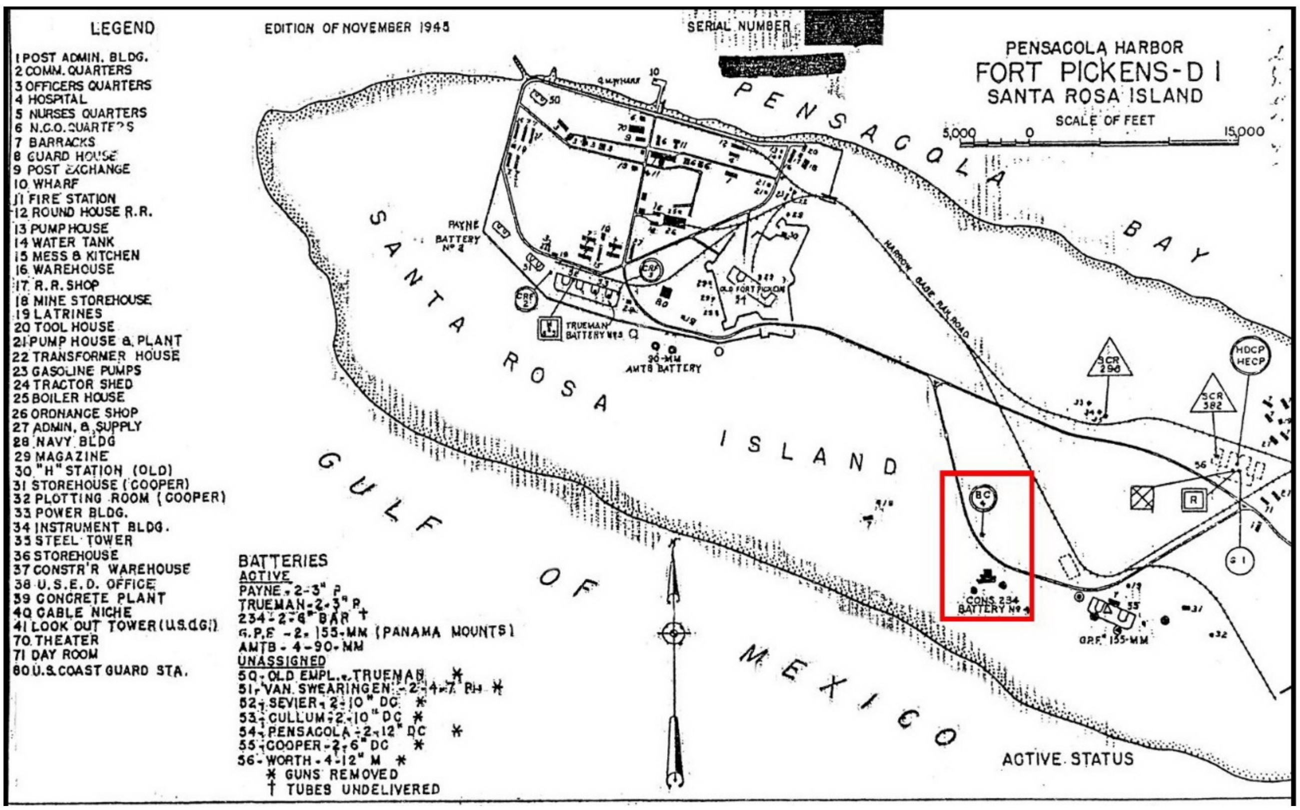

FIGURE 6. Map of Fort Pickens and environs, December 1945, showing the World War II-era defenses of Pensacola Harbor. Battery 234 is marked by the red box. Source: U.S. Army drawing archived as NPS Drawing No. 635-61263A.

22. Emanuel Raymond Lewis, *Seacoast Fortifications of the United States: An Introductory History* (Annapolis, Maryland: Naval Institute Press, 1979), 115–118.

23. Bearss (1982), 293–295.

The battery was constructed as a one-story building measuring 144 feet long by 86 feet 6 inches wide, with 6-foot-thick reinforced concrete walls and roof. The structure was concealed by a 3 foot cover of earth and sand. The battery had cross-axial corridors, one of which extended between the gun positions and the other that extended from the main entrance on the north. The corridors provided access to the store room, compressor room, shell rooms, powder rooms, spotting room, plotting room, switchboard room, fuel pits, muffler gallery, air lock, water cooler room, and latrine (Figure 7 through Figure 10).[25]

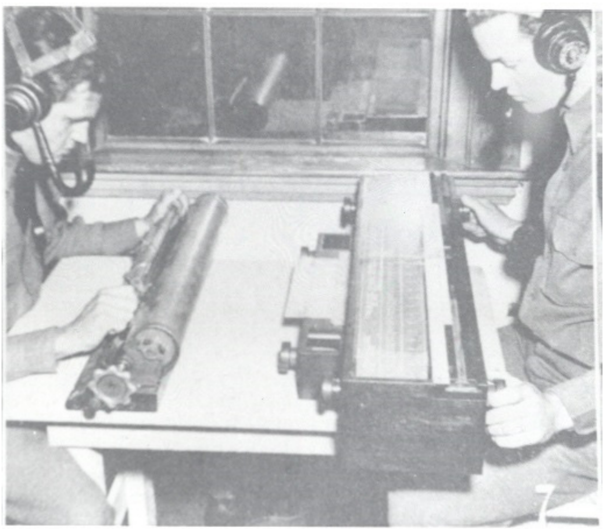

FIGURE 7. Archival photograph of a data computer in use. Source: Gulf Islands National Seashore, catalog no. 3426.

FIGURE 8. Information being taken from an azimuth computer. Source: Gulf Islands National Seashore, catalog no. 3427.

FIGURE 9. A plotting board in use in an old magazine room of a battery. Source: Gulf Islands National Seashore, catalog no. 3428.

25. *Report of Completed Works, Seacoast Fortifications*, September 16, 1943; corrected July 1944.

FIGURE 10. A plotting board in use in a battery. Source: Gulf Islands National Seashore, catalog no. 3429.

The CRF/BCS Tower at Battery 234 was a 52-foot-tall concrete and steel tower with a wood-framed roof covered with built-up tar and gravel (Figure 11). The structure consisted of a concrete footing; a 35-foot 8-inch-tall steel structure; and a two-level cast-in-place concrete observation booth with 8-inch-thick concrete walls, approximately 16 feet tall.

The lower level of the observation booth housed the Battery Commander's Station (Figure 12). The Battery Commander's Station was manned by the Battery Commander, the recorder, azimuth reader, and three operators, and oversaw the command to fire.

The upper level observation booth was larger in plan than the lower level and was used as the Coincidence Range Finder station (Figure 13 through Figure 15). The upper level had a 15 foot CRF observing instrument (Figure 14). The Coincidence Range Finder station was manned by an observer and a reader who worked together to track and record the location of a target.

In the early years of seacoast defenses, gun ranges were limited to a few miles or less and aiming techniques were simple and primarily visual. However, by the 1890s, ranges had reached almost 10 miles, and determination of precise range had become more challenging. In response to the need for a more accurate system, the horizontal-base and vertical-base methods of range-finding were developed. These systems remained in use, with various refinements, until the development of radar during World War II.

As described in *American Seacoast Defenses: A Reference Guide*:

> Prior to the development of radar, range finding was conducted using triangles. With one side and two angles known, the remaining angle and the length of the other two sides of the triangle could be calculated. The key choice was between vertical and horizontal triangles. A vertical triangle relied on an elevated observing instrument, or depression position finder (DPF). The angle at which the instrument was pointed down to see the target was measured, and from this the range to the target was calculated.
>
> A horizontal triangle, on the other hand, used two instruments in separate stations with a carefully measured base line and the target, and this information, combined with the length and azimuth of the base line, established the location of the target. Single-station self-contained range finders were a further development of the horizontal-base method, but since accuracy was proportional to the length of the baseline, self-contained range finders were inherently less accurate, especially at longer ranges. Both vertical and horizontal methods involved advantages and disadvantages.[26]

Advantages of the vertical-base type system included that it required only one station, and could be located above the plotting room; however it also required that the instrument be elevated. Thus, in low-lying areas such as the Gulf Coast, towers needed to be constructed. These structures were expensive and potentially vulnerable to attack.

While all position finding systems furnished data for use in pointing guns at a target, in seacoast artillery the problem was complicated by the fact that the target was expected to be moving. The lapse of time between when an observation was

26 . Bolling W. Smith, "Fire Control and Position Finding: Background," in Berhow, 256–264.

taken and the guns were fired also needed to take into account in the calculations. [27]

Locating the moving target was accomplished by an operation called "tracking," which involved identifying successive positions of the target at regular intervals of time, and plotting these positions on a plotting board. The 15 to 30-second time interval between successive observations, called the "observing interval," was indicated by time interval (TI) bells or buzzers that sounded simultaneously in all stations of the battery.[28]

As further described in *American Seacoast Defenses*:

> In the vertical base system, the target was located by the offset method used in surveying, in which the direction and distance of the target from a known point were determined. The direction was determined by reading the azimuth . . . . The distance was determined by the depression angle method which involved the solution of a vertical right triangle of which the known leg was the effective height of the observation instrument above sea level, the hypotenuse was the line of sight from the observer to the target, and the unknown leg was the desired range to the target. The known angle was the complement to the angle between the hypotenuse and the known side, corrected for refraction. It was called the depression angle. The triangle was solved mechanically by the observation instrument called a "depression position finder" (DPF). This system required but one observation station, the azimuth and range to the target being read from the same instrument.
>
> The *observer* tracked the target in azimuth with the vertical cross wire . . . . At the same time he tracked the target in range with the horizontal cross wire. In the plotting room, only one arm of the plotting board was used. The azimuth and range was received from the *reader* at each sounding of the TI bell. The *arm setter* set the arm in the azimuth and repeated the range to the *plotter* who marked the point at that range by means of range graduations along the edge of the arm.[29]

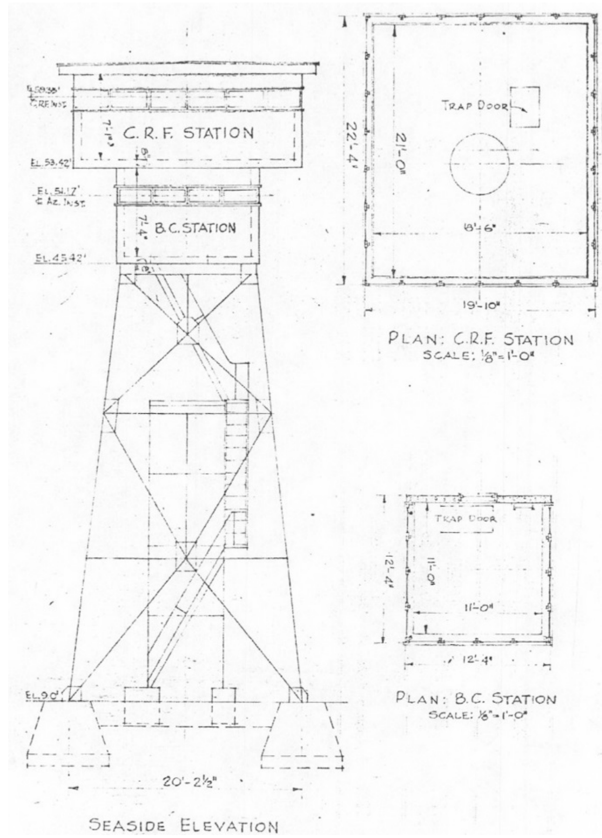

FIGURE 11. Design drawing for the Battery 234 tower, showing the steel frame supporting the two-level concrete observation booth. Source: *Report of Completed Works*, 67, citing National Archives, A52-87 [as noted on drawing], Box 108.

27. Ibid.
28. Ibid.
29. Ibid.

FIGURE 12. The battle board in a Battery Commander's Station. Source: Gulf Islands National Seashore, catalog no. 3425.

FIGURE 13. Azimuth scope (left) and depression position finder (right) on the upper level of a CRF/BCS Tower. Source: Gulf Islands National Seashore, catalog no. 3423.

FIGURE 14. Coincidence range finder at harbor defenses of Portland, Maine. Source: Berhow, 263.

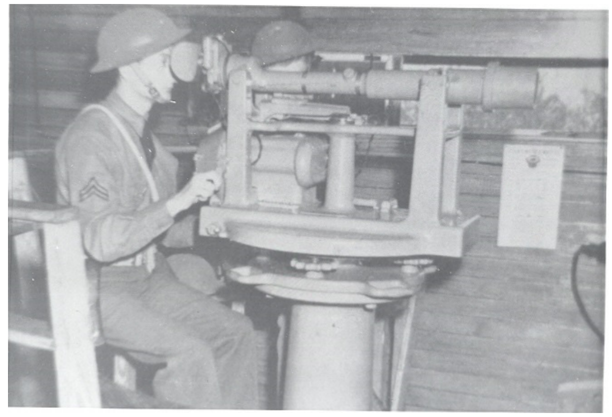

FIGURE 15. The depression range finder in a Coincidence Range Finder station. Source: Gulf Islands National Seashore, catalog no. 3424.

The Battery 234 CRF/BCS Tower was completed in 1943 at a cost of $13,853. It was transferred to the Southern Defense Command on June 20, 1944.[30] The completed tower is shown in Figure 16.

Although not specifically indicated for the Battery 234 CRF/BCS Tower, exposed exterior concrete surfaces of the batteries were often darkened to reduce glare. The treatment consisted of 30 parts portland cement to 1 part lampblack, by weight. Use of a cementitious coating was found to be more cost effective than oil-based paint.[31]

By the time that Battery 234 was completed, the threat of coastal attack had greatly diminished and there was no longer urgency to arm the batteries. [32] The gun positions remained unarmed until 1946, at which time barbette gun carriages No. 61 and 62 were received and installed.[33]

30. Ibid.
31. Bearss (1982), 299.
32. Ibid., 293–295.
33. Ibid.

FIGURE 16. The Battery 234 tower as completed, photograph dated August 26, 1946. Source: Gulf Islands National Seashore, catalog no. 946.

Decommissioning of Battery 234

In 1947, Fort Pickens was deactivated. As a result, guns and carriages at the various batteries were demilitarized, destroyed, and the material salvaged. As part of this effort, the barbette gun carriages at Battery 234 were demilitarized. The 6-inch guns originally planned for the battery were never received and the battery was never fully armed. [34]

In 1949, Universal Enterprises, Pensacola Division, purchased battery tower structures within the park. That same year, the firm began removal of the structures in an effort to salvage the steel. At the request of the Florida Board of Parks and Historic Memorials, the CRF/BCS Tower at Battery 234 was left undisturbed. In exchange, the War Assets Administration agreed to allow Universal Enterprises to dismantle and salvage steel-framed Buildings No. 9 and 105 (the Latrine and the Carpentry Shop).[35] The tower at Battery 234 remained the only standing battery tower in the park.

At some point between 1947 and 1979, the rafters and decking of the roof structure and the framing at window openings of the observation booth of the tower were removed. Physical evidence indicates the location of original mullion supports at window openings.

National Park Service, 1979 to Present

1979–1980 Repairs. In 1979, construction documents were developed for the rehabilitation of the tower. The repair drawings, dated August 12, 1979, were designed by Pensacola Testing Laboratories, Inc., and included the construction of a new center stair tower, repair or replacement of identified structural members, supplemental riveting, stripping and recoating of the tower, and limited patching of spalled concrete.[36] The repair drawings are included in Appendix B, for reference.

Fidelity Construction Company of Fredericksburg, Virginia was the selected contractor. Work began on March 30, 1980. As indicated in Change Order No. 1, dated June 13, 1980, the steel structure was to be painted "Olive Drab" with Sherwin Williams "hi-level exterior gloss paint" or approved equal.[37] Shop drawings for the stairs were designed by Bell Steel Company of Pensacola, Florida, and were submitted for approval on September 17, 1980. The shop drawings are included in Appendix C, for reference. The project was completed in December 1980 at a total project cost, including change orders, of $78,516.16.[38]

34. Ibid.
35. Letter from M. B. Greene of the Florida Board of Parks and Historic Memorials to L. D. Strom, Regional Director of the War Assets Administration, November 23, 1949.
36. NPS drawing 635-80072A, "Battery 234: Rehabilitation of Observation Tower," (Pensacola Testing Laboratories, Inc., August 1979).
37. Change Order No. 1, June 13, 1980.
38. "Completion Report: Rehabilitate Observation Tower, Battery 234," (April 20, 1982).

Later Work. In October 2000 and April 2001, volunteers representing the 13th Coast Artillery set up a temporary installation of military equipment to interpret the military role of Santa Rosa Island, specifically Battery 234 and Battery Cooper, during World War II.[39]

In response to deterioration of the steel and concrete structure, the tower was closed to the public in 2001, and a chain link fence erected around its base.[40] A chain link fence to restrict access was constructed around the tower and other vulnerable structures in 2004–2005, after Hurricane Ivan. The fencing was removed to permit repair work on the tower in 2008.[41]

2008–2009 Repairs. In late 2008 and early 2009, a major rehabilitation program was undertaken (Figure 17 through Figure 23).[42] The contract was for a design-build project, with the selected firm responsible for preparing a report and scope statement as well as performing the repairs. The work included concrete and steel repairs, treatment of the concrete to mitigate future corrosion, and cleaning and repainting of the steel structure. The selected firm, American Contractor and Technology, Inc., completed its inspection and prepared the project manual in the summer of 2008. Work began in December 2008. (Refer to the Treatment and Use chapter for a discussion of the performance over time of these repairs.) The scope of repairs included the following items:

- *Steel repairs*. The contractor's proposal indicated that "unsafe" portions of the steel structure would be cut out and replaced. This included replacement of the stairway landings with new diamond-pattern steel plate to match the older plate (Figure 17 and Figure 18); replacement of the stairway handrails to match the previous configuration; and the installation of an entirely new 42-inch-high steel pipe guardrail at the upper observation level around the ladder access opening (Figure 19).
- *Lower observation level repair*. The pipe columns at the southeast and southwest corners of the lower observation were judged to be corroded beyond repair (Figure 20). With the upper level temporarily shored, the original pipe columns were cut out. Major concrete spalls adjacent to the columns were reportedly removed, and new patching mortar was parged in place to replace the spalled portions of the concrete structure. Finally, two new columns were installed, matching the diameter of the original columns, but secured by welded channel sections that wrapped around the concrete at the top and bottom of the column, rather than being embedded into the concrete as in the original design.
- Replacement of the steel guardrail ("fence") on the west side of the upper observation level was completed as part of the work (Figure 21). However, given the existing condition of this

39. Gulf Islands National Seashore Annual Narrative Report, October1, 2000, through September 30, 2001, 5.
40. David L. Ates, Architect–Project Manager, Architecture Division, Southeast Regional Office, National Park Service, "Statement of Work: Stabilize & Repair Historic Military Observation Tower at Battery 234," May 2008, amended September 2008.
41. William B. Nicholson, P.E., American Contractor and Technology, Inc., to Andre Ward, Gulf Islands National Seashore, August 25, 2008 (Solicitation No. N5320080065, "Stabilize and Repair Historic Military Observation Tower at Battery 234"), illustration 10.
42. "Proposal, Stabilize and Repair Historic Military Observation Tower at Battery 234, Gulf Island National Seashore, Gulf Breeze, FL," Subject: Solicitation No. N5320080065, American Contractor and Technology, Inc., Gulf Breeze, Florida, August 14, 2008; Preconstruction Minutes, Historical Observation Tower Work, Contract. No. C5320080065, December 18, 2008; ACT Project Manual: Stabilize and Repair Historic Military Observation Tower at Battery 234, Gulf Island National Seashore, Gulf Breeze, FL, Contract No. C5320080065.

guardrail, it appears that work had very limited durability.

- Other limited concrete repairs were performed. The repairs consisted of chipping to remove spalled material and patching with a proprietary cementitious repair mortar, Sika Armatec 110 EpoCem. The patches have a gray color that contrasts with the buff color of the original concrete surfaces. Based on observed existing conditions, patches were primarily made to the underside of the lower observation deck floor slab and the underside of the cantilevered portion of the upper observation deck floor slab; refer to Figure 22. Small spots were also patched on the inside face of the walls at both levels of the observation deck; refer to Figure 19. Reinforcing steel exposed during this work was reportedly coated with Sika Armatec 110 EpoCem, a proprietary three-part epoxy-modified cementitious rust-inhibiting coating.

- *Steel repainting*. All steel elements were reportedly cleaned, spot primed, and painted. This included pressure washing the surface with water to remove loose paint flakes and rust, while leaving well-bonded existing paint in place. Areas of corrosion were prepared using power tools. According to information provided by park personnel, Sherwin Williams Macropoxy 920 Pre-Prime, a two-part penetrating epoxy primer, was applied, followed by a topcoat of Sherwin Williams Epoxy Mastic Aluminum II, a two-part aluminum filled epoxy paint.

- *Concrete treatment*. Documentation indicates that all concrete elements, including the foundation pads, were treated with PermaTreat corrosion inhibitor, as manufactured by Innovative Engineering Technologies; however, park personnel have confirmed that this product was not used.

The repair project was completed by February 2009, and the tower was reopened to the public (Figure 23).

FIGURE 17. Deterioration of the upper stair landing, 2008. Source: Gulf Islands National Seashore.

FIGURE 18. Deterioration of the stairs, 2008. Source: Gulf Islands National Seashore.

FIGURE 19. View of the upper observation level, August 2014, showing the steel guardrail and mortar patches installed as part of the 2009 work. Photo by the authors.

FIGURE 20. Corrosion of the southwest corner column and cracking and spalling of concrete at the lower observation level, 2008. Source: Gulf Islands National Seashore.

FIGURE 21. View of the upper observation level, 2008. Replacement of the railing at the west side was proposed. Source: Gulf Islands National Seashore.

FIGURE 22. View of the underside of the concrete structure, August 2014. The gray-colored mortar patches were installed as part of the 2009 work. Photo by the authors.

FIGURE 23. The Battery 234 tower after rehabilitation, February 4, 2009. Source: Gulf Islands National Seashore.

After further deterioration presented significant safety hazards, the tower was again fenced in 2013. According to the Superintendent's Compendium, the tower was closed to public access in that year.

Fort Pickens Battery 234 Tower Chronology

1834	Fort Pickens was completed on the western edge of Santa Rosa Island.
August 1943	The CRF/BCS Tower at Battery 234 was completed.
1944	The CRF/BCS Tower at Battery 234 was transferred to the Southern Defense Command.
1947	Fort Pickens was decommissioned.
1949	Fort Pickens became part of the Florida State Park system. Battery tower structures on Santa Rosa island were removed, with the exception of the CRF/BCS Tower at Battery 234, which remained at the request of the Florida Board of Parks.
After 1947, before 1979	Roof structure and framing within window openings at the lower level Battery Commander's Station were removed.
1972	The western half of Santa Rosa Island, including Fort Pickens, became part of the newly established Gulf Islands National Seashore, under the administration of the National Park Service.
1980	A new stair tower was constructed, and the repair and replacement of identified structural members was completed. The steel structure of the tower was also recoated at this time.
2001	The tower was closed to the public due to deterioration.
2009	The tower was rehabilitated, including localized concrete repairs, replacement of selected stairway components, and repainting of the steel structure.
2013	The tower at Battery 234 was closed to the public. A chain link fence was erected around the tower at this time.

Physical Description and Condition Assessment

Site

The Coincidence Range Finder/Battery Commander's Station (CRF/BCS) Tower at Battery 234 is a steel and concrete observation tower located in the Fort Pickens unit of the Gulf Island National Seashore (Figure 24). The tower is located south of Fort Pickens Road, the main east-west road that runs the length of the island. The tower is accessed from an asphalt-paved one-way loop road, which passes within 10 feet of the southwest corner of the tower. A paved parking lot is located along the north side of the loop road southeast of the tower. Battery 234 is just to the south of the tower facing the Gulf of Mexico, and Battery Cooper is several hundred yards away to the southeast, also along the loop road. Gun emplacements for Battery 234 face the seashore (Figure 25). The site is characterized by shrub-covered sand dunes. The tower is approximately 600 feet from the shore (Figure 26).

FIGURE 24. CRF/BCS Tower at Battery 234. Source: All images in this chapter by the authors, August 27, 2014, unless noted otherwise.

FIGURE 25. View north from the beach past one gun emplacement and Battery 234 to the tower beyond.

FIGURE 26. View south from the tower to the Gulf of Mexico. The earth-covered Battery 234 is at center.

Overview

Measured drawings of the tower are provided in Appendix D.

The CRF/BCS Tower is approximately 50 feet tall and consists of a concrete foundation, steel-framed structure, and a two-level concrete and steel observation booth (Figure 27). At the center of the structure is a steel-framed stair that extends from grade to an access hatch on the underside of the lower level of the observation booth. As part of a major repair project implemented in 1980, many of the steel tower components were replicated and replaced, and the center stair structure was completely replaced.

FIGURE 27. View of the tower from the south.

Foundation

The tower has a concrete strap foundation consisting of four footings, each measuring 4 feet square, which define the corners of the square-shaped plan, and 12-inch-wide grade beams that extend between the footings (Figure 28). The overall foundation plan, from the outside edges of the footings, measures 27 feet 6 inches square. The top 18 inches of the foundation extend above grade. Centered within the tower foundation are four concrete footings that support the stair structure. Three of these footings measure 2 feet square, and the fourth measures 3 feet square (Figure 29). The footings are arranged in a square, with the larger footing located at the southwest corner to support the bottom stair riser and form a landing near grade. The stair footings are spaced 6 feet 6 inches on center. Figure 30 is a foundation plan of the tower.

FIGURE 28. One of the corner footings of the foundation, with grade beams connecting to the other corners of the tower.

FIGURE 29. The four concrete footings for the stair structure.

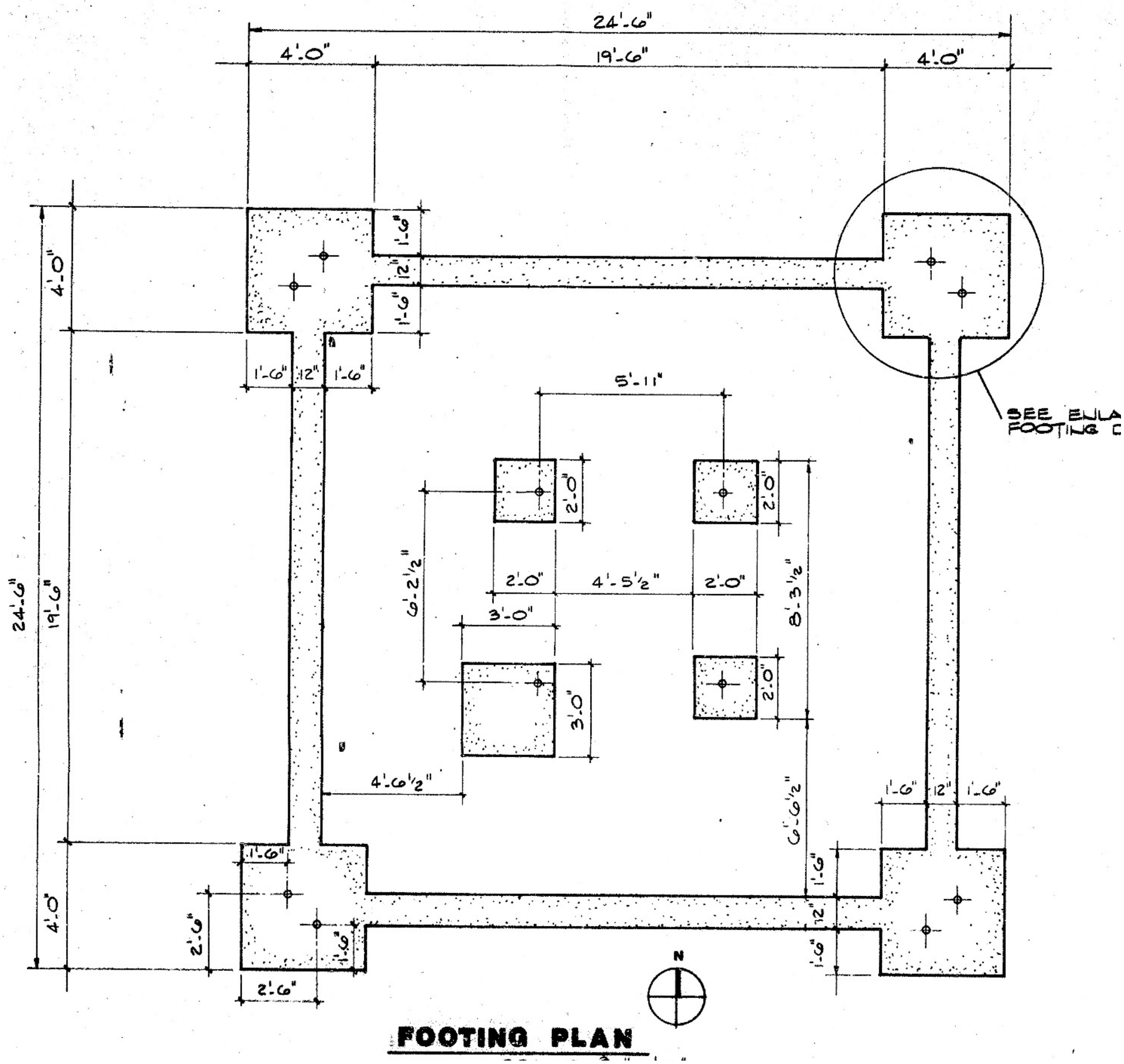

FIGURE 30. Foundation plan of the tower. Source: NPS drawing 635-80072A, sheet 2, “Battery 234: Rehabilitation of Observation Tower,” August 1979.

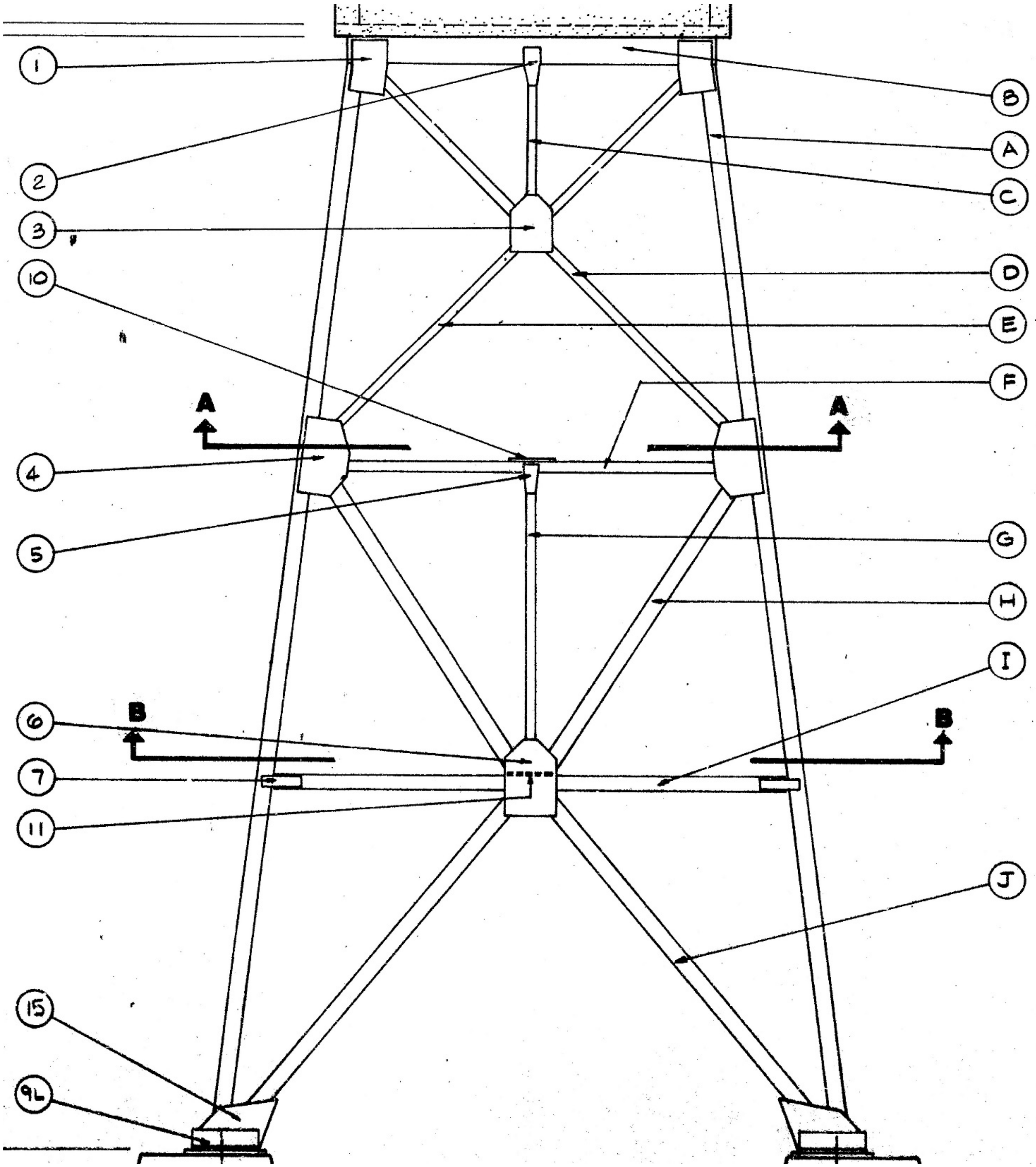

FIGURE 31. Elevation of the tower, with gusset plates indicated by numbers and framing members indicated by letters. Source: NPS drawing 635-80072A, sheet 3, "Battery 234: Rehabilitation of Observation Tower," August 1979.

Primary Steel Structure

The concrete foundation supports a tapered steel-framed structure that is approximately 35 feet 8 inches tall and is painted light grey (Figure 31 and Figure 32).

The steel-framed tower is mounted to the concrete corner footings using an assemblage of steel plates, angles, and irregular-shaped gusset plates riveted together and anchored to the foundation with two anchor bolts embedded into the concrete (Figure 33 and Figure 34). The assemblage consists of a 1-inch-thick steel chamfered square base plate, measuring 25 inches on its long sides, with steel 6 x 8 x 1/2 angles riveted to the two outside edges, perpendicular to each other. Archival documentation indicates that approximately four of the angles were replaced as part of the 1980 repairs.[43] A 2-inch-diameter anchor bolt extends through each angle and the plate and anchors the steel to the concrete footing. Gusset plates, 1/2 inch thick and with an irregular polygonal shape, are riveted to the vertical leg of the angles and support the corner framing members and cross bracing. Construction documents indicate that two of the eight gusset plates were replaced in 1980.[44]

FIGURE 32. Overview of the west face of the steel-framed tower.

FIGURE 33. One of the typical riveted gusset plate-angle assemblies at the base of the tower, anchored to the concrete footing with two anchor bolts (arrow indicates one bolt).

FIGURE 34. A view of one of the base assemblies.

The major corner columns of the tower are composed of 6 x 6 x 5/8 steel angles that extend the full height of the structure (Figure 35). (The corner columns are indicated as element A on the 1979 drawings.) These columns are inclined at a 10 degree angle so that the tower is larger in plan at the bottom than at the top. At the base, the tower measures 24 feet 6 inches. Each corner column is riveted to the base anchorage assembly with sixteen rivets, eight for each flange. Each flange of the corner column has four rivets through the combined steel angle with gusset plate, and four through only the gusset plate (Figure 36). At the top of the tower, the structure measures 12 feet

43. NPS drawing 635-80072A, "Battery 234: Rehabilitation of Observation Tower," August 1979.

44. Ibid.

6 inches square and supports a steel frame consisting of four 10-inch channels that are connected at the inside corners with riveted steel angles (Figure 37). Supplemental steel reinforcing plates added as part of the 1980 repair are spot welded to the inside face of the channel web. Some of these plates are no longer present. The exposed steel channel at these plate locations is uncoated. (The steel channel members at the top of the tower are indicated as element B on the 1979 drawings.) Each corner column leg is connected to the channel frame by a pair of irregular-shaped six-sided gusset plates, measuring 13-1/4 inches wide by 19 inches tall by 3/8 inches thick, which are riveted to each face at the outside corner of the tower (Figure 38). (This gusset plate connection is indicated as plate 1 on the 1979 drawings.)

FIGURE 35. View of the tower at the southwest corner.

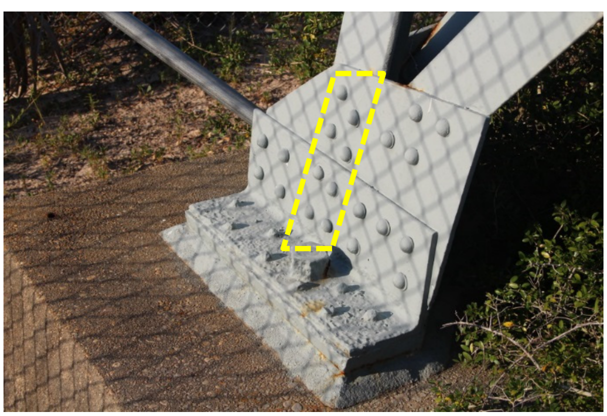

FIGURE 36. The dashed line indicates the eight rivets that connect the primary corner column to the base anchorage assembly.

FIGURE 37. View of the top frame of the steel structure, formed by 10-inch channels. At left, where the 1980 web reinforcing plate is missing, the surface of the channel is uncoated and has extensive corrosion.

FIGURE 38. One of a pair of six-sided gusset plates that connect the corner column to the channel frame at the top of the tower.

The corner columns are laterally supported by diagonal bracing members and horizontal brace frames that divide the structure into three framing series. The horizontal brace frames consist of 5 x 5 x 5/16 angles that span between the corner columns and bracing members that spans between the midpoints of the framing angles (Figure 39). The horizontal framing members are connected with riveted gusset plates (Figure 40). The lower horizontal bracing frame (element I) is approximately 12 feet 4 inches above the foundation and measures 20 feet 4 inches square in plan. The upper horizontal bracing frame (element F) is approximately 22 feet 4 inches above the foundation and measures approximately 17 feet 4 inches square in plan.

FIGURE 39. Node at the first tier of horizontal bracing, showing the intersection of the four diagonal members forming the "X" bracing on the tower face (yellow arrows) and two diagonal members form the bracing in the horizontal plane (red arrows). These plates are noted as plates 6 and 11; refer to Figure 31.

FIGURE 40. View of the gusset plate at midspan of the upper tier of horizontal members (plates 5 and 10; refer to Figure 31).

At each level of horizontal bracing, there are four diagonal 5 x 5 x 3/8 angles that brace the tower in the horizontal plane. These elements extend horizontally from the midpoint of each horizontal bracing member, to the adjacent face of the tower (Figure 41). These members are elements K and L at the upper and lower tiers, respectively.

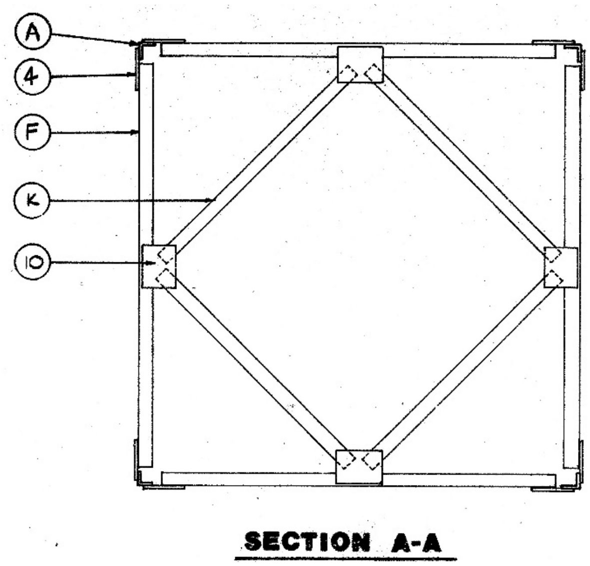

FIGURE 41. Plan section showing diagonal bracing members connecting to the midpoint of each horizontal member. Source: NPS drawing 635-80072A, sheet 3, "Battery 234: Rehabilitation of Observation Tower," August 1979.

Diagonally-oriented bracing members extend between adjacent corner columns and form two tiers in an "X" pattern around the perimeter of the structure (Figure 42). The lower X extends from the base anchorage assembly to the upper horizontal bracing frame, crossing the lower horizontal bracing frame at midspan (elements H and J, refer to Figure 39). The upper X extends from the upper horizontal bracing frame to the top frame of the structure (elements D and E).

At the intersection of the diagonal bracing members is a six-sided gusset plate measuring 29 inches tall by 19-1/2 inches wide by 3/8 inches thick (Figure 43). The gusset plate at the upper tier of bracing is plate 3, while the similar plate at the lower tier is plate 6 (refer to Figure 31).

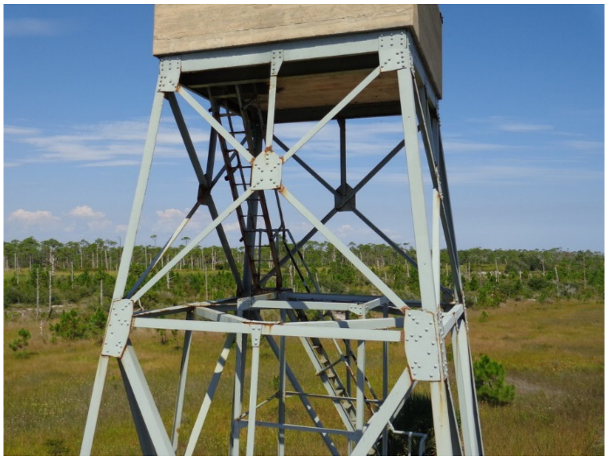

FIGURE 42. The upper tier of diagonal bracing.

FIGURE 43. Six-sided gusset plate at intersection of the upper tier of X bracing.

At each six-sided gusset plate, vertical bracing members extend upward from the gusset plate to the horizontal frame members above. These vertical members are 3-1/2 x 3-1/2 x 5/16 angles. At the upper tier of bracing, the vertical member is element C, while at the lower tier, it is element G.

Throughout the steel-framed tower structure, connections between steel framing members consist of riveted gusset plates. Typical rivets are approximately 1 inch in diameter and have a semicircular head (Figure 44). There appear to be multiple vintages of rivets, which can be distinguished through slight differences in the marks on the head and shape of the rivet buck-tail. It appears that replacement rivets typically have an irregular-shaped ring around the head of the rivet (Figure 45). At the stair structure, the rivets have a conical-shaped buck-tail (Figure 46).

FIGURE 44. Typical rivets used for connections throughout the structure.

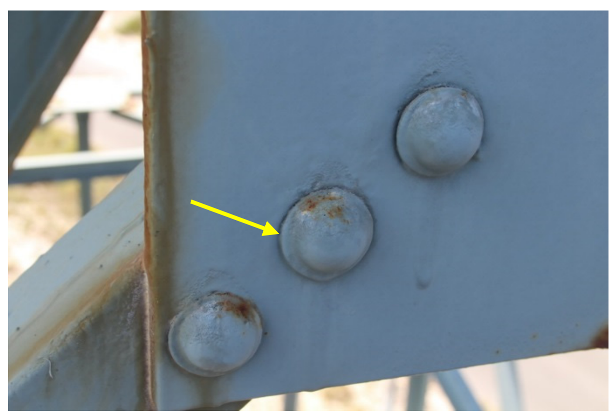

FIGURE 45. Presumed replacement rivets with ring around the head.

FIGURE 46. Conical-headed rivets at stair structure.

FIGURE 47. The central stair structure.

Stair Structure

The steel-framed stair structure was rebuilt in 1980 on the original concrete foundation. The design was based on the configuration of the original stair structure as well as stair structures at similar battery towers.[45] The stair structure consists of a free-standing center tower that structurally supports three flights of steel stairs that extend from the concrete foundation to an access panel on the underside of the concrete observation booth (Figure 47).

The stair support tower has a square plan measuring 6 feet 6-1/2 inches on each side and is 23 feet 9-1/2 inches tall. It consists of four corner angles that extend the full height of the support tower and are welded to a base plate and clip angle. The base assembly is anchored to the foundation with anchor bolts embedded into the concrete (Figure 48). Channels extend horizontally between the vertical corner angles and are spaced approximately 5 feet 6 inches on center vertically. Each intersection between the horizontal channels and vertical angles is connected by a gusset plate measuring 8 inches by 5-1/2 inches by 3/8 inch, and four rivets.

45. NPS Drawing No. 635-61168, "Rehabilitation of Battery 234: Observation Tower," Bell Steel Company, Pensacola, Florida, July 31, 1980.

FIGURE 48. Anchor bolt at base of stair structure; note corrosion on bolt and base plate.

The stair has a U-shaped configuration that wraps the south, east, and north outside faces of the center support tower. Each flight of stairs has a 7:12 pitch and is separated from the next run by a landing measuring 1 feet 9-1/4 inches square. The stairs are constructed of channel stringers, plate steel treads, and pipe metal handrails (Figure 49 and Figure 50). Just below each landing, where the stair structure intersects a diagonal brace, a horizontal slot is cut into the brace. This slot allows the stair tread to extend through the brace without coming into contact with the primary structure (Figure 51).

FIGURE 49. View looking down the stair structure showing steel plate treads and landing.

FIGURE 50. Overview of the stair stringers, treads, and pipe handrail.

FIGURE 51. Below the landing, one stair tread extends through a slot cut into a diagonal bracing member for the primary tower structure.

Observation Booth

The observation booth is a two-story concrete structure consisting of a lower level measuring 11 feet by 11 feet in plan and an upper level measuring 18 feet 4 inches by 18 feet 4 inches in plan (Figure 52). The larger upper level overhangs the lower level by 5 feet on the north and south elevations and 3 feet 9 inches on the east and west elevations. At each floor level, the structure consists of an 8-inch-thick concrete floor slab with an integral drip edge and concrete walls that are 8 inches thick (Figure 53). The concrete has a visible board form finish from 5-1/4-inch-wide form boards. There is a distinct joint line in the form board finish at the centerline of the walls at the second level of the observation booth (Figure 54). The cold joint between the floor slab and the walls has been partially concealed by an applied concrete parge coating. Successive pours of concrete in the wall are distinguished by differences in the segregation of the concrete aggregate.

FIGURE 52. Overview of the two-story observation booth.

FIGURE 53. View of the underside of the cantilevered upper floor level, with drip edge at the perimeter.

FIGURE 54. Vertical joint in form boards at the center of upper level walls.

At the lower level of the observation booth, there is a continuous ribbon window opening along the west, south, and east elevations (Figure 55). The opening is approximately 19 inches tall and wraps the corners of the structure. A steel post supports the structure at the southeast and southwest corners of the opening (Figure 56). A single window opening is located at the center of the north elevation (Figure 57). At the window openings, metal dowels, spaced approximately 3 feet apart, are embedded into the concrete at the head (Figure 58). The dowels are severely corroded and appear to have served as anchorage for a previously existing window or screen system.

The upper level of the observation booth has partial-height walls measuring approximately 3 feet 4 inches tall above the floor. There is a full-height opening centered on the north elevation that measures 20 inches wide. This opening has a guard constructed of steel reinforcing bar welded to steel angles (Figure 59).

FIGURE 55. Continuous window opening at the lower level of the observation booth.

FIGURE 56. Southeast corner post at the lower level window opening.

FIGURE 57. Window opening on the north side of the lower level, viewed from the exterior.

FIGURE 58. Typical anchor for former window or screen system at the lower level window openings.

FIGURE 59. Guard at the opening on the west side of the upper level.

A steel roof frame is mounted to the top of the concrete wall of the upper level and served as the framework to support a roof structure. The remaining portions of the roof framework consist of a 10-inch-tall steel channel frame anchored to the concrete wall at the corner with steel posts (Figure 60). Steel brackets, 18 inches in length and spaced 24 inches apart, are welded to the face of the channel. The roof framework is painted grey.

FIGURE 60. Remaining portion of the upper level roof framing.

The lower level of the observation booth is the only enclosed portion of the structure. The interior has exposed concrete walls, floors, and ceiling with a board form finish. The stair structure extends along the north side of the tower and provides access to the northwest corner of the lower level of the observation booth. A steel-framed grate with metal bars is located at the top of the stair and has a keyed padlock to restrict access. Along the perimeter of the stair opening is a non-original pipe steel handrail. The handrail is mounted to the north interior wall of the enclosure and consists of two vertical corner supports that are mounted to the floor and ceiling, and an upper and lower horizontal rail (Figure 61).

FIGURE 61. Access gate and railing at the stair opening in the lower level of the observation booth.

Along the north wall of the enclosure are two sets of paired circular penetrations in the concrete floor slab (Figure 62). The penetrations are approximately 4 inches in diameter, have metal pipe sleeves, and were most likely used as conduit chases.

FIGURE 62. Abandoned conduit sleeves in the floor of the observation booth.

Extending along the south side of the lower level of the observation booth is a wood-framed observation platform. The platform is of recent construction and appears to have been installed when the tower was open to visitors (Figure 63).

FIGURE 63. Wood-framed viewing platform at the south side of the observation booth.

At the center of the lower level is a bronze marker embedded in the floor slab indicating that the facility is a triangulation station (Figure 64). The marker location is labeled H73 FL80.

FIGURE 64. Bronze marker embedded in the floor.

At the northeast corner of the lower level is a steel-framed ladder constructed of flat steel bar side rails and round bar ladder rungs (Figure 65). The ladder provides access through a cast opening in the floor slab to the upper level of the observation booth. The opening in the floor slab has an embedded steel channel on three sides, likely indicating that the opening at one time had an access hatch.

FIGURE 65. Ladder from the lower level to the upper level.

The upper level is composed of partial height concrete walls with board form finish and steel framing for a roof canopy. Features include the previously mentioned wall opening in the west elevation wall, a circular concrete foundation pad, and a non-original pipe metal railing that wraps around the ladder access portal (Figure 66).

FIGURE 66. The upper level of the observation booth.

At the center of the upper level is a concrete base with a circular plan (Figure 67). The concrete foundation is raised approximately 5 inches above the floor level and is approximately 3 feet in diameter.

FIGURE 67. Raised concrete base at the center of the upper level.

Condition Assessment

Concrete Foundation

The concrete foundation includes the concrete strip footings for the steel-framed tower as well as the concrete footing for the stair structure. In general, the concrete foundations for the steel-framed tower and stair structure are in good condition.

- Previously installed concrete patches were observed at the stair structure footing (Figure 68). The patches were approximately 10 inches square and surrounded the anchor plates for the stair structure. Patch material is distinguished by eroded joints that separate the patch from the original concrete, and a finer standard aggregate size than the original concrete. The patches were most likely installed when the stair support tower was replaced in 1980.

- Mild paste erosion was observed throughout the concrete foundation (Figure 69). Areas of paste erosion were characterized by pronounced aggregate exposed on multiple sides.

- Small spalls were observed at the corners of the footing but did not appear to impact the structural integrity of the foundation.

FIGURE 68. Previously installed concrete patch at the stair structure footing.

FIGURE 69. Paste erosion of the concrete foundation.

FIGURE 70. White-colored surface staining associated with breaches in the coating.

Steel Structure

The steel-framed tower is in fair condition overall, while the steel-framed stair structure is in very poor condition. Prior repairs to the tower have included a restoration and repainting in 1980, during which many of the structural elements were repaired or removed and replaced in kind. The stair structure was completely replaced in 1980. Most recently, the steel was overcoated in 2009.

- Areas of white-colored surface staining were observed on many of the steel framing members throughout the structure (Figure 70). Each surface stain was typically a few inches in area and associated with breaches in the surface coating.

- Pitting, or localized corrosion resulting in cavities of varying size and depth, was observed on the underside of many of the steel angles, particularly at the top half of corner columns and at diagonal bracing members (Figure 71). Pitting was more prevalent on structural members at the west and south elevations. The depth of pitting was typically 1/8 inch. Advanced pitting, resulting in complete section loss of the steel, was observed at the diagonal bracing members at mid-height of the tower on the south and west elevations (Figure 72).

FIGURE 71. Pitting of steel elements.

FIGURE 72. Corrosion and pitting resulting in section loss at steel elements. The location shown is at element H (refer to Figure 31).

- Rust jacking is the outward displacement of members due to the expansive forces of corrosion, especially where pack rust (layers of corrosion product in a contained location, such as between steel plates) has occurred. Rust jacking was observed at numerous locations, specifically at the lap joints between steel angles and gusset plates and above the channel frame at the top of the steel-framed tower (Figure 73). Displacement at gusset plates was typically 3/8 inch. Upward displacement due to rust jacking was observed at the top flange of the steel channel members and was most pronounced above steel channels at the north end of the structure (Figure 74).

FIGURE 73. Rust jacking and section loss at the joint between a steel element and gusset plate.

FIGURE 74. Upward displacement of the concrete observation booth due to corrosion of the top flange of the channel members at the top of the steel frame.

- Crevice corrosion is localized corrosion occurring within crevices and joints on metal surfaces, such as holes, lap joints, or crevices under bolts and rivets, which are exposed to moisture, salts, or other corrosives. Crevice corrosion at the tower was most pronounced at rivet heads and at lap joints between gusset plates and framing members:
  - At rivet heads, the corrosion was typically 1/8 inch deep and had an annular pattern that extended 1/4 inch around the rivet head (Figure 75).
  - Crevice corrosion was most pronounced at lap joints between the gusset plates and the structural framing members (Figure 76). At many locations the corrosion resulted in the section loss along the edge of the gusset plate or at the end of the framing member. Crevice corrosion at lap joints was often associated with pack rust and rust jacking.
- Observed corrosion typically had a striated or layered appearance where observed along the edges of horizontal and vertical gusset plates (Figure 77). The corrosion was concentrated at areas adjacent to connections with other framing members. Corrosion staining and peeling paint were present at the framing members adjacent to areas of corrosion on the gusset plate, and areas of crevice corrosion and rust jacking at lap joints.

FIGURE 75. Corrosion of gusset plate around a rivet head.

FIGURE 76. Corrosion of steel framing member and gusset plate at lap joint.

FIGURE 77. Layers of corrosion product at a gusset plate.

- Surface corrosion, or the uniform occurrence of corrosion on the face of a metal element, was observed at many of the steel framing members throughout the structure. The extent of corrosion ranged from small areas of mild corrosion on the face of the members to severe corrosion, resulting in total loss of section. The stair structure had the most severe surface corrosion. At many locations, steel stair treads, landing platforms, railings, and stringers were observed to have complete section loss (Figure 78). The severe, widespread corrosion at the stair structure assembly presents a potential life safety hazard for persons accessing the tower (Figure 79).

- For the tower structure, surface corrosion was observed to be most severe at the flanges of the channel members at the top of the structure as well as at the edges of horizontal bracing members (Figure 80 and Figure 81).

FIGURE 78. Severe corrosion and section loss at stair treads.

FIGURE 79. Severe corrosion and section loss at framing members for a stair landing.

FIGURE 80. Widespread surface corrosion near the top of the steel structure.

FIGURE 81. Corrosion along the toe of one angle framing member.

- Evidence of previous repairs to the structure included a spliced horizontal framing member. The repair segment was welded to the original portion of the horizontal brace frame member and painted (Figure 82).

FIGURE 82. Welded splice between original member (left) and new horizontal repair segment (right).

Concrete Observation Booth

The concrete observation booth is in fair to poor condition. Numerous patches have been previously installed in the concrete structure. The patches are clearly visible and distinguished by color and aggregate size. Many of the patches are cracked, debonded, or spalled.

- Spalls were observed at the corners of the lower level of the observation booth, above and below a steel column at the corners of a continuous opening on the south elevation (Figure 83 and Figure 84). The spalls are approximately 2 feet square and significantly decrease the load-bearing surface area supported by the corner columns. The spalled area had been previously repaired with patch material. The patch material was poorly bonded to the concrete substrate and was typically cracked and spalling. It appeared that there is no steel reinforcing or anchorage in the concrete patches.

- Incipient spalls and spalls at locations of corroding embedded reinforcement were located throughout the underside of the upper and lower floor slabs as well as on the east and north elevations of the lower level (Figure 85). Incipient spalls are characterized by shallow, curved cracks. The concrete on one side of the crack was debonded or displaced from the concrete substrate. Some incipient spalls were removed by hand during the survey. Corrosion-related spalls were as large as 1 foot square. At all locations where corrosion-related spalls and incipient spalls were removed, the spalls were observed to be approximately 1/2 inch deep and revealed exposed steel reinforcing bar with surface corrosion (Figure 86).

FIGURE 83. Previous patching of spalls and subsequent cracking at the corner of the lower level, above the window opening.

FIGURE 84. Previous patching of spalls and subsequent cracking at the corner of the lower level, below the window opening.

FIGURE 85. Previously installed patches, as well as cracks and incipient spalls, at the underside of the upper level cantilever.

FIGURE 86. Spalled concrete with exposed reinforcing steel.

- Previously installed concrete patch repairs were observed at the underside of the upper level overhang. Many of the patch repairs were observed to be debonded, have corrosion staining, or exhibit spalls (Figure 87 through Figure 89). Where patches had failed, the concrete patch was observed to be approximately 1/2 inch deep.

- Metal debris was observed embedded in the surface of the underside of the upper and lower floor slab (Figure 90). The debris consisted of tie wires and small strips of metal. All of the observed debris had surface corrosion and was often associated with small spalls in the concrete. It is assumed that these miscellaneous metal items date to original construction and were used to secure form boards or provide temporary support for embedded reinforcing steel.

- Some cracking was observed at the west wall of the upper level (Figure 91). The cracks were typically 1 millimeter in thickness and extended vertically from the corners of the access opening.

- Mild paste erosion was observed at the walls of the upper and lower levels.

FIGURE 87. Previously installed patches at the underside of the upper level.

FIGURE 88. Corroding reinforcing steel at spalled patch.

FIGURE 89. Corroding reinforcing steel at spalled patch.

FIGURE 90. Metal debris from original construction embedded in the concrete.

FIGURE 91. Vertical crack in concrete.

Limited Structural Analysis

A limited structural analysis was conducted to evaluate the adequacy of the tower structural framing to resist current code-required gravity and wind loads. Calculations from this evaluation are provided in Appendix E. The evaluation was based on the assumption that the 1979 tower rehabilitation drawings accurately represent the as-built configuration of the tower. The analysis also assumes that no deterioration of the steel or concrete elements is present. Also, the analysis was performed assuming that the upper observation level roof is not present; however, reconstruction of the roof would not significantly affect the structural performance of the tower. (Note that a new roof would need to be designed and anchored to resist wind uplift.)

A finite element model of the tower was constructed to determine forces in the members and connections (Figure 92). The concrete structure at the top of the tower was modeled using two-dimensional shell elements, and the steel framing supporting the concrete structure was modeled using one-dimensional frame elements. The steel framing members were modeled as pinned truss members, except where members were continuous across gusset plate connections. Member centroids were assumed to connect at single nodes, and the effects of truss member eccentricity were instead accounted for in calculation of member capacity, as described below. Design factored-level wind loads for the site location (hurricane-force winds) were applied to the walls of the concrete structure and the faces of the steel framing elements. These loads were combined with calculated dead loads and an assumed live load of 100 psf applied to the floors of the concrete structure in the code-required load combinations.

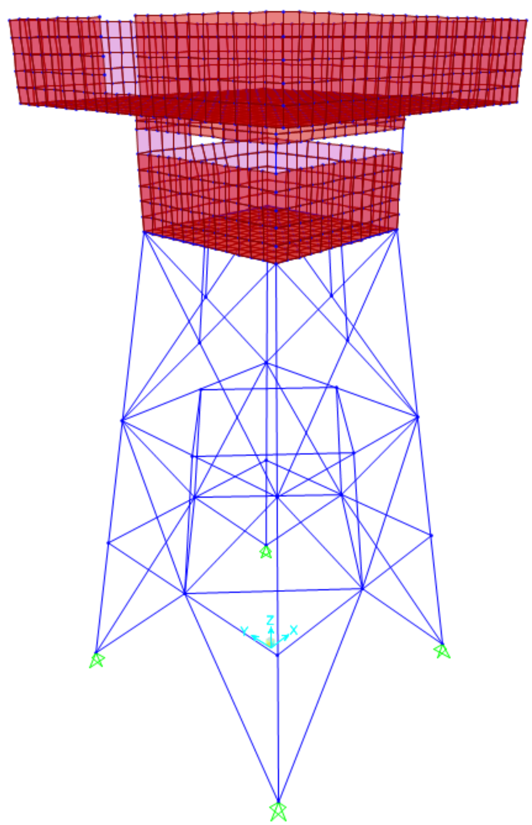

FIGURE 92. Finite element model of the tower.

The capacity of the concrete framing was calculated in accordance with typical American Concrete Institute (ACI) practice. Capacities of steel framing members and connections were calculated in accordance with American Institute of Steel Construction (AISC) practice. The effects of eccentricity and end restraint of the single-angle truss members were considered in development of the capacity of these members. The demands in the primary structural framing members and connections were compared to the calculated capacities. Uplift at the foundation was also evaluated.

The analysis indicates that the primary framing elements and connections of the tower have adequate design strength to resist current code-required gravity and wind loads. Uplift is minimal under factored-level loads. Typical member and connection demand-to-capacity ratios are on the order of 0.5 to 0.8, indicating some reserve capacity in these elements to accommodate moderate deterioration (less than 20 percent section loss).

Significance and Integrity

National Register of Historic Places

The National Register of Historic Places is the official list of the nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.[46]

The significance evaluation identifies the important historical associations of the property, and comments on its architectural, archeological, and social value as they relate to the National Register of Historic Places. A property's significance is tied to a discrete period of time in which its important contributions were made and to relevant national, state, and local historic contexts.

Significance Criteria

In order for a property to be eligible for inclusion in the National Register of Historic Places, it must possess significance under one of four criteria. The Criteria for Evaluation for listing in the National Register of Historic Places state:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. That are associated with the lives of persons significant in our past; or
>
> C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> D. That has yielded, or may be likely to yield, information important in prehistory or history.

Criteria Considerations

Ordinarily cemeteries, birthplaces, graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties *will qualify* if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

a. A religious property deriving primary significance from architectural or

46. National Park Service, "National Register of Historic Places" available at http://www.nps.gov/nr/ (accessed January 29, 2015.)

artistic distinction or historical importance; or

b. A building or structure removed from its original location but which is primarily significant for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

c. A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building associated with his or her productive life; or

d. A cemetery that derives its primary importance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

e. A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

f. A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

g. A property achieving significance within the past 50 years if it is of exceptional importance.[47]

National Register Status of the Battery 234 CRF/BCS Tower

The Battery 234 CRF/BCS Tower is not presently listed in the National Register of Historic Places. The early nineteenth century Fort Pickens was listed in the National Register in 1972 as a structure significant for its role in the nation's Third System Coastal Defenses, the American Civil War, and post-Civil War use as a prison. However, there are other resources in the vicinity of the fort and on western Santa Rosa Island, ranging from early twentieth century mining support structures to World War II structures, such as Battery 234, that postdate the period of significance associated with Fort Pickens but are important features of the evolving military response to advances in armaments and other technology designed to protect American coastal areas from attack and invasion.[48] A draft nomination for a Fort Pickens historic district to address the collection of coastal defense structures on western Santa Rosa Island associated with the Endicott System and later engineered features was developed in 1977. However, it appears that the nomination was never completed, and these features are not currently listed in the National Register of Historic Places. In the draft documentation prepared in 1977, the Battery 234 CRF/BCS Tower is assessed as contributing to the significance of the proposed historic district.[49]

This HSR is being prepared in coordination with a National Register nomination for a historic district that encompasses the Endicott System and later military resources located on western Santa Rosa Island. Typically, Endicott System structures were not fortresses like Fort Pickens, but instead were components of a system of well-dispersed emplacements with a few large guns at each location. The structures were often open-topped concrete walls protected by sloped earthworks. Many of these featured disappearing guns, protected by the concrete front walls, which could be raised to fire and lowered again afterwards. Mine fields were a critical component of the defense, and smaller guns were also employed to protect the mine fields from minesweeping vessels.

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47. *Code of Federal Regulations, Title 36, Part 60,* "The National Register Criteria for Evaluation."
48. Randy F. Nimnicht, Historic Preservationist, Division of Archives, History and Records Management, Florida Department of State, Fort Pickens National Register of Historic Places nomination form, March 10, 1971. Entered into the National Register, May 31, 1972.
49. Anne Castellina-Dudley, Historian, Gulf Islands National Seashore, Fort Pickens Historic District National Register of Historic Places nomination form, draft, May 27, 1977.

Based on findings of this report and the concurrent National Register study, the Battery 234 CRF/BCS Tower is considered a contributing structure to the larger National Register-eligible historic district currently in development. The tower is significant for its association with World War II-era activities conducted by the U.S. Army to protect the strategically-important Pensacola Harbor using Endicott system batteries. It is the only standing tower of those constructed at the western end of Santa Rosa Island during World War II.

Under National Register Criterion A, the tower is an example of the broad pattern of coastal defense in the history of the eastern United States, as described above. It is the only surviving example of this type of tower on Santa Rosa Island.

Under National Register Criterion C, the tower is notable as an example of utilitarian military design applied to meet the specific needs of 1940s defensive technology. The distinctive features of the tower, such as the height of the observation booth above sea level, the cantilevered upper level of the observation booth, and the separation between the stair tower structure and primary steel structure, reflect its particular function. Therefore, the design of the tower is significant and representative of the military technology of the World War II era.

The Battery 234 CRF/BCS Tower survives with sufficient integrity to convey its historic associations.

Period of Significance

The period of significance for the CRF/BCS Tower at Battery 234 begins with construction of the battery in 1943 and concludes with deactivation of Fort Pickens, including Battery 234, and decommissioning of all military facilities on Santa Rosa Island in 1947.

The tower also contributes to the larger historic district, which is currently assessed as significant between 1894, when the earliest examples of the Endicott system were constructed, and 1947, when the property ceased being used for military defense purposes.

Since the end of U.S. Army use of the site, the Battery 234 tower has been available for public access as an observation tower, until its temporary closure in 2013. The structure has also been interpreted as part of the military history of the site, initially as part of the Florida State Park from 1949 to 1972, and later as part of the Gulf Islands National Seashore from 1972 to present.

Character-Defining Features

The historic nature of significant buildings and structures is defined by their character, which is embodied in their identifying physical features. Character-defining features can include the shape of a building; its materials, craftsmanship, interior spaces, and features; and the different components of its surroundings.[50]

The following list identifies existing character-defining features found on the exterior and interior of the Battery 234 CRF/BCS Tower:

- Concrete tower foundations.
- Tapered steel-framed base extending from the concrete foundations to the two-level concrete observation booth.
- Exposed steel stair extending to the lower level of the observation tower.

50. Lee H. Nelson, FAIA, *Preservation Brief 17: Architectural Character: Identifying the Visual Aspects of Historic Buildings as an Aid to Preserving Their Character* (Washington, D.C.: National Park Service, Technical Preservation Services, 1988).

- Unfinished board-formed concrete of the two-level observation booth.
- Configuration of the two-level observation booth, particularly the larger upper level that projects over the lower level on all sides and the raised circular base at the center of the upper level.
- Continuous ribbon opening along the west, south, and east elevation of the lower level of the observation booth.
- Single opening on the north elevation of the lower level of the observation booth.
- Full-height opening centered on the west wall of the upper level of the observation booth and steel gate present in the opening.
- Remnant steel framing for the roof above the second level of the observation booth (roof no longer extant).

Assessment of Integrity

Assessment of integrity is based on an evaluation of the existence and condition of the physical features which date to a property's period of significance, taking into consideration the degree to which the individual qualities of integrity are present. The seven aspects of integrity as defined in the National Register Criteria for Evaluation are location, design, setting, materials, workmanship, feeling, and association. As noted in *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*:

> Location is the place where the historic property was constructed or the place where the historic event occurred. . . . Design is the combination of elements that create the form, plan, space, structure, and style of a property. . . . Setting is the physical environment of a historic property. . . . Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property. . . . Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. . . . Feeling is a property's expression of the aesthetic or historic sense of a particular period of time. . . . Association is the direct link between an important historic event or person and a historic property.[51]

The property must retain the essential physical features that enable it to convey its historical significance. The essential physical features are those features that define both why a property is significant (National Register criteria) and when it was significant (period of significance). The *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* defines integrity as "the ability of a property to convey its significance."[52]

The historic integrity of the Battery 234 CRF/BCS Tower has been assessed within the context of its contribution to the proposed National Register historic district for western Santa Rosa Island. See Figure 93 and Figure 94 for comparative views of the tower and its environs as they appeared in 1946 and in 2014.

Integrity of Location. The tower retains a high degree of integrity of location. The location of the tower has remained unchanged since it was constructed in 1943.

Integrity of Design. The tower retains a moderate degree of integrity of design. This aspect of integrity is slightly diminished as the roof over the upper level of the observation booth is no longer extant. Also, the windows or screens that originally enclosed both levels of the observation booth are also missing.

51. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: Government Printing Office, 1997), 44–45.

52. Ibid.

Integrity of Setting. The tower retains a high degree of integrity of setting. Its most important spatial relationship is to the gun emplacement for Battery 234 to the south. The gun emplacement is intact. Much of the setting for the tower and the gun emplacement itself is covered with native plants and shrubs; however, the World War II military strategy would have called for the environs of the battery to be left in a natural state to better camouflage the gun position. The loop road that provides access to the tower and battery is a World War II era site feature; the road has been changed slightly by the addition of a parking area near the tower. However, in general the setting of the tower is little changed from the 1940s.

Integrity of Materials and Workmanship. The tower retains a moderate degree of integrity of materials and workmanship. The structure's primary materials, concrete and steel, exhibit areas of deterioration. Some original materials have been lost and not replaced, while significant portions of the original steel framing, including the entire stair structure, have been previously removed and replaced with matching replica materials.

Integrity of Feeling. The tower retains a high degree of integrity of feeling. The tower was built as part of Battery 234 as a utilitarian structure to serve the specific range-finding function and allow the Battery 234 guns to be accurately targeted. While the tower was never activated and no longer serves a military function, it remains a visible icon of World War II-era construction on western Santa Rosa Island as part of Gulf Islands National Seashore.

Integrity of Association. The tower retains a high degree of integrity of association. The tower was built as part of Battery 234, to provide unobstructed views over the Gulf of Mexico to track and target enemy ships. The sweeping views out to sea afforded from both levels of the observation booth remain a distinctive aspect of the tower today. The tower remains visually and spatially associated with the adjacent Battery 234 gun emplacement.

FIGURE 93. The Battery 234 tower as completed, photograph dated August 26, 1946. Note the roof structure at the upper level of the observation booth, the observation booth windows at both levels, and the relatively dark color paint on the steel frame. Source: Gulf Islands National Seashore, catalog no. 946.

FIGURE 94. A present-day view from the same vantage point. Note the removal of the roof structure and windows and the relatively light-colored grey paint on the steel frame. The loop road, adjacent Battery 234, and landscape setting are much the same as in 1945.

Treatment and Use

Requirements for Treatment and Use

Although not listed individually in the National Register of Historic Places, Battery 234, including the CRF/BCS Tower, was identified as a contributing structure in the draft National Register Nomination for the proposed Fort Pickens Historic District.[53] The CRF/BCS Tower at Battery 234 is also considered to be a contributing structure in the historic district that encompasses the Endicott System and later military resources located on western Santa Rosa Island, for which a National Register nomination is currently in progress. The tower is significant for its association with World War II-era activities conducted by the U.S. Army to protect the strategically-important Pensacola Harbor. It survives with sufficient integrity to convey its historic associations.

Therefore, treatment and use of the CRF/BCS Tower at Battery 234 should be considered within the context of the legal mandates and policy directives established by National Park Service Cultural Resources Management Guideline (Director's Order 28) for the protection of cultural resources. The CRF/BCS Tower at Battery 234 should be understood for its association with the other military resources on western Santa Rosa Island and preserved for the enjoyment of present and future generations.

53. Anne Castellina-Dudley, Historian, Gulf Islands National Seashore, Fort Pickens Historic District National Register of Historic Places nomination form, draft, May 27, 1977.

Laws, Regulations, and Functional Requirements

Key laws, regulations, and functional requirements that apply to the recommended work include the following:

- National Park Service Cultural Resources Management Guideline (Director's Order 28), which requires planning for the protection of cultural resources on park property.

- Section 106 of the National Historic Preservation Act (NHPA), which mandates that federal agencies, including the National Park Service, take into account the effects of their actions on properties listed or eligible for listing in the National Register of Historic Places and give the Advisory Council on Historic Preservation a reasonable opportunity to comment.

Treatment of the building and site is also to be guided by the following:

- Secretary of Interior's Standards for the Treatment of Historic Properties

- Americans with Disabilities Act (ADA)

- *International Building Code* (IBC), 2012

- *International Existing Building Code* (IEBC), 2012

- Florida Building Code, 2010 (which references the 2009 IBC and 2009 IEBC, as well as the 2010 edition of ASCE 7)[54]

The National Park Service is self-regulating in terms of enacting and enforcing building code standards. Gulf Islands National Seashore is therefore not legally subject to local or state building code requirements. When undertaking repairs to historic structures, NPS endeavors to have the work comply with model building code standards. At this time, the 2012 IBC with Appendices (replacing Chapter 34 with the IEBC) is the model building code used by the NPS and is referenced by the NPS Denver Service Center for design and construction. The NPS Denver Service center also references the 2012 IEBC, with Appendices and Resource A.

In the 2009 and 2012 editions of the *International Building Code*, Section 3409–Historic Buildings, paragraph 3409.1 states:

> Historic Buildings. The provisions of this code relating to the construction, *repair, alteration, addition*, restoration and movement of structures, and change of occupancy shall not be mandatory for *historic buildings* where such buildings are judged by the *building official* to not constitute a distinct life safety hazard.

Since the CRF/BCS Tower at Battery 234 is a historic structure, alternatives to full prescriptive legislative and code compliance should be considered where such compliance would compromise the integrity of the structure. For example, the width and rise-to-run ratio of the stair assembly does not comply with current codes; however, the geometry of the existing configuration would not necessarily be considered hazardous (if the stair were in good condition).

However, the tower requires repair to mitigate previous and ongoing structural deterioration; in its present condition, potential hazards to life safety are present. The structure was previously accessed by the general public as well as staff of the NPS; however, access to the structure is currently restricted by chain link fencing that surrounds the tower. The hazardous conditions requiring repair before the tower can be safely used again are discussed in the specific recommendations presented below.

Current Planning Efforts

Planning is underway to develop a commercial ferry service, connecting the Fort Pickens area to nearby Pensacola and Pensacola Beach. In addition to the new ferry service, a landside tram service is being planned to accommodate those visitors who arrive at Fort Pickens via the planned ferry.

A feasibility study is currently underway by the NPS for a Pensacola Bay ferry and shuttle transportation system. Currently, a schematic site design and architectural planning report are under development. The current draft report proposes development of a 3.6 mile tram tour route that forms a loop between some of the parks landmarks. The route would include up to seven stops at which visitors could board or exit the tram. Each of the proposed stops is associated with a landmark and includes the ferry boat landing, the Fort Pickens museum, Battery 234, Battery Cooper, the campground store, Battery Worth, and Fort Pickens. Infrastructure alterations are proposed at each stop.

In the current planning documents, the site of the Battery 234 tram stop is proposed to be approximately 40 feet northwest of the tower. In addition to the tower, the stop at Battery 234 would provide access to the extant coastal gun batteries at Battery 234 and the adjacent Gulf of Mexico beach area. Construction of a new sun shelter, interpretive signage, and comfort station are proposed.[55]

54. The Fifth Edition (2014) of the Florida Building Code has been approved by the Florida Building Commission, with a tentative effective date of June 30, 2015.

55. The 100 percent draft report for the *Pensacola Bay Ferry Service – Ferry and Shuttle Transportation Feasibility Study* is dated June 2014.

Alternates for Treatment and Use

The U.S. National Park Service has developed definitions for the four major treatments that may be applied to historic structures: preservation, rehabilitation, restoration, and reconstruction. The four definitions are as follows:

> **Preservation** is defined as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.
>
> **Rehabilitation** is defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.
>
> **Restoration** is defined as the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.
>
> **Reconstruction** is defined as the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.[56]

Of the four treatment approaches, *rehabilitation*, which involves making possible a compatible use through repair, alterations, or additions, is most appropriate for the Battery 234 CRF/BCS Tower. This treatment would allow for the repairs necessary to stabilize and preserve the structure, while also permitting modifications to be made to accommodate a change in use.

Preservation, which involves sustaining the buildings in their existing form, would be incorporated in the overarching rehabilitation treatment approach. *Restoration* would return the structure to its appearance during the period of significance. As part of an overarching rehabilitation treatment approach, restoration of missing features (such as the roof) should be considered. However, as a treatment alternative, restoration would not accommodate modifications needed for the structure to serve its proposed use.

The use of the Battery 234 CRF/BCS Tower is anticipated to be as an observation tower for park visitors. Where future modifications are considered to provide improved public use, these modifications should be designed taking into consideration the goal of retaining original historic materials and features wherever possible. Where incorporation of new amenities would require significant alterations to the tower that could diminish its integrity as an historic resource, consideration should be given to limiting or avoiding these modifications.

Many of the distinctive materials, features, and spaces of the Battery 234 CRF/BCS Tower are essentially intact, and in spite of certain alterations, the structure retains its historic integrity. Repair of original materials and character-defining features as part of the overall rehabilitation is practical and

56. Secretary of the Interior's Standards for the Treatment of Historic Properties.

appropriate, and will assist in the interpretation of the structure.

Ultimate Treatment and Use

Guidelines for Treatment

Guidelines and requirements for treatment have been defined based on the objectives and requirements for treatment and use outlined above for the CRF/BCS Tower at Battery 234. All treatment guidelines and recommendations were developed in accordance with the Secretary of Interior's Standards for Rehabilitation.

The Secretary of the Interior's Standards for Rehabilitation are as follows:

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired. [57]

The basic guidelines for work on the subject buildings and their immediate setting are as follows:

- Undertake all work in compliance with the Secretary of the Interior's Standards for Rehabilitation.

- Retain the character of the historic site by protecting the individual structure and significant site features.

57. Ibid.

- Ensure that proposed new elements or construction are compatible with historic character of the structure and site.

- Protect adjacent natural resources during construction activities.

- Document through detailed as-built drawings, photographs, and written narrative all changes and treatments to the historic site and structure. Maintain records of treatments and preserve documentation according to professional archival standards. Maintain a copy of records in NPS archives.

- Retain features and materials at the structure that date from the period of significance to the greatest extent possible.

- Incorporate sustainable design principles in all future projects that respect the preservation principles listed above.

Recommendations

Site

1. Retain the visual connection between the CRF/BCS Tower and the adjacent landscape features and gun batteries that are a part of the Battery 234.

2. Retain and maintain the historic patterns of spatial organization that includes the circulation routes that provide access to the tower and other features of Battery 234.

3. Avoid constructing new features that interfere with views of the tower and other features of Battery 234.

4. Continue to interpret the CRF/BCS Tower as part of Battery 234 and in relation to other World War II-era structures at the site.

Tower

The park desires to return the structure to use as an observation tower accessible to visitors, and is planning a major rehabilitation to be implemented in the near future. Until rehabilitation is completed, access to the tower should continue to be limited.

Should the rehabilitation project be delayed, the following repairs should be implemented in the near term to address safety hazards presented by deteriorated concrete and corroded steel:

- The corners of the concrete observation booth should be shored from the lower level deck to the underside of the upper level deck.

- Loose and cracked patching material and incipient spalls should be removed.

- Severely deteriorated stair treads, landings, framing members, and handrail components should be supplemented or replaced.

- The tower should be inspected at least every six months to identify additional incipient concrete spalls, loose patch materials, and areas of significant corrosion. Temporary shoring members should remain in place until permanent repairs are implemented.

The following repairs are recommended based on the understanding that the overall rehabilitation will proceed in the near term.

Concrete. The 2009 repair work was implemented using proprietary patching mortars. The repair process apparently involved limited removal of existing concrete and limited repair or protection of reinforcing steel where exposed by the work. The repair implemented in 2009 have not proven to be durable, and cracking and spalling of the repair mortar is now apparent (Figure 95 and Figure 96). Trowel-applied mortar repairs to the concrete, such as those implemented in 2009, would be expected to have limited durability. Appropriate concrete repairs will include more extensive preparation work, repair of reinforcing steel, and formed concrete patches, as discussed in more detail below.

FIGURE 95. Cracking and spalling of concrete at the southwest corner of the lower observation level, 2008. Source: Gulf Islands National Seashore.

FIGURE 96. Cracking of repair mortar at the same location, August 2014. Note that the repair mortar has cracked in an almost identical pattern to the previous concrete distress. Photo by the authors.

Concrete deterioration and distress should be repaired using concrete repair techniques and procedures that include the following steps:

- The concrete should be cleaned with a biocide/detergent at affected areas to remove organic growth. Cleaning mock-ups should be performed to evaluate cleaning systems to be used overall and to determine concrete appearance for matching of concrete repair materials.

- Concrete repair mixes should be developed to match the color, finish, and texture of the original concrete. This includes the architectural formboard finish on the surfaces of the concrete elements. Form and pour techniques should be used for repairs rather than trowel-applied patches.

- Trial repairs and mock-ups should be performed to determine the exact concrete mix designs and repair techniques. Multiple samples of various mixes will be required. Initial samples should be prepared off the tower, followed by mock-ups of selected repair mixes and techniques on the tower, as needed to achieve a match to original surface finishing, texture, and color.

- Cracked or spalled original concrete and all previous patch materials should be removed and replaced.

- At the southeast and southwest corners of the lower level where severe spalling was observed, the following precautions and preventative measures should be performed:
    - Shoring should be installed at the corners during repairs and during the full duration of the concrete curing process.
    - Concrete repair and 28-day curing should be performed at one corner at a time.
    - With the shoring in place, the repair should include removal and replacement of the existing steel corner column assemblies. The new corner column assemblies should use hot-dipped galvanized or stainless steel components matching the configuration of the original, including the use of stainless steel embedments concealed in the concrete to attach the columns, in lieu of the exposed channel brackets added as part of the 2009 repair.
- Repair of concrete deterioration should include the following steps:
    - A 3/4-inch deep sawcut should be made around the entire perimeter of each repair area. The sawcut may align with edges of the formboard profile when appropriate.
    - Chipping hammers should be used to remove concrete to a depth of at least 3/4 inches beyond the exposed reinforcing steel.
    - The exposed concrete surfaces and exposed reinforcing steel within the repair area should be sandblasted and air blasted to remove corrosion and roughen the surface.
    - The exposed steel reinforcing bars should be inspected for loss of section due to corrosion and repaired or replaced as necessary.
    - All exposed steel reinforcing should be immediately coated with two coats of a corrosion-inhibiting coating.
    - Formwork should be installed to match the original profile of surface, including matching the original formboard finish.
    - Repair concrete, customized to match the original concrete, should be placed and consolidated.
    - The concrete patch should be wet cured with the formwork and plastic.

A surface treatment may be considered to provide further protection against moisture penetration into the concrete. Available surface treatments include clear penetrating sealers (silanes) and film-forming coatings. Clear penetrating sealers and film-forming coatings are applied to protect concrete against the ingress of water and aggressive chemicals. Penetrating sealers based on silanes and siloxanes penetrate into the pores in the concrete and react chemically with the surfaces of pores and fine cracks in the concrete to make them water repellant, or hydrophobic, while allowing moisture that does enter the concrete to escape. These products will make the surfaces of a fine, hairline crack hydrophobic, but they do not fill or bridge cracks. Once applied, most clear, penetrating sealers cannot be readily removed, thus careful consideration and field testing is required to determine whether the treatment is effective and appropriate prior to use. Applying some penetrating sealers may affect the bond of repairs (such as crack or patch repairs involving certain cementitious materials); therefore, trial repairs should be evaluated prior to full-scale application of a sealer.

Pigmented and film-forming coatings are generally not considered appropriate for historic concrete and masonry structures that were not coated originally or during the period of significance.

It should be noted that existing moisture and chloride levels in the structure will likely continue to facilitate corrosion of embedded reinforcement and associated concrete distress, even after repairs have been implemented. Thus, regular inspection and ongoing maintenance should be anticipated.

Steel. The CRF/BCS Tower at Battery 234 is a steel-framed structure in a coastal marine environment. As such, it is exposed to chloride salts in the air that are deposited on the steel and coated steel surfaces and have the potential to accelerate corrosion. Therefore, maintenance of an intact coating system is essential.

The recoating work implemented in 2009 has had a limited service life (for example, compare Figure 97 with Figure 98). Based upon the available information, it appears that the surface preparation work was limited, and that adequate measures to control and mitigate chloride contamination on the surface prior to coating application were not performed. Therefore, the following steps are recommended for comprehensive coating replacement:

- The existing surface coating and rust scale should be removed to bare steel using abrasive blasting in preparation for a new coating system. Because of the windy site and exposure to airborne chloride contaminants, scaffolding or containment of the tower will be necessary during the surface coating removal and preparation process and new coating application. Prior to paint removal, the existing coatings should be sampled to check for potentially hazardous materials. Significant repair work performed at the tower in 1980, after lead was removed from most commercially available paints; however, other traces of original lead-containing paint and/or other potentially hazardous elements may be present in the existing coating. If hazardous materials are present, it may be necessary to first use chemical paint strippers and/or water blasting to removing the coating, followed by abrasive blasting to prepare the steel surface to receive the new coating system.

- The steel surfaces should be pressure washed to remove chloride contamination.

- All steel surfaces of the structure should be coated with a zinc-rich primer and high performance coating system.

- Mock-ups of coating removal, surface preparation, and application of the new coating system should be performed to evaluate work processes and to serve as a standard for the overall work.

- Following removal of surface coating and rust scale and prior to application of the new surface coating, the condition of each steel framing member should be assessed. Gusset plates and steel framing members with structurally significant deterioration or section loss should be removed and replaced entirely with new steel. In some cases, in may be possible to remove a deteriorated portion and splice a new steel member to the existing member. Replacement steel should match the existing member sizes and configuration. All connections should be made using new steel rivets. Surfaces of new or existing steel members or gusset plates that will be concealed following installation should be primed and coated prior to installation. Where replacement elements are needed, consideration should be given to the use of hot-dipped galvanized elements or plates.

- The existing non-original guardrail at the west side of the upper observation level should be replaced with a new hot-dipped galvanized or stainless steel railing, configured and painted to match the original appearance.

- The non-original and severely deteriorated central stair structure should be completely replaced with a new hot-dipped galvanized, stainless steel, or aluminum stair tower and stair. The new stair system should match the geometry and configuration of the existing stairs.

FIGURE 97. Detail of the Battery 234 tower after repainting, February 4, 2009. Source: Gulf Islands National Seashore.

FIGURE 98. A similar view, August 27, 2014. Note the development of corrosion and staining.

Other. The structure currently does not have a roof, and there is no waterproofing membrane at the upper level of the observation booth. Rain water collects at the upper deck level and drains through penetrations in the slab, primarily the access hatch to the lower deck level. Construction of a roof can be considered to address water management issues and to restore the historic appearance of the tower. The design of the roof should be compatible with the existing original steel roof framework and should be based on available archival photographs and documentation.

Recommendations for Further Research

- Consideration should be given to preparing a cultural landscape study for Battery 234 including the CRF/BCS Tower, the immediate environs, and the area encompassed by viewsheds from the tower. Information developed for a cultural landscape study would inform future planning and treatment for the site. Alternately, consider development of a comprehensive Cultural Landscape Report for the western end of Santa Rosa Island, as part of a potential series of cultural landscape studies for Gulf Islands National Seashore.

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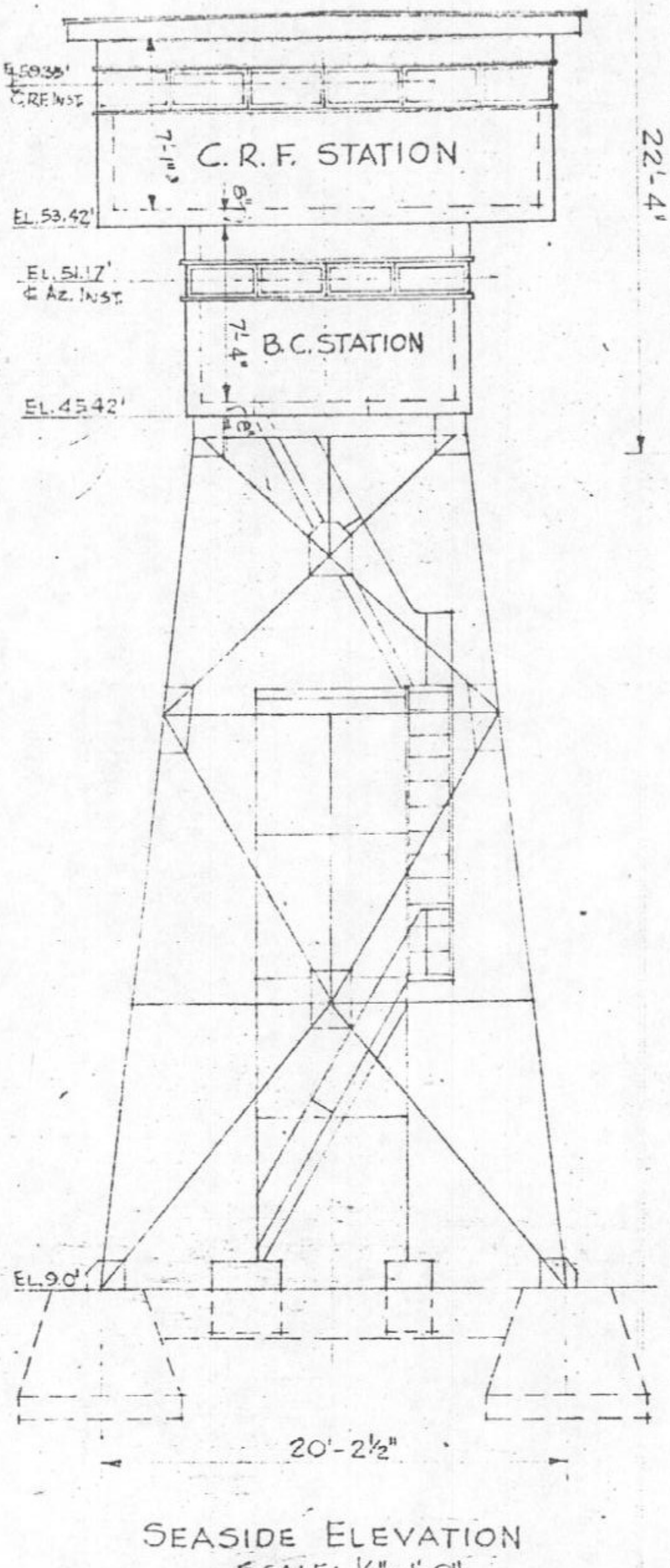
List of Classified Structures, Gulf Islands National Seashore.

Appendices

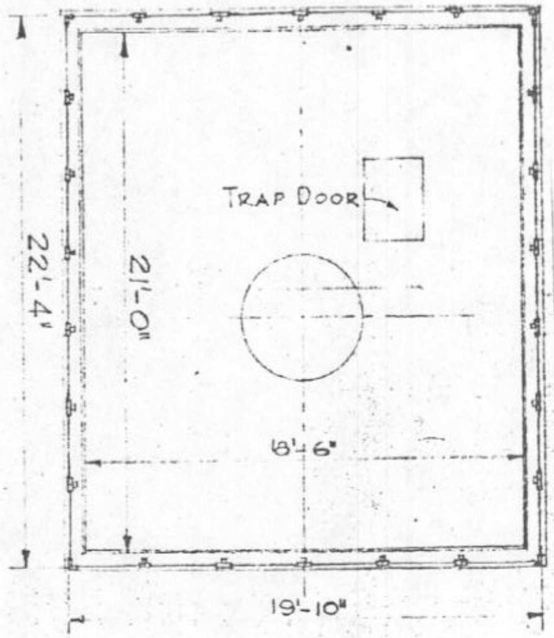
Appendix A: Excerpt, Report of Completed Works, 1944

P.67 in RCWs

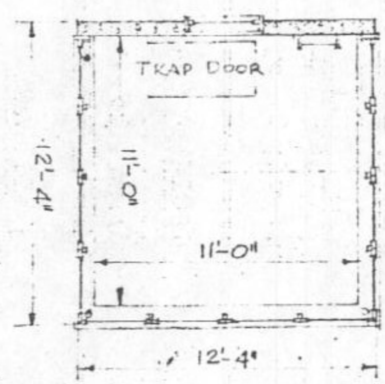
Nara A52-87 Box 108 Pensacola Part 2 is over 2



SEASIDE ELEVATION
SCALE: ⅛"=1'-0"



PLAN: C.R.F. STATION
SCALE: ⅛"=1'-0"



PLAN: B.C. STATION
SCALE: ⅛"=1'-0"

132975

REPORT OF COMPLETED WORKS - SEACOAST FORTIFICATIONS SECRET
(Fire Control or Submarine Mine Structures)

HARBOR DEFENSES OF .. Pensacola
FORT .. Pickens, Florida
STRUCTURE . BC-CRF Station - Battery 234

Part II Corrected to 1 July 1944

STRUCTURE:
Location (by coordinates) x. 98 065.89 y. 59 214.73
Location (by site description) Rear of Battery 234
Date of transfer ... 20 June 1944
Cost to that date .. $13,853.00
Type (for observing stat.--tower, dug-in, cottage, etc.) ... Tower
Type of construction
(a) Roof Built-up tar & gravel on timber
(b) Remainder of bldg. Concrete on steel tower
How concealed ..... None
How protected ..... Splinterproof
Height above concealment .. 36 feet
Height above protection ... -
Conspicuous at 5,000 yards

UTILITIES:
Electric Power ..... Connected
Source of .... Post Power
Characteristics: Voltage 110 Ac ~~DC~~ .. Phase Single
Kilowatts required 0.5
Type of lighting fixtures . CSE Vaportight
Heat
How heated .... No heat
Water Sewer
Connected to water mains ... No
Connected to sewer .... No
Type latrine .... None

REFERENCE:
Reference of site ...... 9.0 MLW
Reference of instrument axis .. 59.35' MLW
where applicable (Type and Capacity of Crane
(Max. dia. of reel handled

(Where applicable)

INSTRUMENTS & EQUIPMENT:
Type of observing inst. .. 15' CRF
Type of plotting board ... -

DATA TRANSMISSION:
Type .... Signal Corps telephone
Date of transfer ..... -

TIDE STATION:
Give description of tide gauge .. None

DATUM POINTS:
Give Forts from which visible
McRee, Barrancas

QUARTERS:
Give stations served .... None

CABLE HUT:
Give S. C. Type

Paste on blue print showing plan of each story of building, giving principal dimensions including height of ceiling.

Still There 1976

P.62 in RCWs

92-4882

ED Form A-1623
16 Sept. 1943.

Control Approval Symbol SPEKM-1

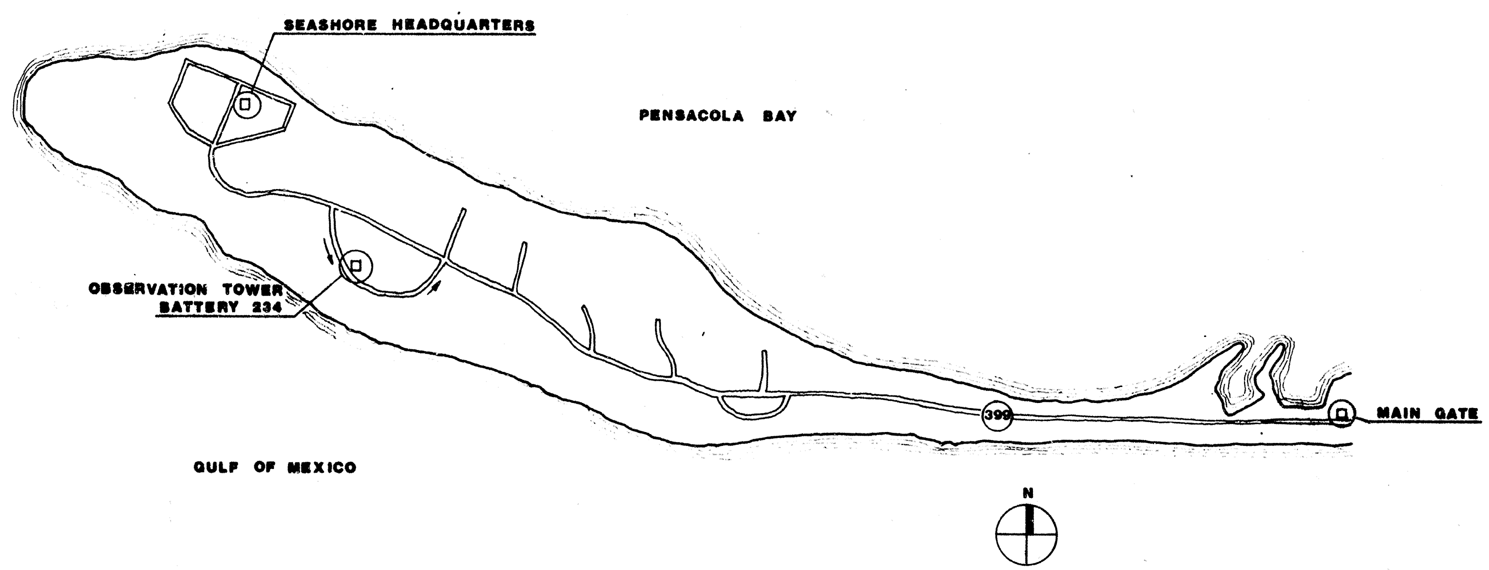
Appendix B: Rehabilitation Drawings, 1979

BATTERY 234
REHABILITATION OF OBSERVATION TOWER
GULF ISLANDS NATIONAL SEASHORE
SANTA ROSA ISLAND
GULF BREEZE, FL

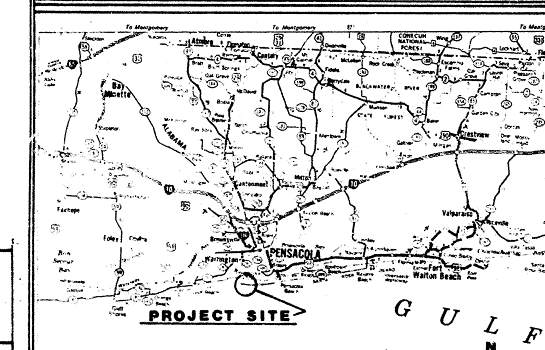
NATIONAL PARK SERVICE
Department of the Interior

SHEET INDEX

SHEET NUMBER	DESCRIPTION
1	TITLE/LOCATION OF PROJECT SHEET
2	FOUNDATION AND BASE PLATE DETAILS
3	TOWER ELEVATIONS AND SECTIONS
4	OBSERVATION LEVEL ELEVATIONS
5	STAIR TOWER DETAILS
6	TOWER STRUCTURAL DETAILS
7	TOWER STRUCTURAL DETAILS
8	GUSSET (CONNECTION) PLATE DETAILS



LOCATION MAP FORT PICKENS AREA
NO SCALE



VICINITY MAP
NO SCALE

PENSACOLA TESTING LABORATORIES INC.
217 EAST BRENT LANE PENSACOLA, FL. 32503
PHONE 433-8100

SUBJECT REHABILITATION OF BATTERY 234 OBSERVATION TOWER

PROJECT NO. 79-07 DATE 8 / / 79
BY JRM SHEET 1 OF 8 SHEETS
SCALE AS NOTED C. L. Wheeler, P.E. #8021

BASIC DATA

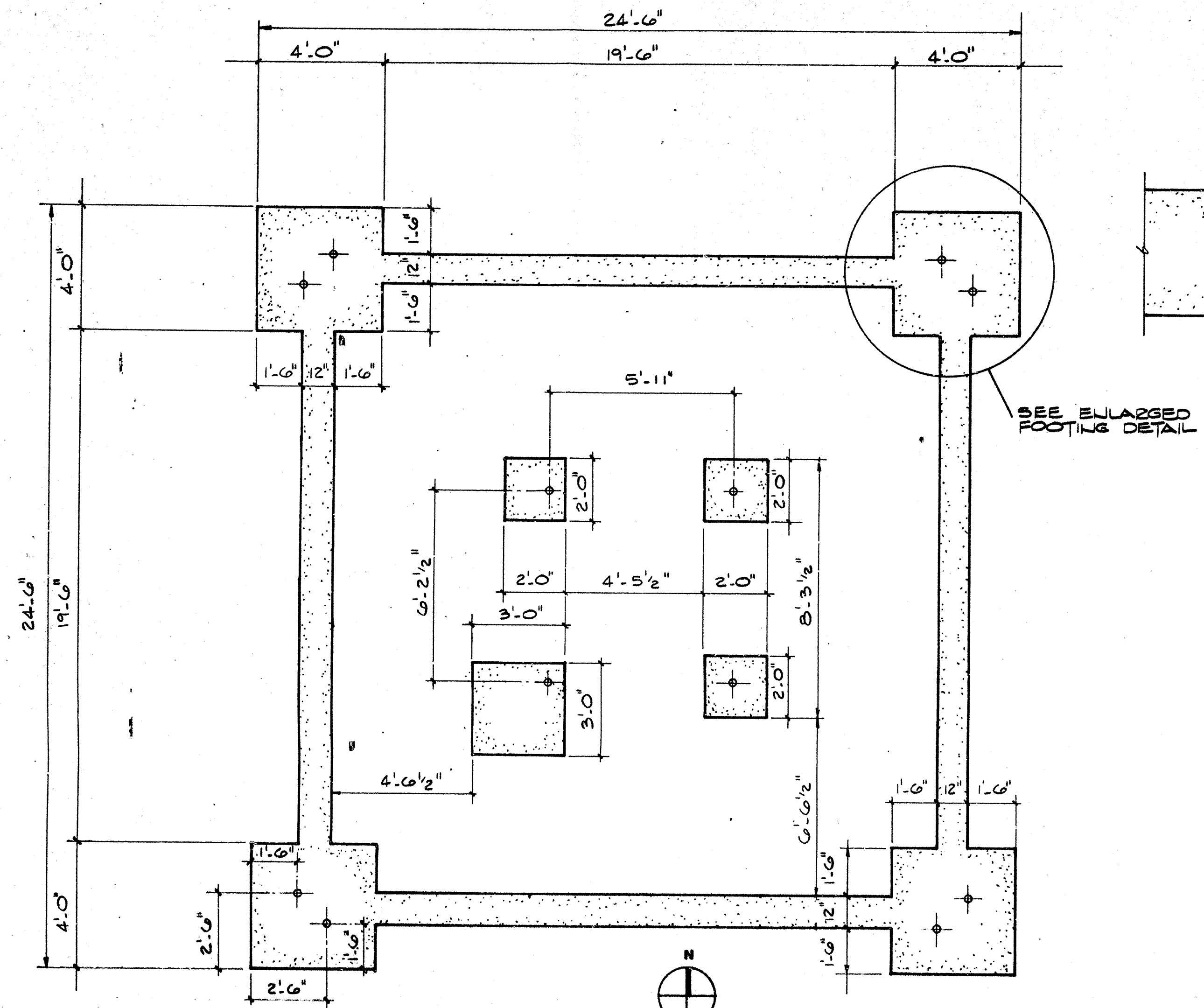
Charles Mirth 8-12-79

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
DENVER SERVICE CENTER

PREPARED
DESIGNED
DRAWN
CHECKED
DATE

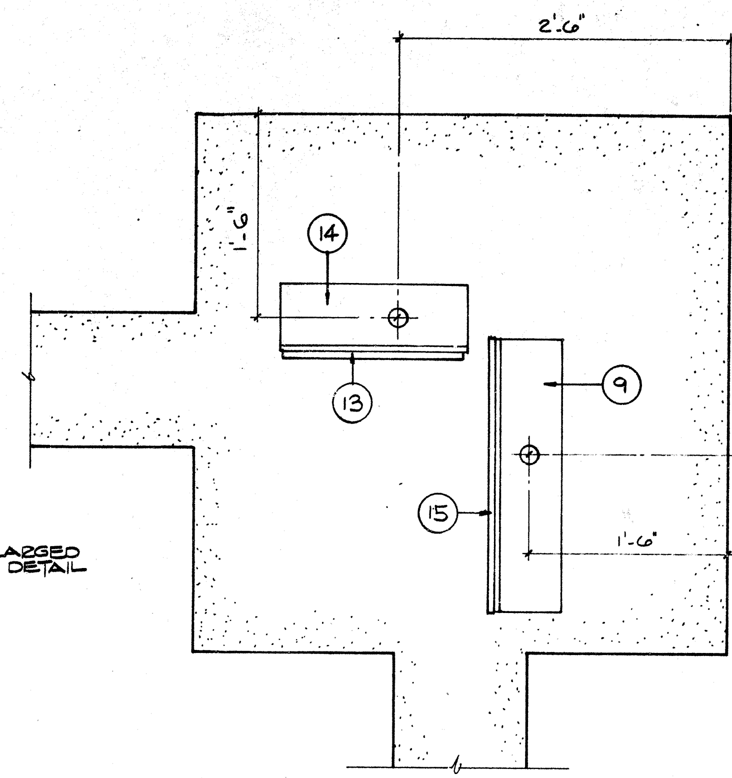
TITLE OF DRAWING
TITLE SHEET
LOCATION WITHIN PARK
BATTERY 234
NAME OF PARK
GULF ISLANDS NAT'L SEASHORE
SOUTHEAST — REGION | ESCAMBIA — COUNTY | FLORIDA — STATE

DRAWING NO. 635 80072
PCIP PKG
SHEET 1 OF 8



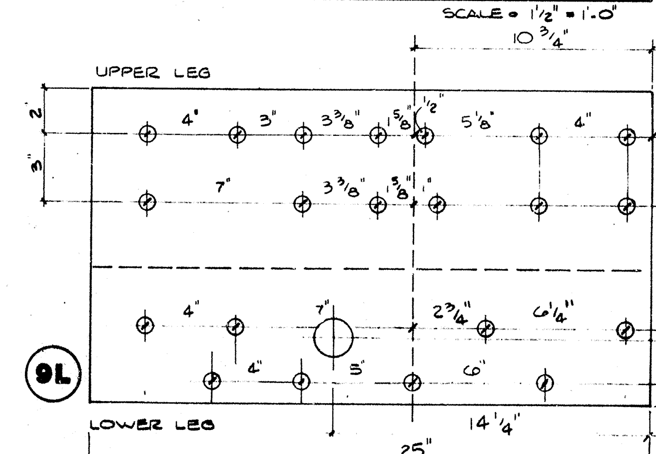
FOOTING PLAN

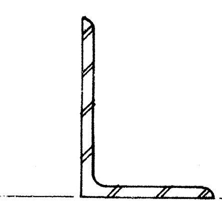
SCALE = 3/8" = 1'-0"



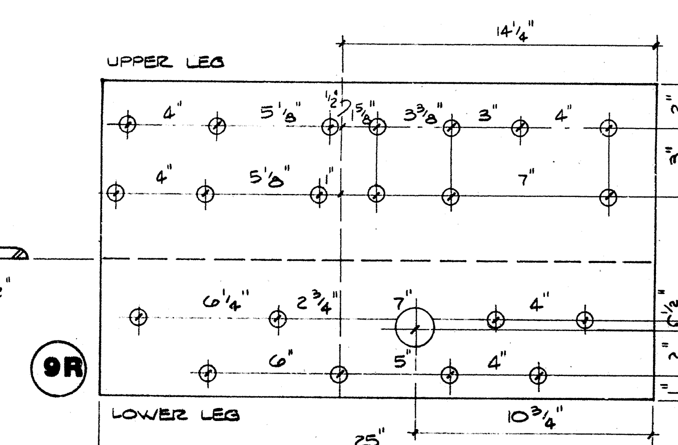
ENLARGED FOOTING DETAIL

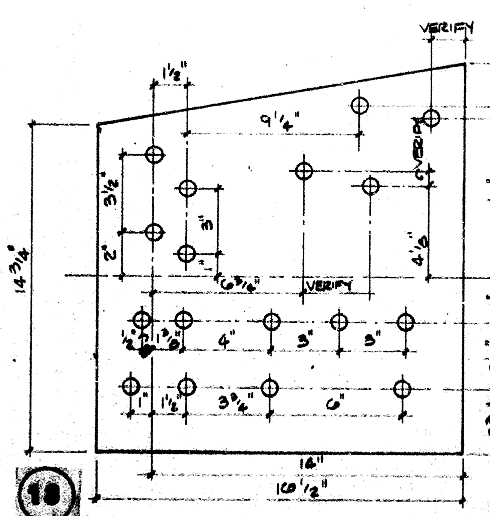
SCALE = 1 1/2" = 1'-0"

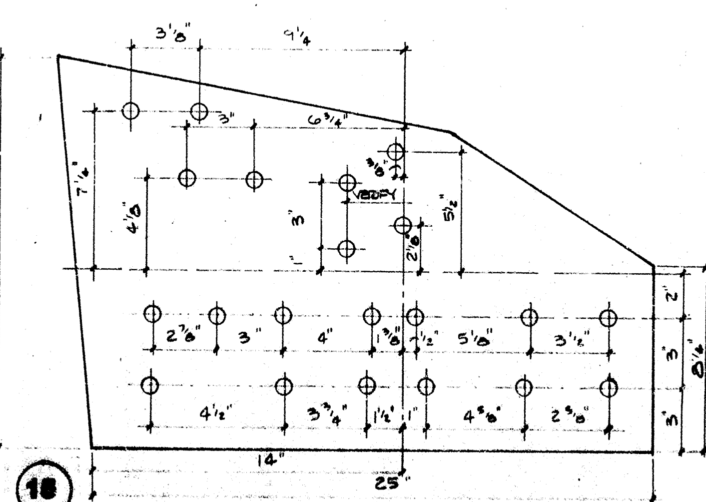


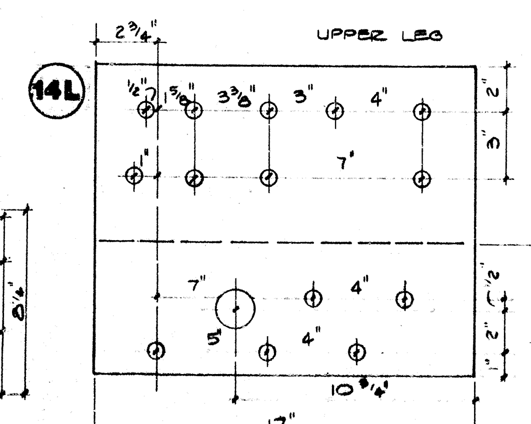


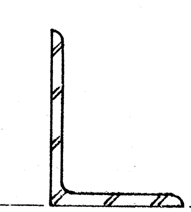
L-6" × 8" × 1/2"





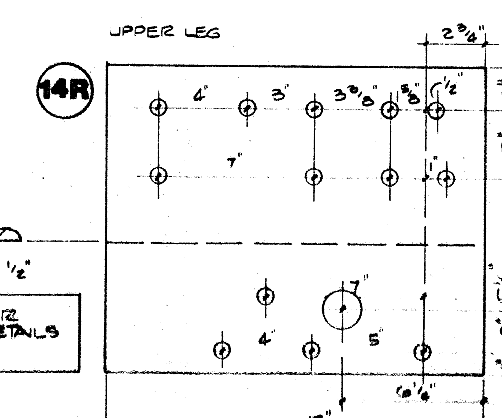






L-6" × 8" × 1/2"

NOTE: CONNECTOR PLATE & ANGLE DETAILS SCALE 3" = 1'-0"



GENERAL NOTES

1-01 DESCRIPTION OF WORK

A. The work includes the furnishing of all labor and materials, fabrication, delivery, erection and repair or replacement of all structural steel shown, scheduled or otherwise required to complete the work. This includes all necessary connectors and accessories. A minor amount of concrete repair involving removal and replacement of spalled areas is also required.

B. Sequence of Work:

1 Shore, brace or otherwise temporarily stabilize Battery 234 Observation Tower prior to beginning Work. Submit proposed details of stabilization system for review by NPS prior to commencing same.

2 Repair and/or replace as necessary all damaged, weathered and corroded structural elements and connectors of the Tower.

3 White metal blast with coarse silica sand to produce a light surface etch over all exposed steel, immediately followed by 0.003 inch (0.076 mm) of Aluminum coating applied with ColmonoyWirespray Equipment (Wall Colmonoy Corporation, 3224 Peachtree St. Atlanta, Ga 30305).

4 Apply a seal coat of Wash Primer (Air drying, 2 part acid-zinc chromate wash coat primer mixed 4 parts resin component with 1 part acid component) followed by 1 coat of Aluminum Vinyl (A vinyl copolymer aluminum flakes, air drying) coating material.

5 Replace and/or repair as necessary all damaged, weathered and corroded steel elements and remove/replace spalled concrete in Observation Area of Tower. Concrete repair to match existing in color and texture as closely as possible.

6 It is the intent of the NPS and these documents to retain as much of the original and existing Tower as is possible. No unnecessary replacement of materials shall be done. The completed Work shall produce a safe, structurally and aesthetically restored and rehabilitated Observation Tower as close to original appearance as possible.

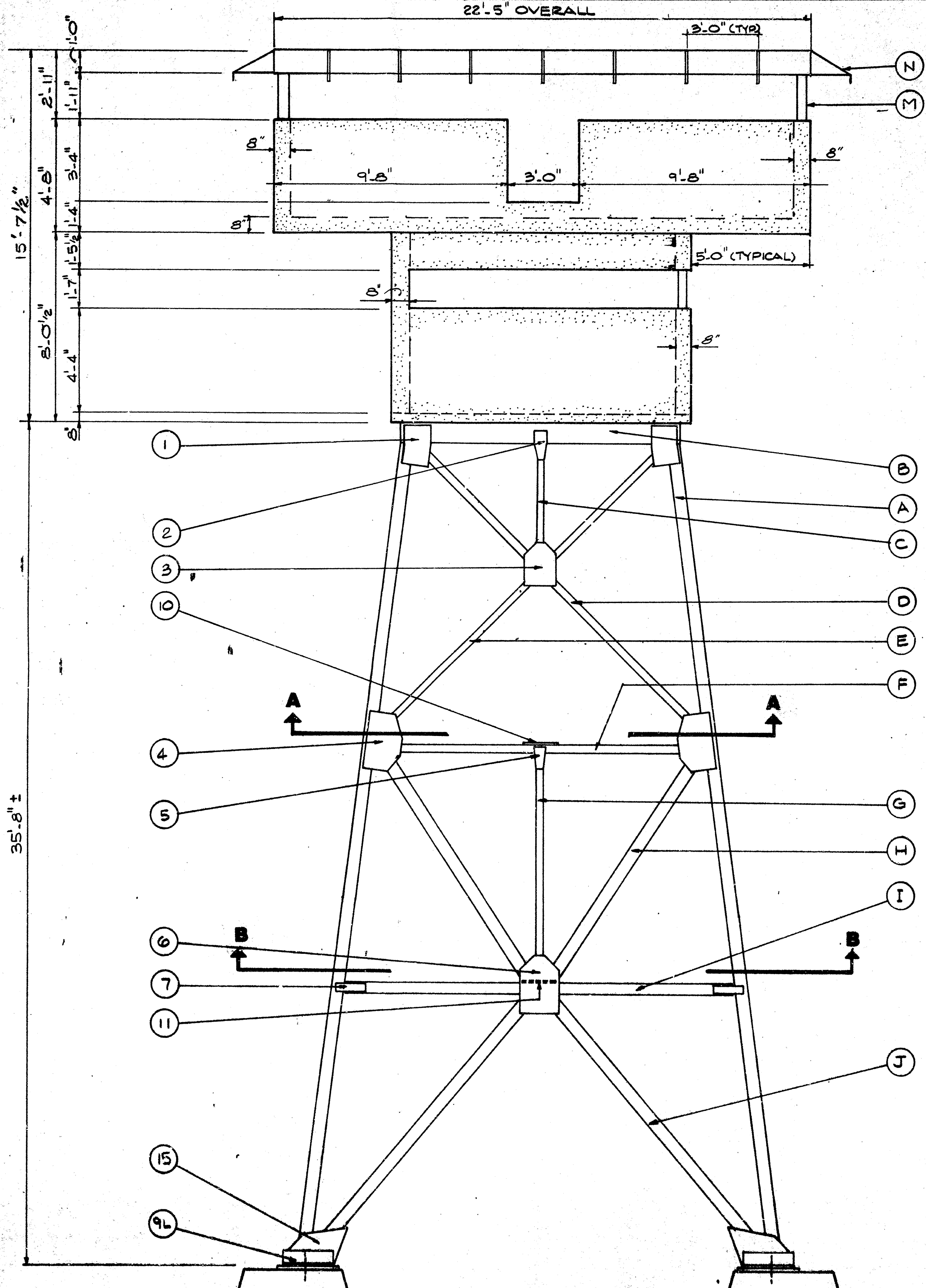
PENSACOLA TESTING LABORATORIES INC.

SUBJECT REHABILITATION OF BATTERY 234 OBSERVATION TOWER

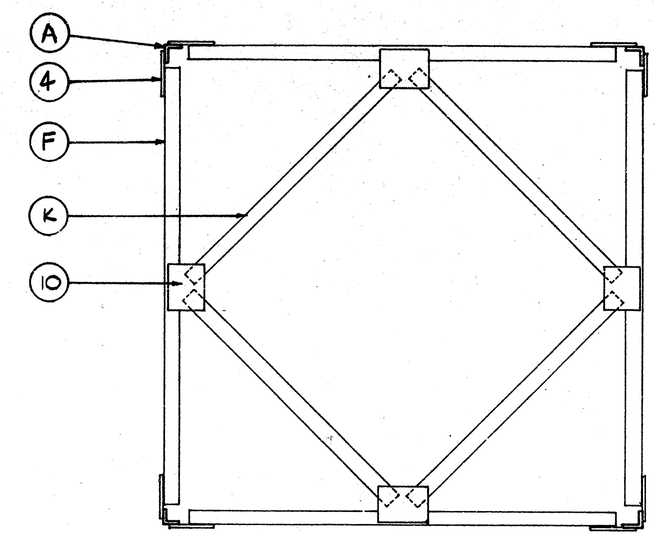
PROJECT NO. 79-07 DATE 6/7/79
BY JRM SHEET 2 OF 8 SHEETS
SCALE AS NOTED C. F. Meister PE #8021

PREPARED	DRAWING NO. 635 80072
DESIGNED	
DRAWN	PCIP PKG. / SHEET 2
CHECKED	
DATE	OF 8

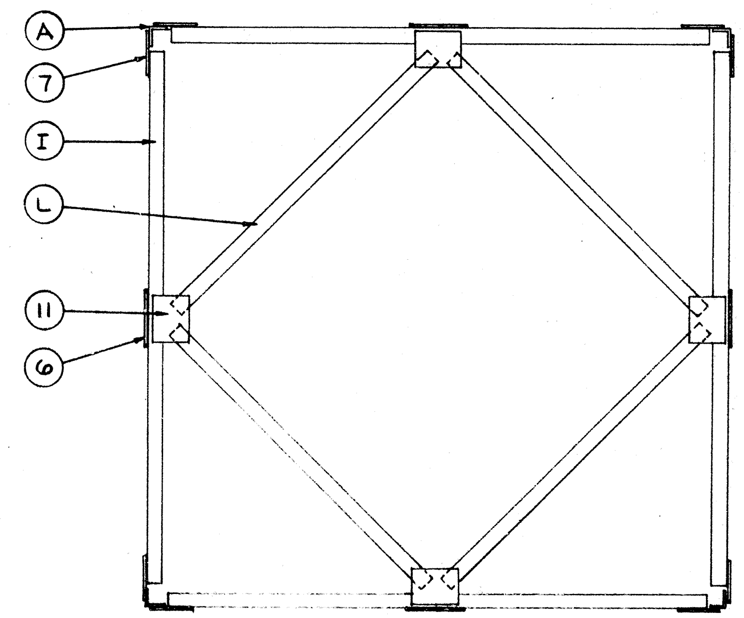
Charles F. Meister
8-12-79



WEST TOWER ELEVATION SCALE = 3/8" = 1'-0"



SECTION A-A
SCALE = 3/8" = 1'-0"



SECTION B-B
SCALE = 3/8" = 1'-0"

STRUCTURAL STEEL

1-02 QUALITY ASSURANCES

A. The following codes and publications, of the latest edition, govern this work unless indicated or specified otherwise.
   1. Code of Standard Practice for Steel Buildings and Bridges: A publication of AISC.
   2. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings: A publication of AISC.
   3. Structural Welding Code: A publication of AWS.
   4. Standard Building Code: A publication of the Southern Building Code Congress International, Inc.

B. Shop Drawings: Furnish for approval.

C. Substitutions: Make requests for substitions of sections and modifications to details by obvious notation on shop drawings.

D. Mill Reports: When requested by the NPS, furnish two copies.

E. Marking: Shop and field mark each piece of steel, plainly in a protected location in accordance with reference numbers on the shop drawings.

F. Testing: An independent laboratory, under the direction of a Professional Engineer licensed to practice in Florida will be employed by the NPS to insure that fasteners are installed in accordance with the specifications.

PART - 2 PRODUCTS

2-01 General

A. Structural Steel: ASTM A36.

B. Fasteners: ASTM A502 Steel Structural Rivets, Grade 2, Hot Driven, 5/8" diameter, Full Head to match existing.

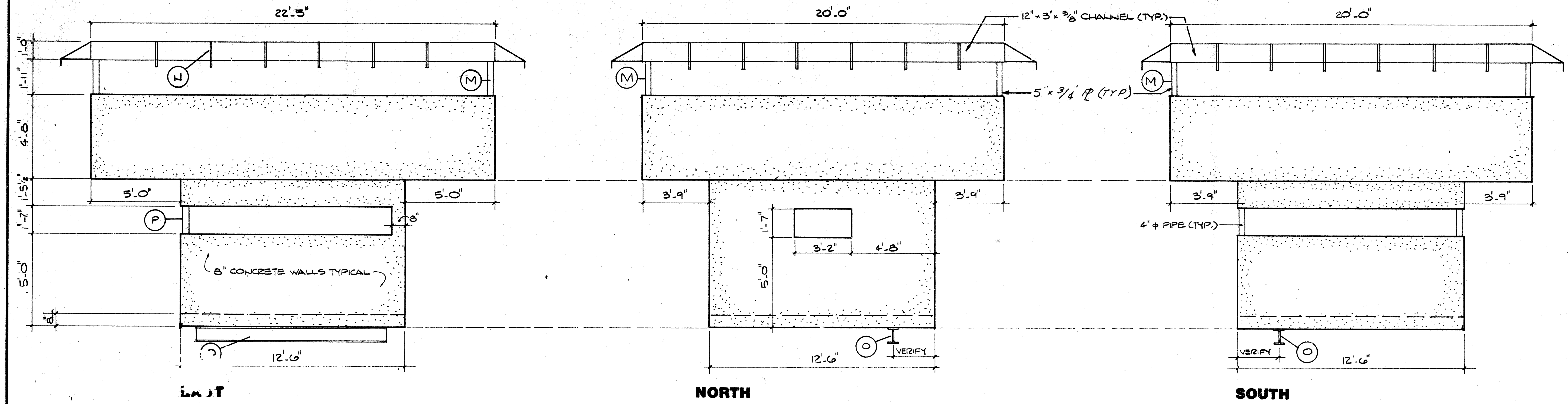
Charles L. Meister
8-12-79

PENSACOLA TESTING LABORATORIES INC.
317 EAST BRENT LANE PENSACOLA, FL.
PHONE 4776[illegible]

SUBJECT REHABILITATION OF BATTERY 234 OBSERVATION TOWER

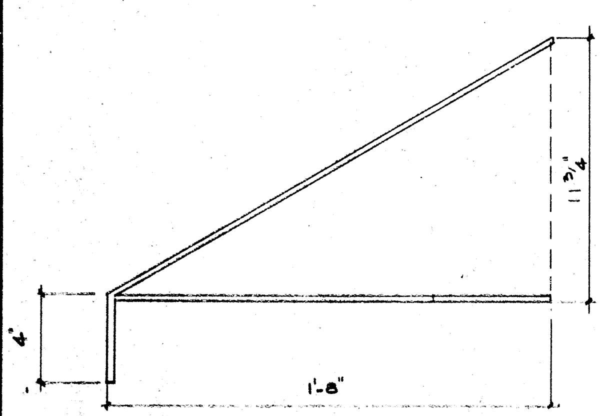
PROJECT NO. 79-[illegible] DATE 8 / 79
BY JEM SHEET 3 OF 8 SHEETS
SCALE AS NOTED

PREPARED	DRAWING NO. 635 80073A	
DESIGNED		
DRAWN	PCIP PKG.	SHEET 3
CHECKED		
DATE		OF 8

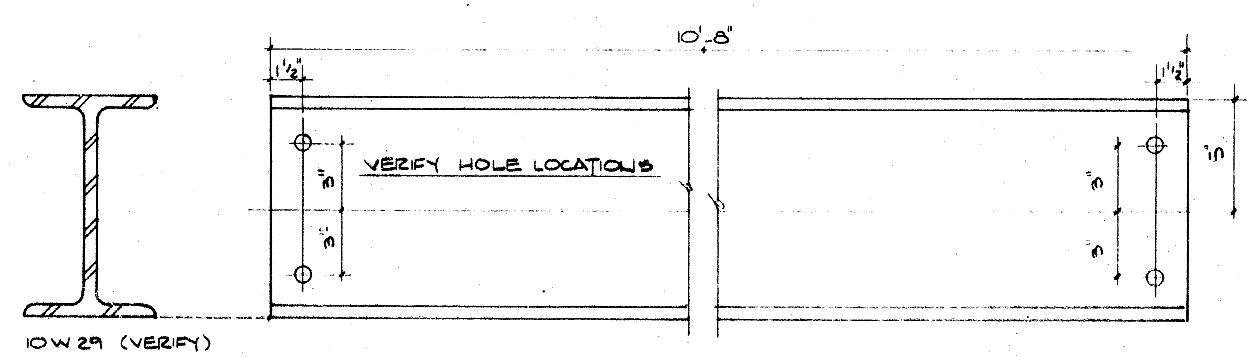


OBSERVATION LEVEL ELEVATIONS

SCALE: 3/8" = 1'-0"



N OUTRIGGER DETAIL



O

NOTE: ALL MISCELLANEOUS DETAILS SCALE 3" = 1'-0" U.N.O.

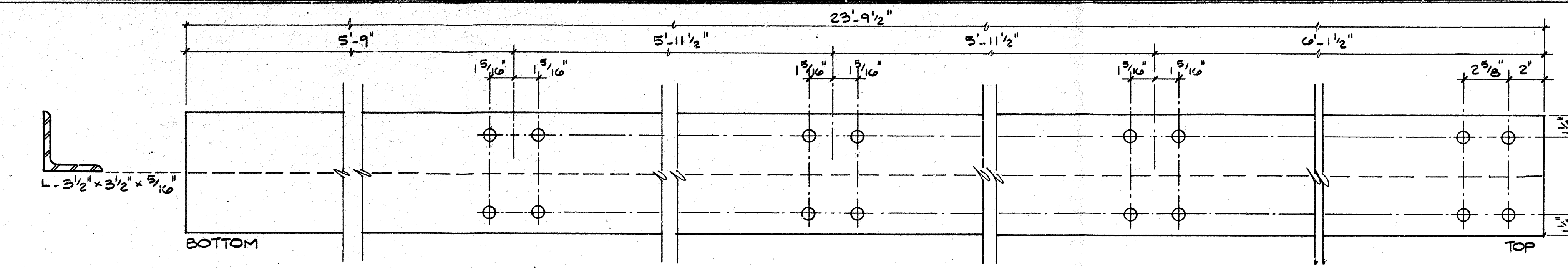
Charles L. Meister
8-12-79

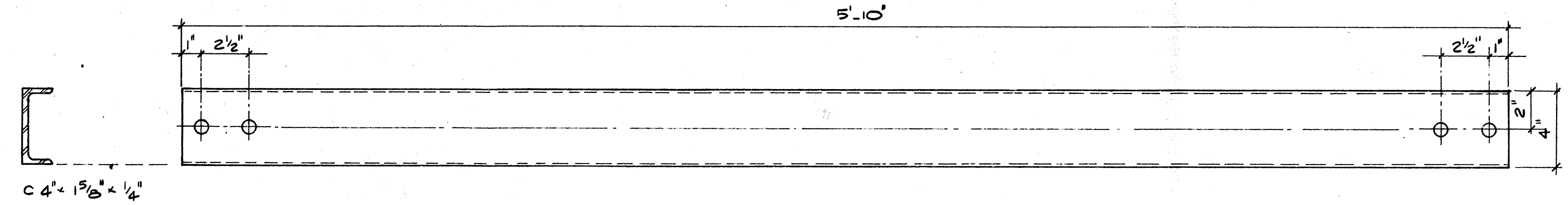
PENSACOLA TESTING LABORATORIES INC.

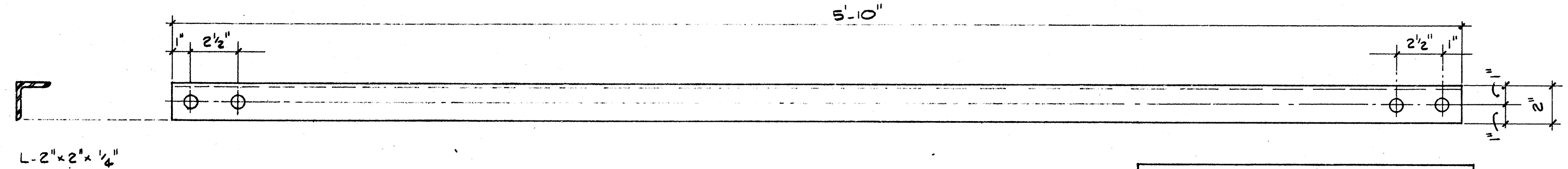
SUBJECT: REHABILITATION OF BATTERY ... OBSERVATION TOWER

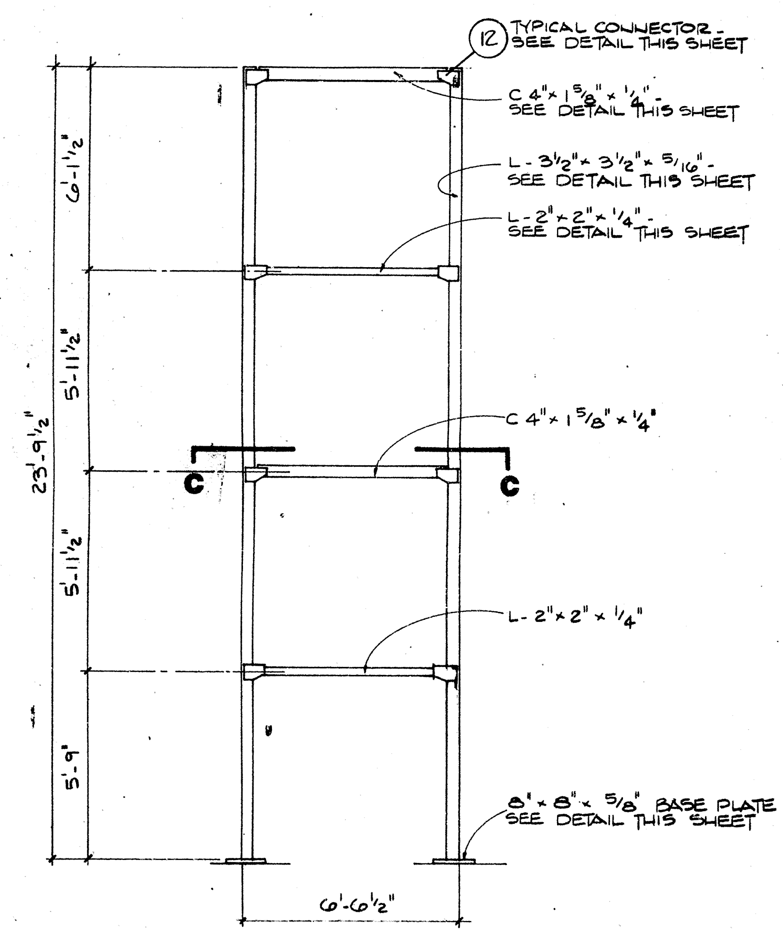
BY J.H.M. SCALE AS NOTED C.L. Meister PE 9021

PREPARED	DRAWING NO.
DESIGNED	635 800 72A
DRAWN	PCIP PKG. / SHEET 4
CHECKED	
DATE	OF 8



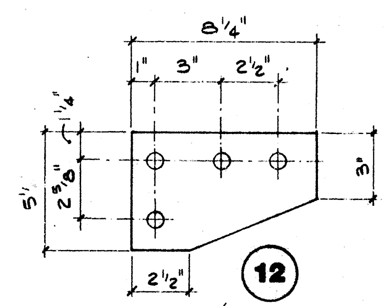


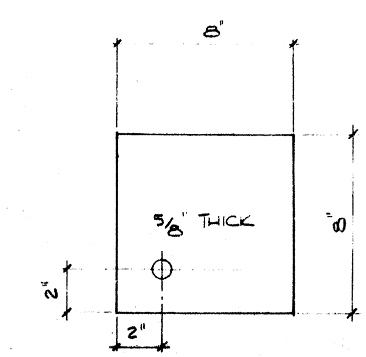




STAIR TOWER ELEVATION

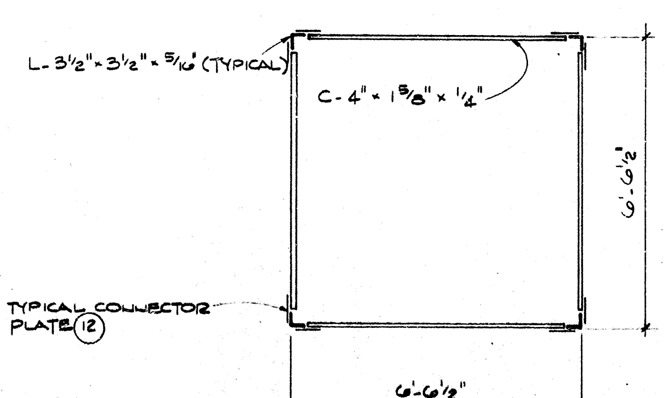
SCALE = ⅜" = 1'-0"





BASE PLATE

SCALE = 3" = 1'-0"



SECTION C-C

SCALE = ⅜" = 1'-0"

NOTE = ALL CONNECTORS & OTHER ITEMS THIS SHEET SCALE 3" = 1'-0" U.N.O.

SCHEDULE OF STAIR TOWER ASSEMBLY

Structural Member Designation	Description	Number in Tower	Preliminary Condition Estimate: Satisfactory	Repair Needed	Replace
Stair Tower Assembly	3½ x 3½ x 5/16 Angle 7.2 Lbs./Ft. 23'9½" Long	4 ea.			4 ea.
	4" Channel 5.4 Lbs./Ft. 5'10" Long	8 ea.			8 ea.
	2" x 2" x 1/4 Angle 3.19 Lbs./Ft. 5'10" Long	8 ea.			8 ea.
Stair Tower Assembly	8" x 8" x 5/8" Plate	4 ea.			4 ea.
3/4" Stair Tower Anchor Bolt		4 ea.			4 ea.
Steel Stair Support Channel	5" x 1-3/4 2.63 Lbs./Ft.	(Approx. 120 Lin. Ft.)			120 Lin. Ft.
1½" Pipe Railing		(Approx. 110 Lin. Ft.)			110 Lin. Ft.
5/16" Plate 17½" Wide for Risers 10½" Risers, 6" Tread		(Total Plate Length Approx. 60 Lin. Ft.)			(Total Plate Length Approx. 60 Lin. Ft
5/8" Ø Rivets		800 ea.			600 ea.

SPECIAL NOTE

STAIR TOWER AND STEPS: The original details of the steps and railing are not known. Deterioration and corrosion have rendered this portion of the Tower beyond measurement. Details of reconstruction will be supplied by the NPS from photographs or measurement of the stair details on other similar towers located elsewhere in the country.

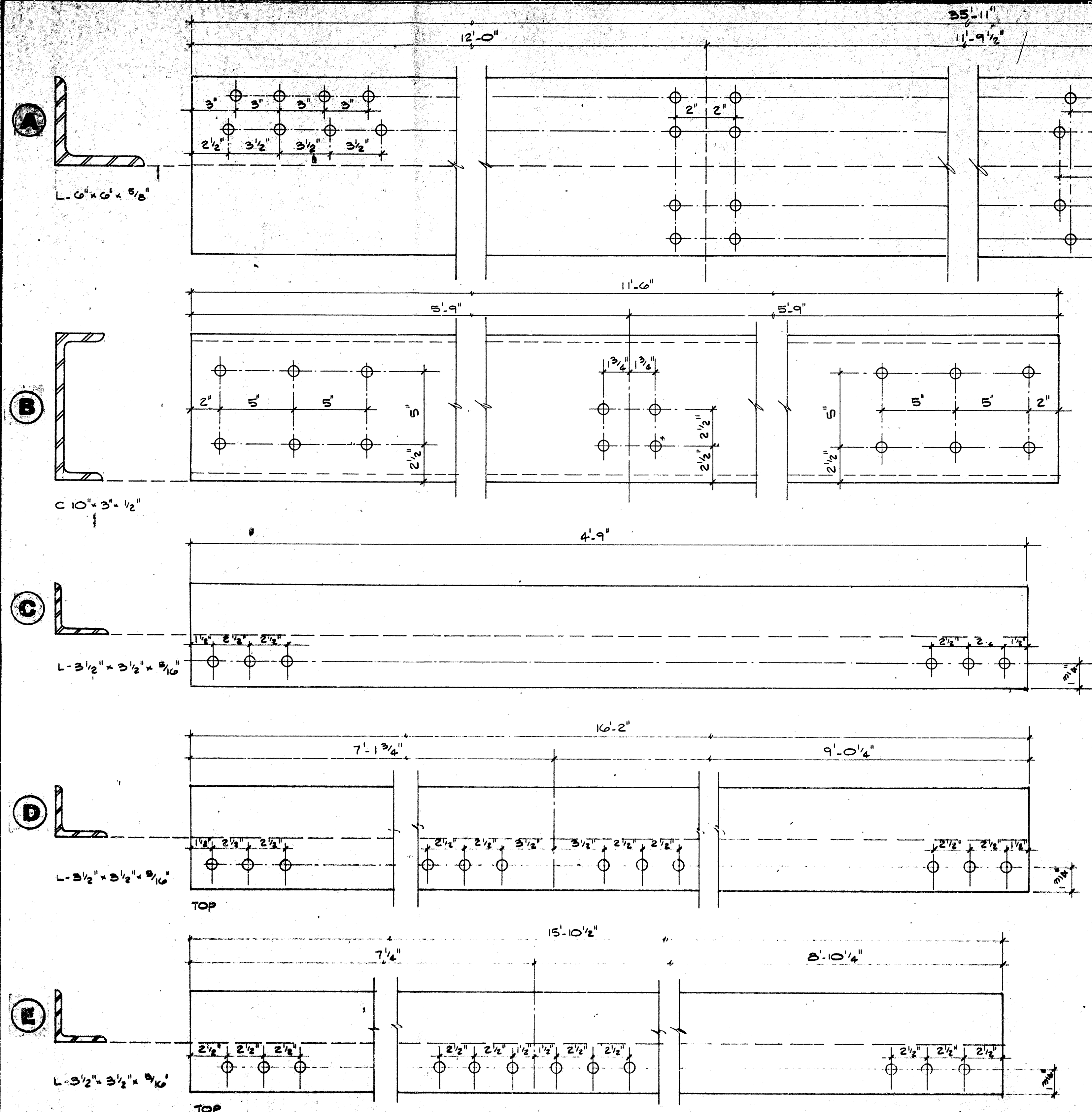
Charles L. Meister 8/3/79

PENSACOLA TESTING LABORATORIES INC.
217 EAST BRENT LANE PENSACOLA, FL. 32503
PHONE 477-8100

SUBJECT REHABILITATION OF BATTERY 234 OBSERVATION TOWER

PROJECT NO. 79-07 DATE 6/7/79
BY JEM SHEET 5 OF 6 SHEETS
SCALE AS NOTED C.L. Meister PE 8021

PREPARED	DRAWING NO. 635 B00728
DESIGNED	PCIP PKG.
DRAWN	SHEET 5
CHECKED	
DATE	OF 6



SCHEDULE OF TOWER MEMBERS

Structural Member Designation	Description	Number In Tower	Preliminary Condition Estimate Satisfactory	Repair Needed	Replace
A	6 x 6 x 5/8 Angle, 24.2 Lbs Per Ft. 35'11" Long, Main Tower Support Leg	4 ea.	4 ea.		
B	10 Channel 30 Lb. 11'6" Long	4 ea.	4 ea.		
C	3½ x 3½ x 5/16 Angle 7.2 Lbs./Ft. 4'9" Long	4 ea.			4 ea.
D	3½ x 3½ x 5/16 Angle 7.2 Lbs./Ft. 16'2" Long	4 ea.		1 ea.	3 ea.
E	3½ x 3½ x 5/16 Angle 7.2 Lbs. 15'10½" Long	4 ea.		1 ea.	3 ea.
F	5 x 5 x 5/16 Angle 10.3 Lbs. 13'8" Long	4 ea.		1 ea.	3 ea.
G	3½ x 3½ x 5/16 Angle 7.2 Lbs./Ft. 11'0½" Long	4 ea.			4 ea.
H	6 x 6 x 3/8 Angle 14.9 Lbs./Ft. 12'6-1/8" Long	8 ea.	2 ea.	2 ea.	4 ea.
I	5 x 5 x 5/16 Angle 10.3 Lbs./Ft. 16'8" Long	4 ea.	2 ea.	1 ea.	1 ea.
J	6 x 6 x 3/8 Angle 14.9 Lbs./Ft. 13'11-5/8" Long	8 ea.	6 ea.	2 ea.	
K	5 x 5 x 3/8 Angle 12.3 Lbs./Ft. Horizontal Diagonal Brace, 8'9" Long	4 ea.			4 ea.
L	5 x 5 x 3/8 Angle 12.3 Lbs./Ft. 11'5" Long Horizontal Diagonal Brace	4 ea.		2 ea.	2 ea.
M	5" x 3/4" Steel Plate 23" Long	4 ea.			4 ea.
N	1½ x 1/4 Plate (Strap) Outrigger 48" Long	32 ea.		16 ea.	16 ea.
O	10" Wide Flange 29 Lbs. Beam 10'8" Long	1 ea.		1 ea.	

NOTE = ALL ITEMS ON THIS SHEET SCALE 3" = 1'-0" U.N.O.

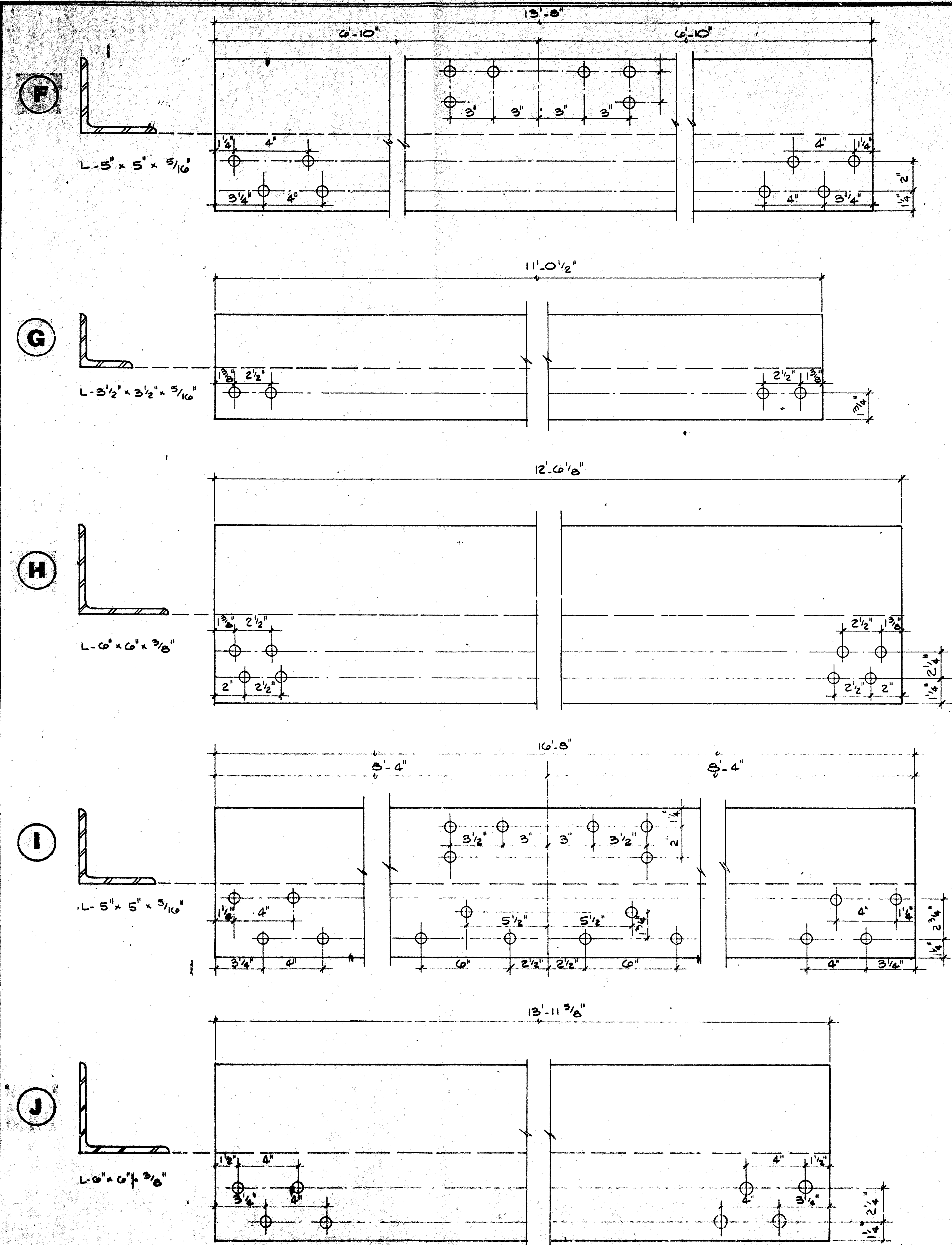
PENSACOLA TESTING LABORATORIES INC.
217 EAST BRENT LANE PENSACOLA, FL. 32503
PHONE 477-5100

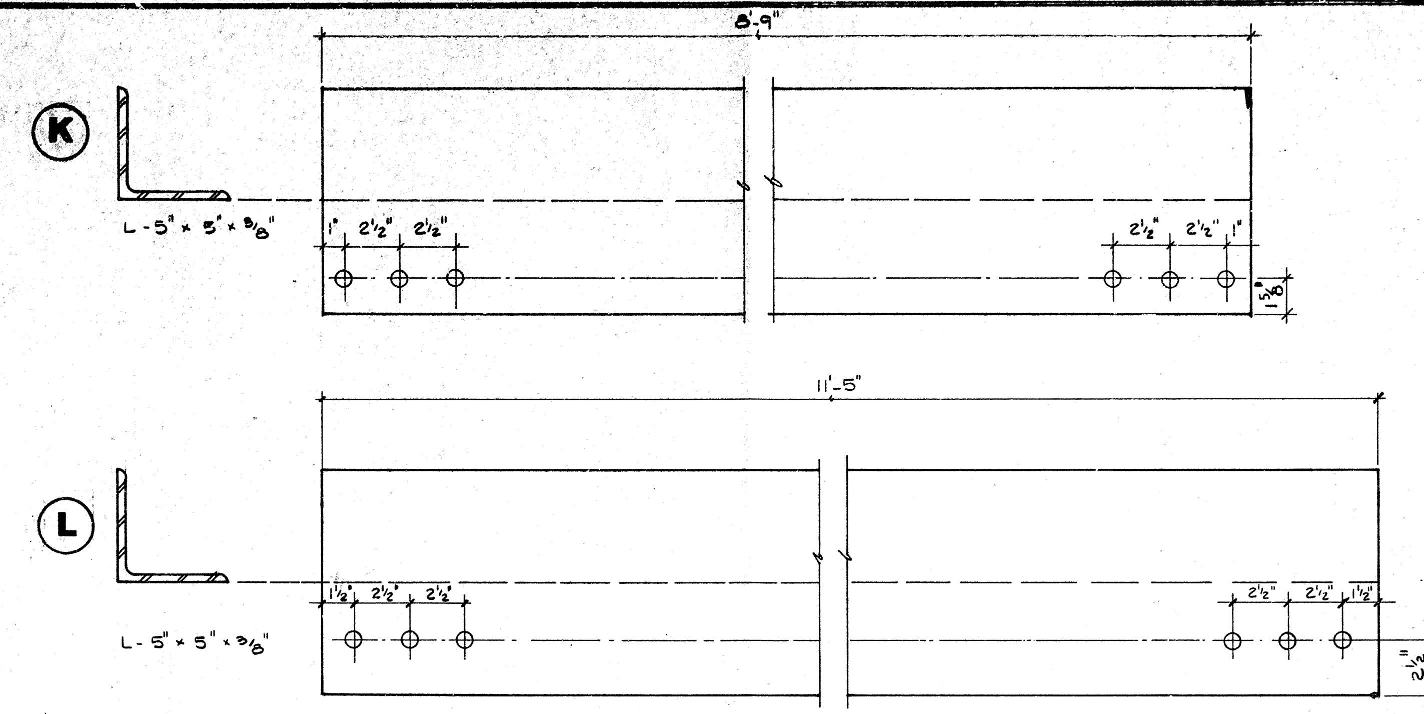
SUBJECT REHABILITATION OF BATTERY 234 OBSERVATION TOWER

PROJECT NO. 79-07 DATE 8/7/79
BY JRM SHEET 6 OF 8 SHEETS
SCALE AS NOTED

Charles F. Minter 8-12-79
C.F. Minter PE #8031

PREPARED	DRAWING NO. 635 800 72A
DESIGNED	
DRAWN	PCIP PKG.
CHECKED	SHEET 6
DATE	OF 8





SCHEDULE OF GUSSET PLATES

Structural Plate Designation	Description	Number In Tower	Preliminary Condition Estimate: Satisfactory	Repair Needed	Replace
1	13¼ x 19½ x 3/8 Plate	8 ea.	8 ea.		
2	6½ x 14 x 3/8 Plate	4 ea.	4 ea.		
3	16¼ x 15-3/8 x 3/8 Plate	4 ea.			4 ea.
4	29¼ x 13¼ x 3/8 Plate	8 ea.	3 ea.	2 ea.	3 ea.
5	6 x 10¼ x 3/8 Plate	4 ea.			4 ea.
6	19½ x 29 x 3/8 Plate	4 ea.	2 ea.	1 ea.	1 ea.
7	4¼ x 15½ x 3/8 Plate	8 ea.		2 ea.	6 ea.
8	Deleted				
9	6 x 8 x 1/2, 23 Lb/Ft. Angle 25" Long	4 ea.	2 ea.		2 ea.
10	17 x 12-3/4 x 1/2 Plate	4 ea.		2 ea.	2 ea.
11	13 x 17 x 1/2 Plate	4 ea.	4 ea.		
12	5¼ x 8¼ x ¼ Plate Stair Tower Connectors	32 ea.			32 ea.
13	17½ x 16½ x 1/2 Plate	4 ea.		4 ea.	
14	6 x 8 x 1/2 Angle 23 Lbs./Ft. 17" Long	4 ea.	2 ea.		2 ea.
15	17½ x 25 x 1/2 Inch Plate	4 ea.	2 ea.		2 ea.

NOTE: ALL ITEMS ON THIS SHEET SCALE 3" = 1'-0" U.N.O.

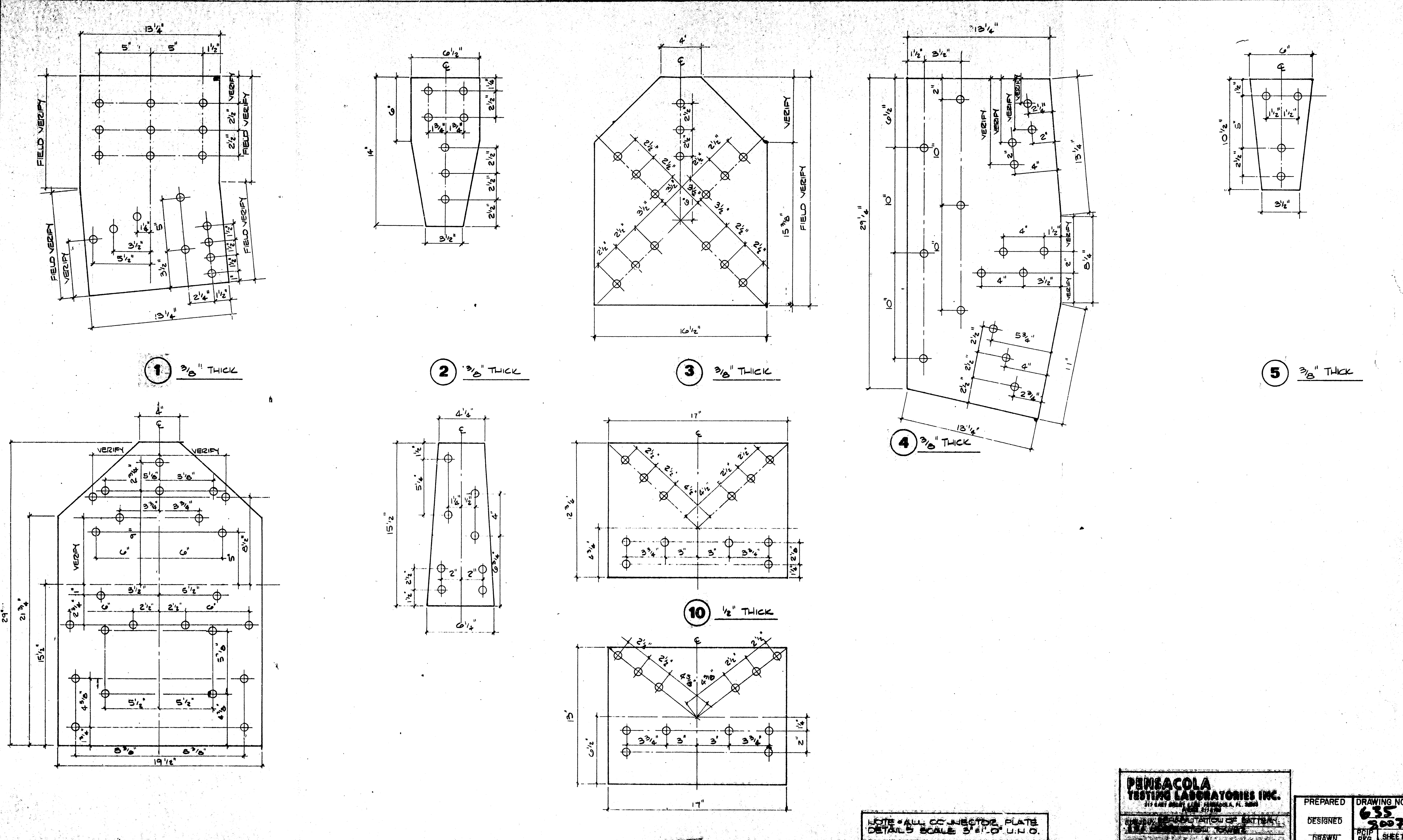
PENSACOLA TESTING LABORATORIES INC.
217 EAST BRENT LANE PENSACOLA, FL. 32503
PHONE: 477-6100

SUBJECT REHABILITATION OF BATTERY 234 OBSERVATION TOWER

PROJECT NO. 79.07 DATE 8 / 79
BY JRM SHEET 7 OF 8 SHEETS
SCALE AS NOTED C. L. Mieste P.E. #8021

Charles L. Mieste 8-12-79

PREPARED	DRAWING NO.
DESIGNED	635 80072A
DRAWN	PCIP PKG. — SHEET 7
CHECKED	
DATE	OF 8



1 3/8" THICK

2 3/8" THICK

3 3/8" THICK

4 3/8" THICK

5 3/8" THICK

6 3/8" THICK

7 3/8" THICK

10 1/2" THICK

11 1/2" THICK

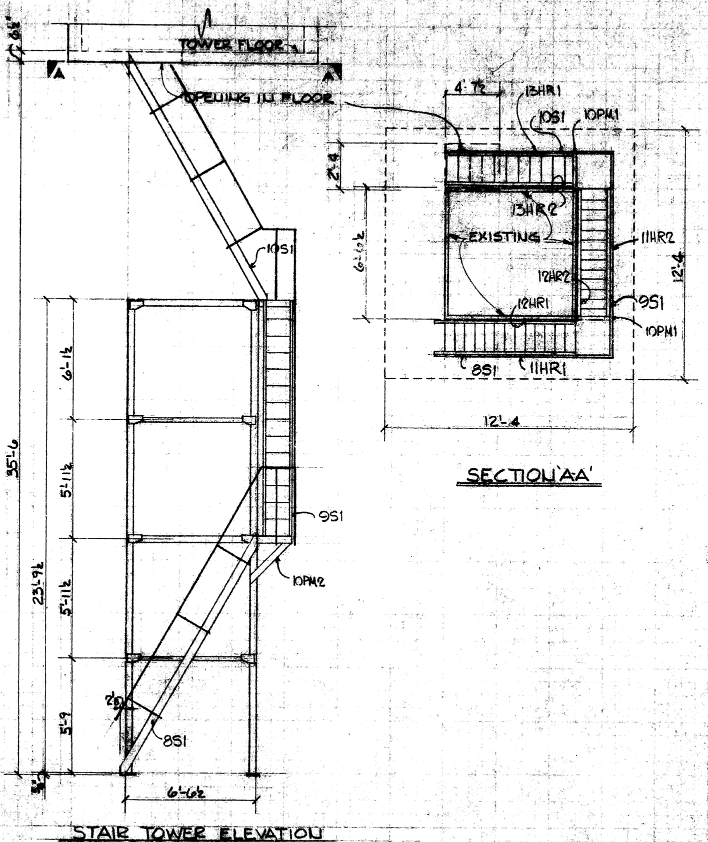
NOTE: ALL CONNECTOR PLATE DETAILS SCALE 3"=1'-0" U.N.O.

PENSACOLA TESTING LABORATORIES INC.

SUBJECT: REHABILITATION OF BATTERY

PREPARED	DRAWING NO.
DESIGNED	635
DRAWN	30072A
CHECKED	PCIP PKG. / SHEET OF 8
DATE	

Appendix C: Stair Shop Drawings, 1980

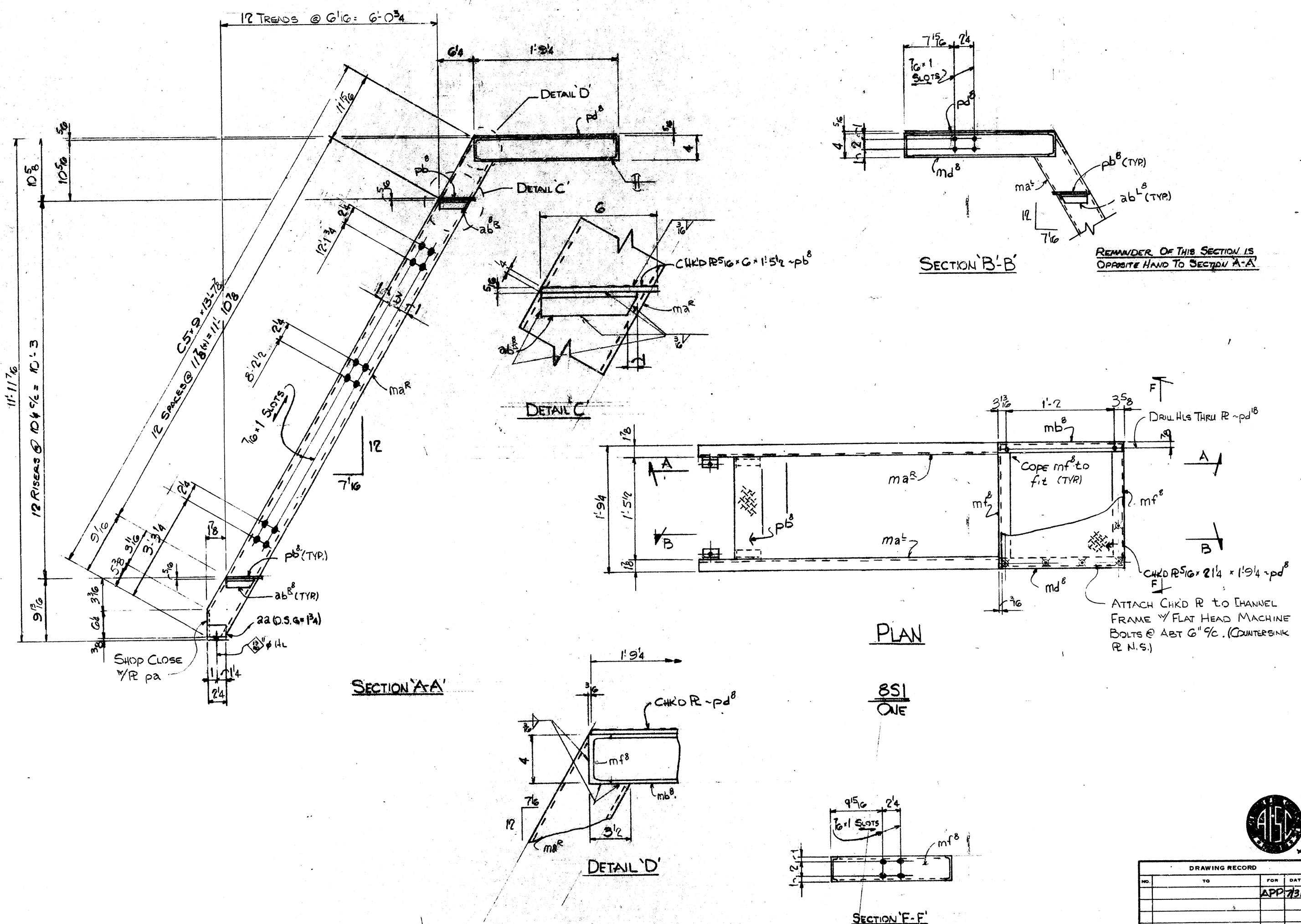


FOR APPROVAL

SEP 17 1980

NOTES	BELL STEEL COMPANY PENSACOLA, FLORIDA
	STRUCTURE: REHABILITATION OF B... Y 234; OBSERVATION TOWER
	LOCATION: FT PICKENS, FLA.
	CONT.: FIDELITY CONST. CO.
	DETAIL: ERECTION.
Holes ... Unless Noted	ARCH. OR ENG.: PENSACOLA TESTING LAB.
Paint	REVISIONS 1 2 3 4 — SHOP ORDER 3886-80 — SHEET No. E2
Made BOB Date 25 JULY 80	
Chkd. MWS Date 7-29-80	

APP 7/31/80 1 OF 7 635 / 61168



SHOP BILL

No.		Description	Length Ft.	Length In.	Assem. Mark	Shipping Mark	Remarks	Item No.	Weight
ONE		STAIR				8S1			
	2	C5×9	13	7 7/8	ma R/L				
	1	C4×5.4	1	9 7/16	mb8				
	1	C	1	9 7/16	md8				
	2	C do	1	8 7/8	mf8				
	2	L3×3×3/8	0	2 1/4	aa			T	
	26	L2×2×1/4	0	5	ab R/L 8		(13R 13L)		
	2	R 5/16×1 1/2	0	5 5/8	pa				
	13	CHK'D R 5/16×6	1	5 1/2	pb8				
	1	CHK'D R 5/16×2 1/4	1	9 1/4	pd8				
	12	1/4"φ F.H.M.B	0	1		W/NUTS			

FOR APPROVAL

SEP 17 1980

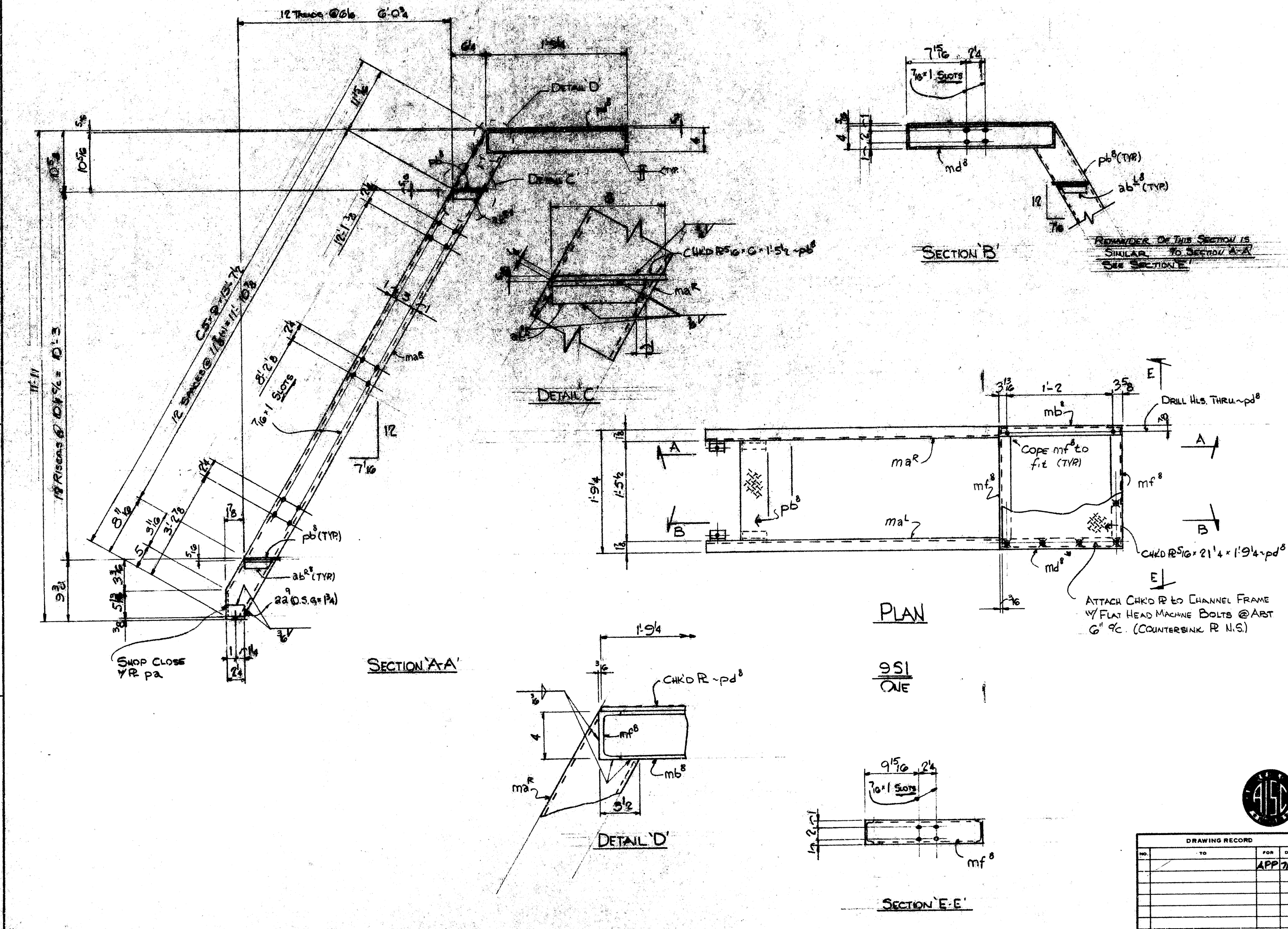
NOTES
MAT'L = A36, PIPE: A53
WELDS = E70XX

DRAWING RECORD
APP 7/31/80

Holes 11/16" Unless Noted
Paint NONE
Made BOB Date 23 Jul 80
Chkd MWS Date 7-29-80

BELL STEEL COMPANY
PENSACOLA, FLORIDA

STRUCTURE: REHABILITATION of BATTERY 234; OBSERVATION TOWER
LOCATION: FT. PICKENS, FLA.
CONT.: FIDELITY CONST.
DETAIL: STAIRS and LANDING.
ARCH. OR ENG.: PENSACOLA TESTING LABORATORIES
SHOP ORDER: 3886-80
SHEET No.: 8



SHOP BILL

No.		Description	Length Ft.	Length In.	Assem. Mark	Shipping Mark	Remarks	Item No.	Weight
ONE		STAIR				9S1			
	2	C5 × 9	13	7 1/2	ma RL				
	1	C4 × 5.4	1	9 7/16	mb8				
	1	C do	1	9 7/16	md8				
	2	C do	1	8 7/8	mf8				
	2	L3 × 3 × 3/8	0	2 1/4	aa9			T	
	26	L2 × 2 × 1/4	0	5	ab RL8		(13R - 13L)		
	2	PL 5/16 × 1 1/2	0	5 1/4	pa				
	13	CHK'D PL 5/16 × 6	1	5 1/2	pb8				
	1	CHK'D PL 5/16 × 21 1/4	1	9 1/4	pd8				
	12	1/4" ∅ F.H.M.B.	0	1		W/NUTS			

FOR APPROVAL

SEP 17 1980

DRAWING RECORD

NO.	TO	FOR	DATE
		APP	7/31/80

NOTES

MAT'L = A36, PIPE = A53

WELDS = E70XX

Holes 11/16 ∅ Unless Noted

Paint NONE

Made BOB Date 23 JULY 80

Chkd. MWS Date 7-30-80

BELL STEEL COMPANY
PENSACOLA, FLORIDA

STRUCTURE: REHABILITATION of BATTERY 234; OBSERVATION TOWER

LOCATION: FT. PICKENS, FLA.

CONT.: FIDELITY CONST.

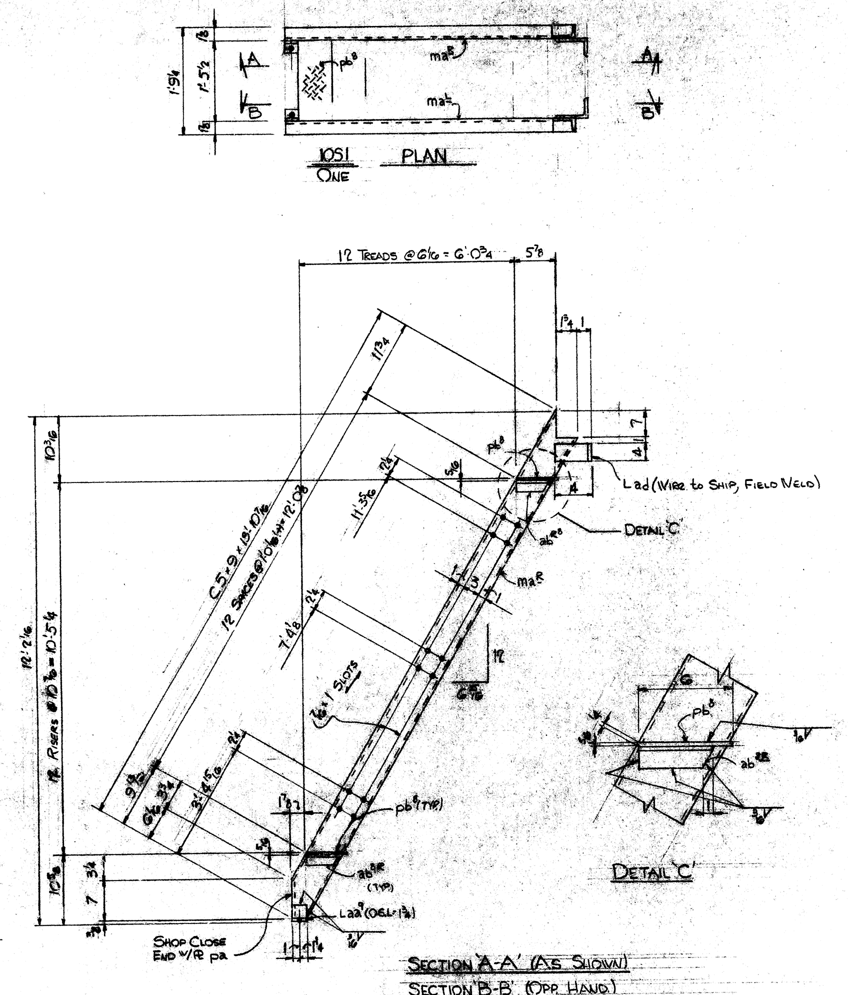
DETAIL: STAIRS and LANDING.

ARCH. OR ENG.: PENSACOLA TESTING LABORATORIES

REVISIONS 1	2	3	4	SHOP ORDER	SHEET No.
				3886-80	9

3 OF 7

635 / 61168



SHOP BILL

No.		Description	Length Ft.	Length In.	Assem. Mark	Shipping Mark	Remarks	Item No.	Weight
ONE		STAIR				1051			
	2	C5×9	13	10 7/16	ma^R/L				
	26	L2×2×¼	0	5	ab^8R/L		(13^R 13^L)		
	2	PL 5/16×1½	0	6⅜	pa				
	2	PL ⅜×6½	0	6½	pd			T	
	13	CHK'D PL 5/16×6	1	5½	pb^8				
	2	L3×3×⅜	0	2¼	aa^9			T	
	2	L4×3×5/16	0	4	ad	(SHIP LOOSE)			
		RAIN MAT'L							
2		BAR 4×¼	1	9¼		10PM1			
2		L3×3×5/16	4	0		10PM2			
		FIELD BOLTS + %							
	5	⅝"φ HS BOLTS	0	2		W/NUTS			
	5	⅝"φ BEVELED WASHERS							
	3	¾"φ WEJ-ITS	0	5					

FOR APPROVAL
SEP 17 1980

DRAWING RECORD			
NO.	TO	FOR	DATE
		APP	7/31/80

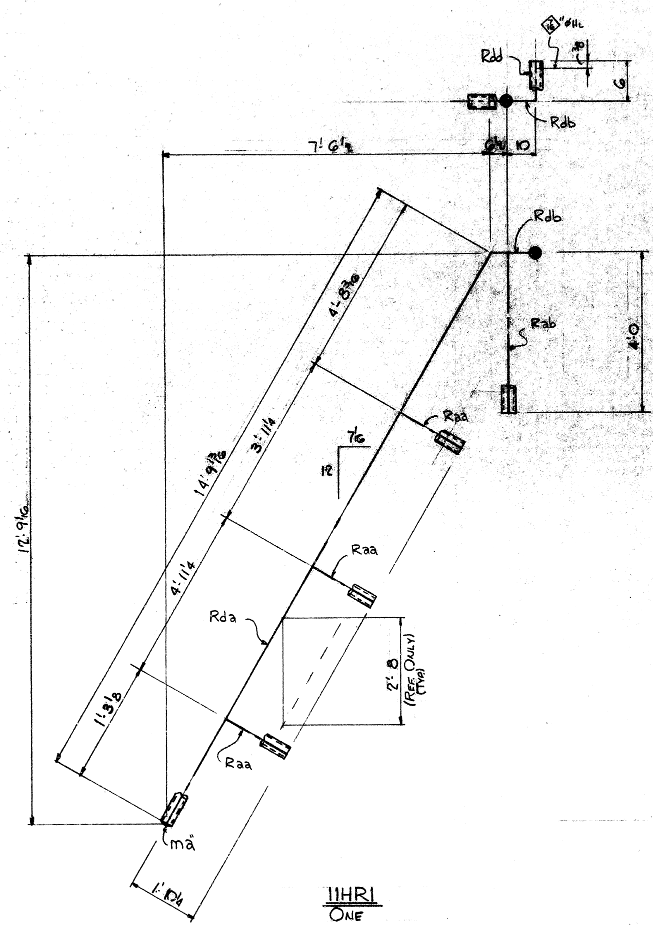
NOTES
MAT'L = A36, PIPE = A53
WELDS = E70XX

Holes 13/16"φ Unless Noted
Paint NONE
Made BOB Date 24 JULY 80 (FIELD MKS. 9-17-80)
Chkd. WS Date 7-30-80

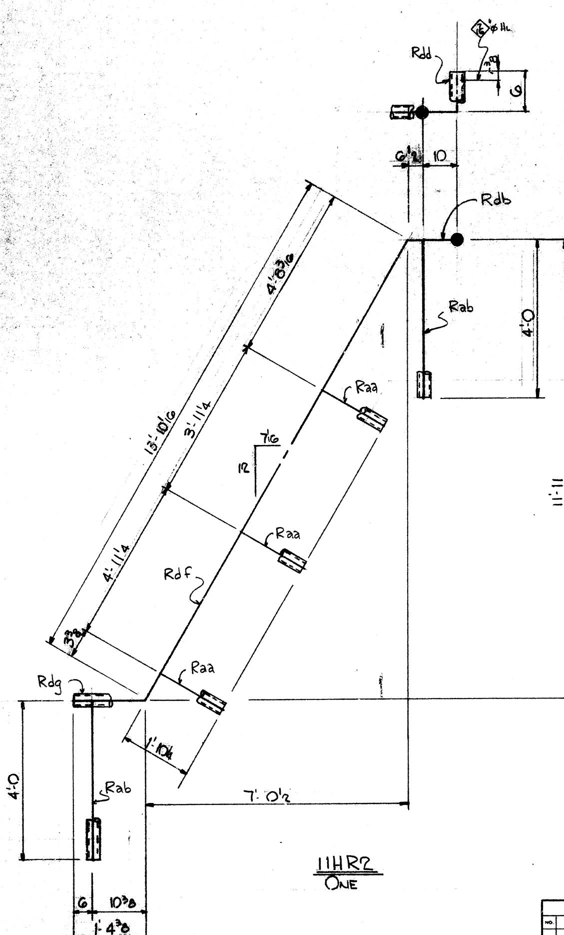
BELL STEEL COMPANY
PENSACOLA, FLORIDA

STRUCTURE	REHABILITATION of BATTERY 234 : OBSERVATION TOWER
LOCATION	FT PICKENS, FLA.
CONT.	FIDELITY CONST. CO.
DETAIL	STAIRS
ARCH. OR ENG.	PENSACOLA TESTING LABORTORIES

REVISIONS 1	2	3	4	SHOP ORDER	SHEET No.
				3886-80	10



11HR1
ONE



11HR2
ONE

SHOP BILL

No.		Description	Length Ft.	Length In.	Assem. Mark	Shipping Mark	Remarks	Item No.	Weight
ONE		HANDRAIL				11HR1			
	3	1 1/2"⌀ STD PIPE	1	9 3/4	Raa				
	1		3	11 1/2	Rab				
	1		14	10 3/8	Rda				
	1		1	0 1/16	Rdb				
	1	d.o.	0	7	Rdd				
	1	END CAP							
		WAGNER #3212			mā				
ONE		HANDRAIL				11H2			
	1	1 1/2"⌀ STD PIPE	13	11 3/16	Rdf				
	1		1	5 1/8	Rdg				
	3				Raa				
	2				Rab				
	1				Rdb				
	1	d.o.			Rdd				

FOR APPROVAL
SEP 17 1980

NOTES
MAT'L: A53
WELDS: E70XX 3/16 FILLET

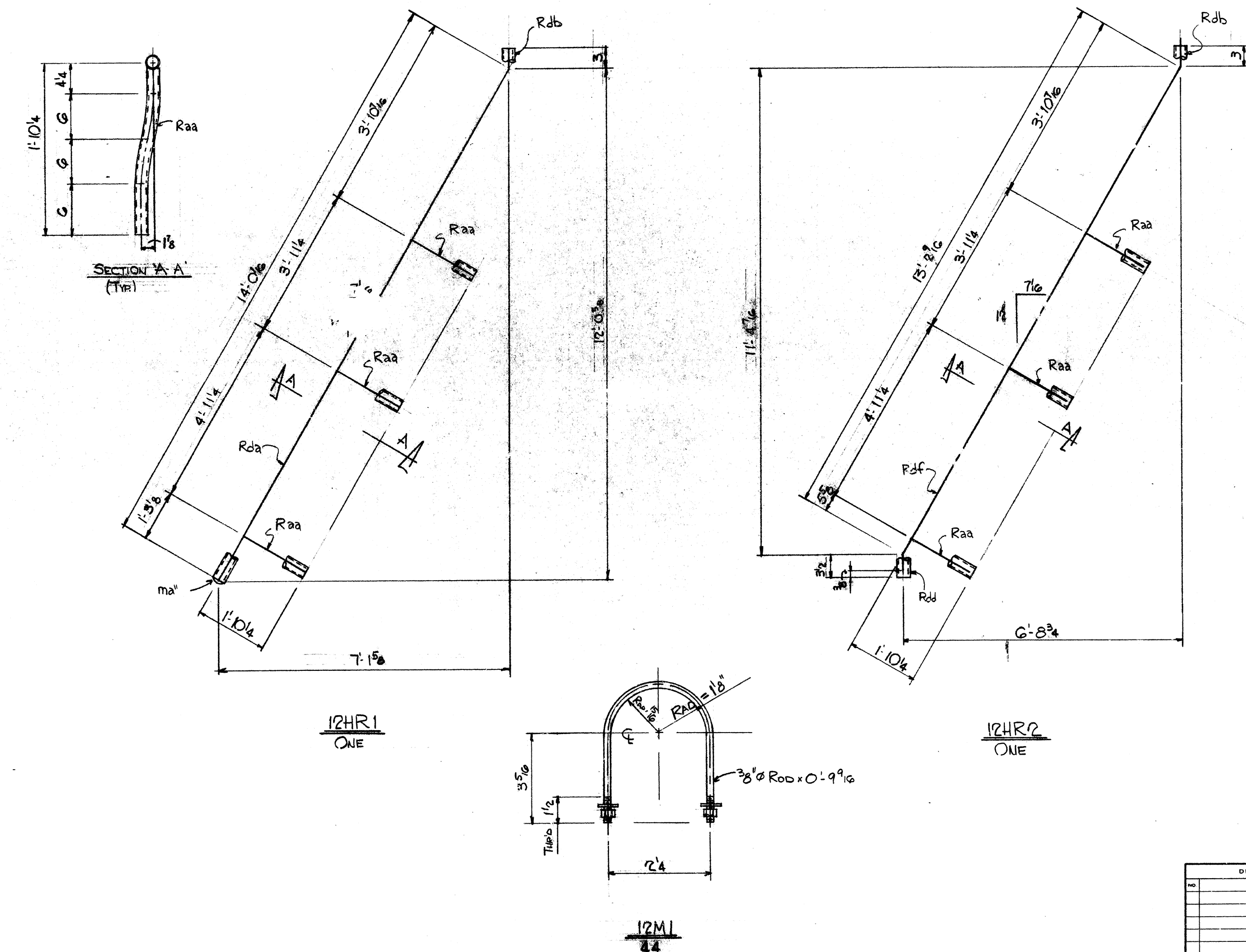
BELL STEEL COMPANY
PENSACOLA, FLORIDA

STRUCTURE: REHABILITATION of BATTERY 234: OBSERVATION TOWER
LOCATION: FT. PICKENS, FLA.
CONT.: FIDELITY CONST.
DETAIL: HANDRAILS
ARCH. OR ENG.: PENSACOLA TESTING LABORATORIES

REVISIONS: 1 2 3 4
SHOP ORDER: 3886-80
SHEET No.: 11

DRAWING RECORD
NO.	TO	FOR	DATE

Holes: NOTED
Paint: NONE
Made: BDB Date: 11SEPT80
Chkd: LECROY Date: 17SEPT80



SHOP BILL

No.	Description	Length Ft.	Length In.	Assem. Mark	Shipping Mark	Remarks	Item No.	Weight
ONE	HANDRAIL				12HR1			
3	1½"ø STD PIPE	2	0	Raa		(2" ADDED FOR BENDING)		
1	do.	14	0⅜	Rda				
1		0	3¼	Rdb				
1	END CAP WAGNER #3212			ma"				
ONE	HANDRAIL				12HR2			
1	1½"ø STD PIPE	13	3⅛	Rdf				
1		0	3¾	Rdd				
1	do.			Rdb				
3				Raa				
44	CLAMPS				12M1			
44	⅜"ø ROD	0	9⁹⁄₁₆			both THR'D		
88	⅜"ø HEX NUTS							
88	⅜" FLAT WASHERS							

FOR APPROVAL
SEP 17 1980

NOTES
MAT'L: A53
WELDS: E70XX; ³⁄₁₆ FILLET

DRAWING RECORD

NO.	TO	FOR	DATE

Holes ⁷⁄₁₆"ø Unless Noted
Paint NONE
Made BOB Date 11 SEPT 80
Chkd LeCROY Date 17 SEPT 80

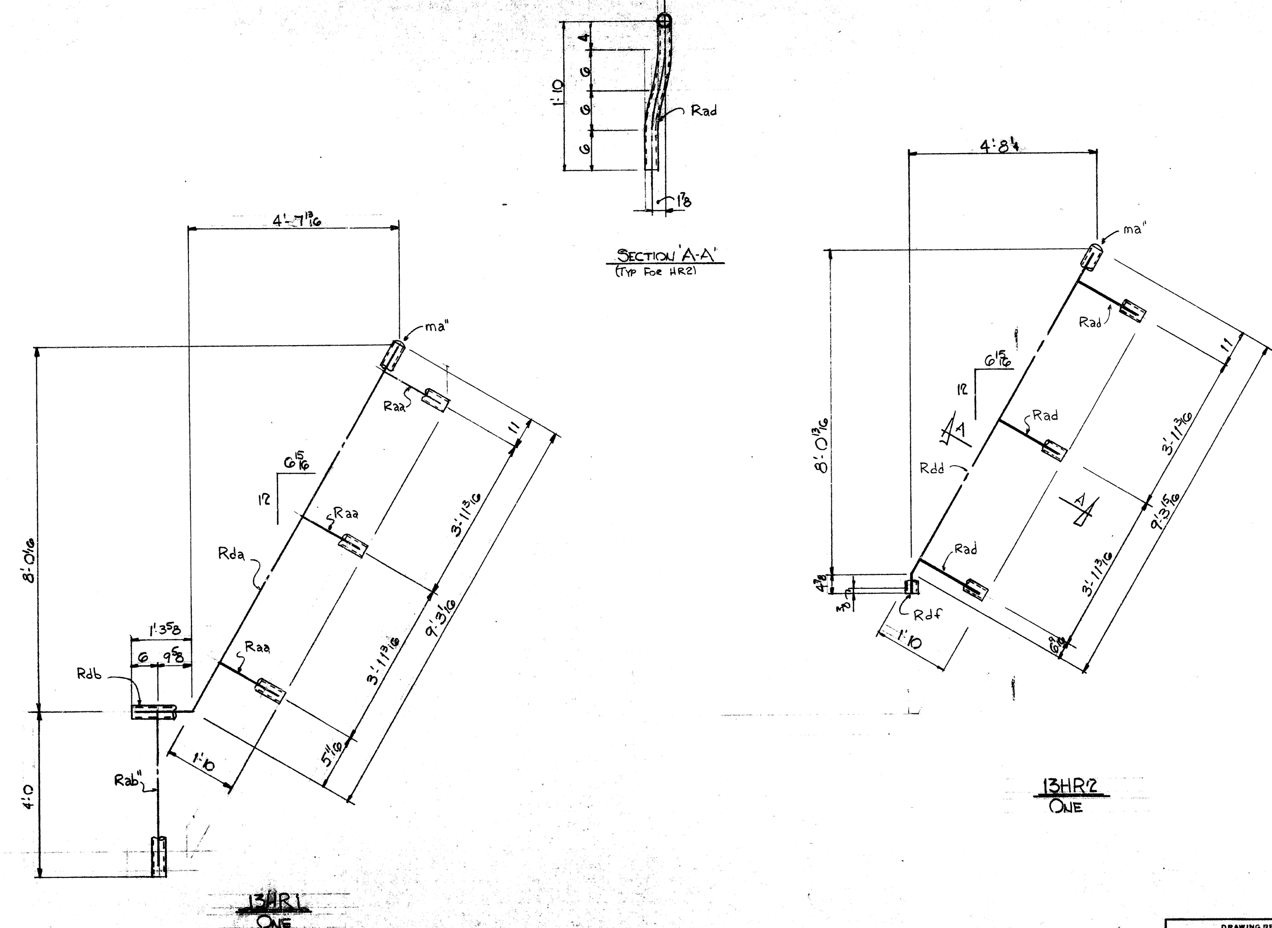
BELL STEEL COMPANY
PENSACOLA, FLORIDA

STRUCTURE: REHABILITATION OF BATTERY 234; OBSERVATION TOWER
LOCATION: FT. PICKENS, FLA.
CONT.: FIDELITY CONST.
DETAIL: HANDRAILS & MISC.
ARCH. OR ENG.: PENSACOLA TESTING LAB

REVISIONS 1	2	3	4	SHOP ORDER	SHEET No.
				3886-80	12

6 OF 7

635/61168



SHOP BILL

No.		Description	Length Ft.	Length In.	Assem. Mark	Shipping Mark	Remarks	Item No.	Weight
One		Handrail				13HR1			
	3	1½"ø Std Pipe	1	9½	Raa				
	1	do.	3	11½	Rab"				
	1	do.	9	3	Rda				
	1	do.	1	4	Rdb				
	1	End Cap							
		Wagner #3212			ma"				
One		Handrail				13HR2			
	3	1½"ø Std Pipe	2	0	Rad		(2" Added For Bending)		
	1	1½ do.	9	4 3/16	Rdd				
	1	1½ do.	0	5 1/8	Rdf				
	1	End Cap			ma"				
4		Field Bolts Splice Locks Wagner #3318							

FOR APPROVAL
SEP 17 1980

NOTES
Mat'l: A53
Welds: E70XX

DRAWING RECORD

No.	To	For	Date

Holes 7/16"ø
Paint None
Made BOB Date 12 Sept. 80
Chkd. LeCroy Date 17 Sept. 80

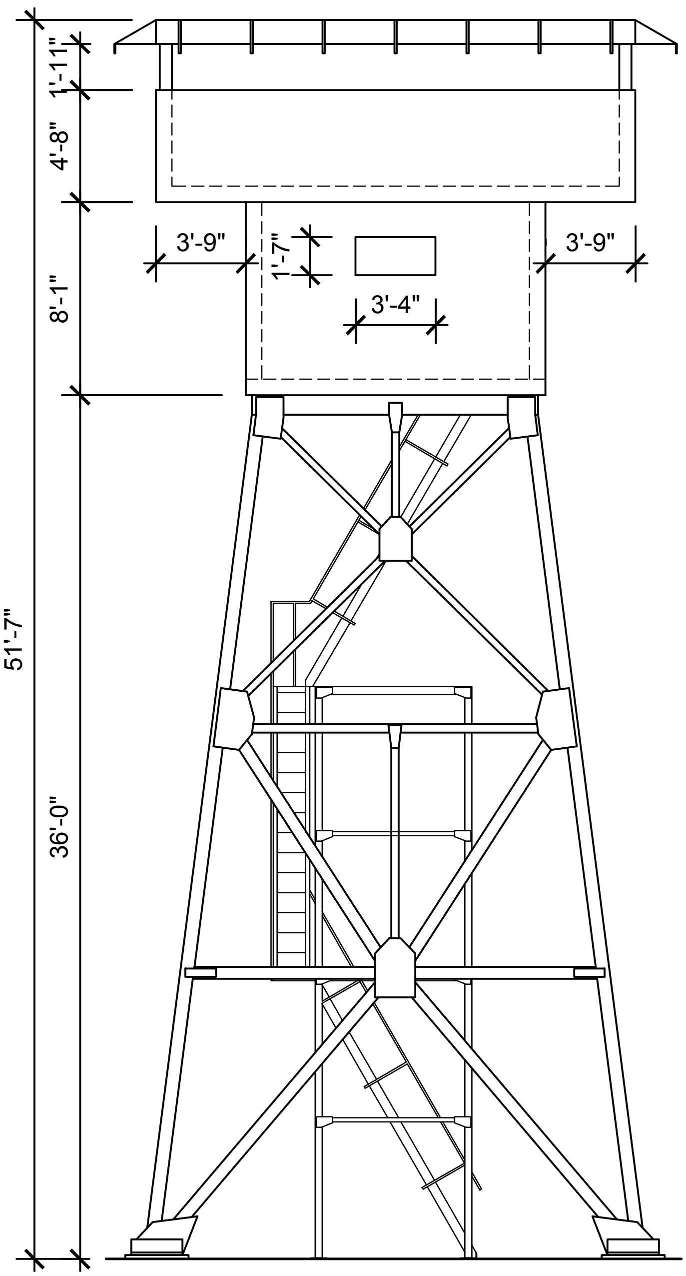
BELL STEEL COMPANY
PENSACOLA, FLORIDA

Structure: Rehabilitation of Battery 234; Observation Tower
Location: Ft. Pickens, Fla.
Cont.: Fidelity Const. Co.
Detail: Handrails
Arch. or Eng.: Pensacola Testing Lab.

Revisions: 1 2 3 4
Shop Order: 3886-80
Sheet No.: 13 of 13

7 of 7 635/61168

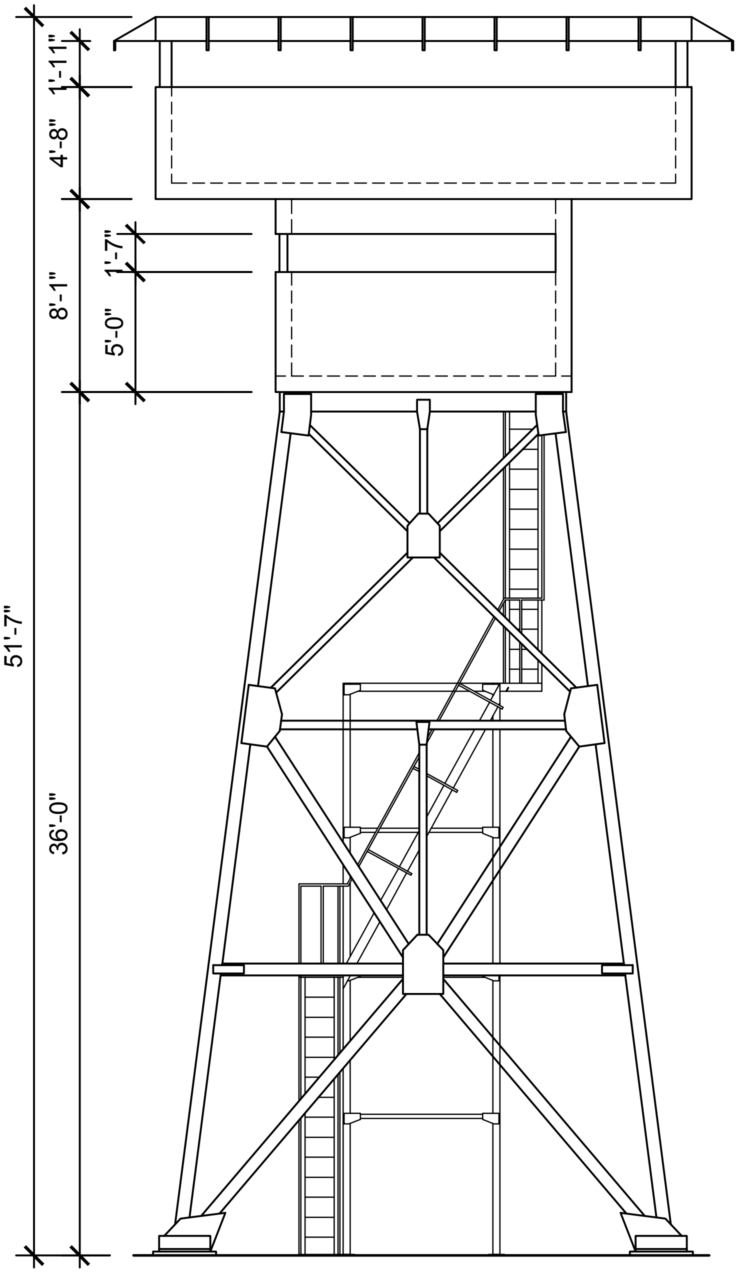
Appendix D: Measured Drawings



North Elevation

Scale: 1/8" = 1'-0"

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS	**Battery 234 CRF/BCS Tower** HISTORIC STRUCTURE REPORT	Date April 3, 2015 Proj. No. 2014.3591 Scale As Shown	A-1



East Elevation

Scale: ⅛" = 1'-0"

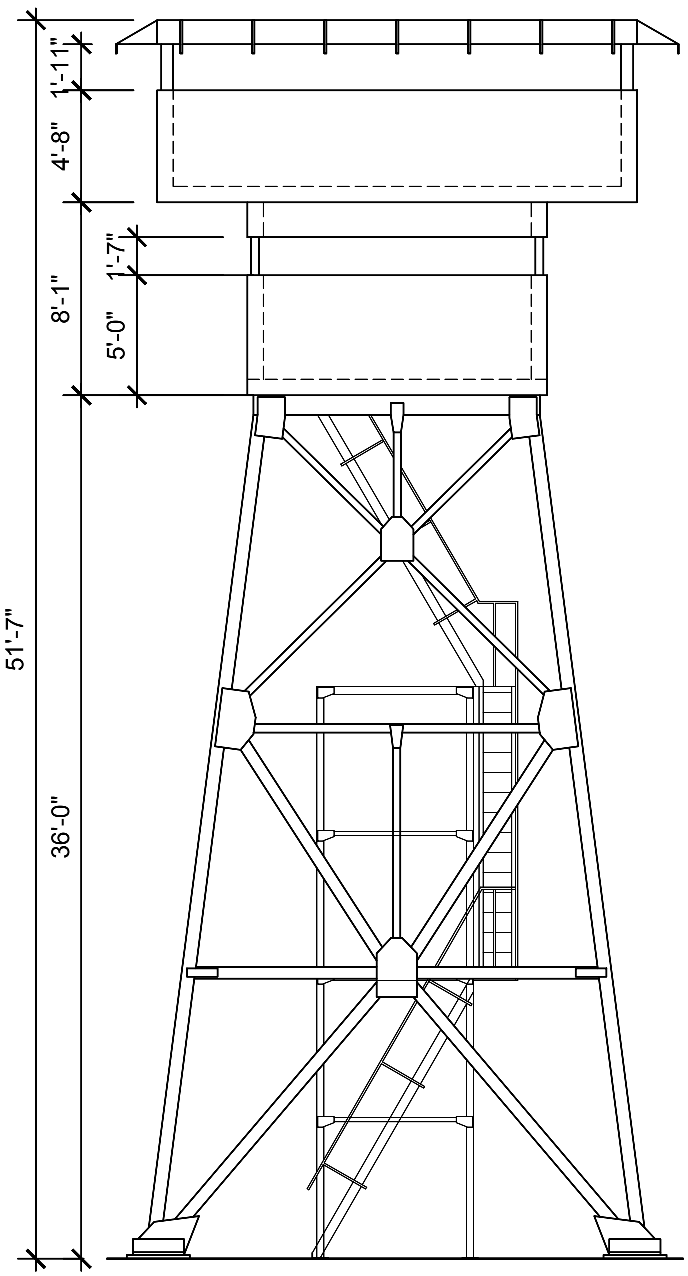
WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Battery 234 CRF/BCS Tower

HISTORIC STRUCTURE REPORT

Date	April 3, 2015
Proj. No.	2014.3591
Scale	As Shown

A-2



South Elevation

Scale: 1/8" = 1'-0"

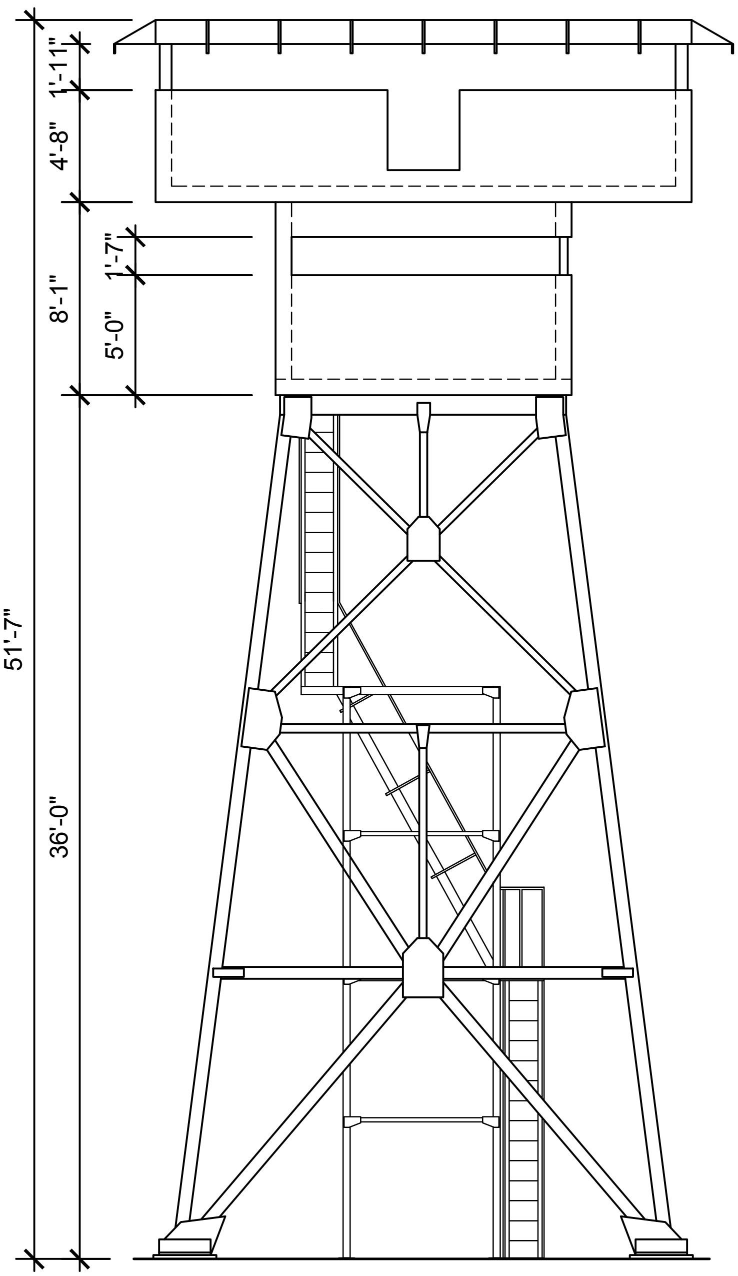
WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Battery 234 CRF/BCS Tower

HISTORIC STRUCTURE REPORT

Date	April 3, 2015
Proj. No.	2014.3591
Scale	As Shown

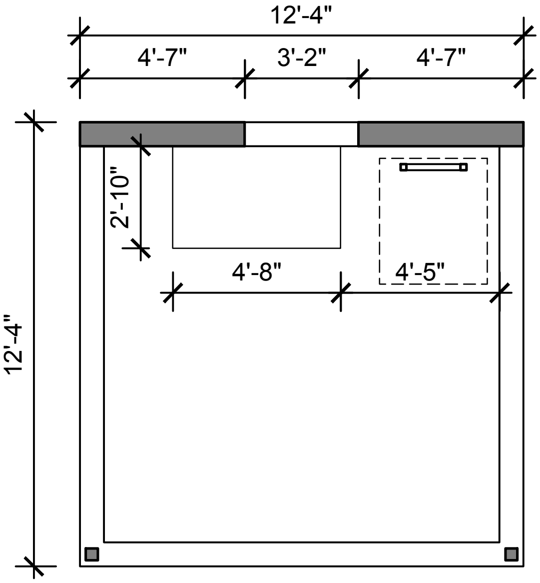
A-3



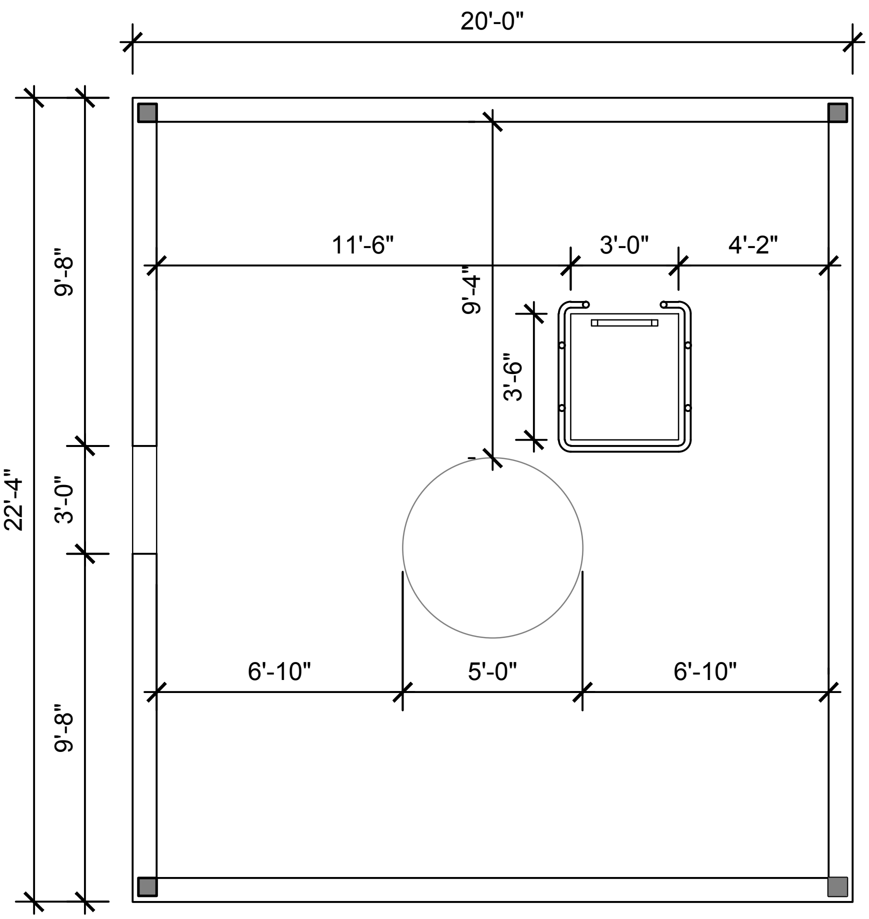
West Elevation

Scale: 1/8" = 1'-0"

WJE — ENGINEERS ARCHITECTS MATERIALS SCIENTISTS	**Battery 234 CRF/BCS Tower** HISTORIC STRUCTURE REPORT	Date: April 3, 2015 Proj. No.: 2014.3591 Scale: As Shown	A-4



Lower Level Plan
Scale: 3⁄16" = 1'-0"



Upper Level Plan
Scale: 3⁄16" = 1'-0"

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS	**Battery 234 CRF/BCS Tower** HISTORIC STRUCTURE REPORT	Date April 3, 2015 Proj. No. 2014.3591 Scale As Shown	A-5

Appendix E: Limited Structural Analysis

Appendix E: Limited Structural Analysis

Calculation Package

March 12, 2015 WJE No. 2014.3591

Analysis Assumptions

1. As-built tower conforms to 1979 tower rehabilitation drawings.

2. No deterioration is present in framing members and connections.

3. Wind loads in one direction (from the east) are considered. Response would be symmetric for other directions. Effect of quartering winds (applying loads to more than one face) may increase total load effects somewhat, but tower should have adequate capacity based on reported demand-to-capacity ratios for winds from east.

Contents

1. **Tower Loads.** Calculates gravity and wind loads applied to tower and specifies load combinations used to evaluate framing elements and connections.

2. **Finite Element Model.** Screen shots and data from SAP finite element model.

    a. Meshing

    b. Internal forces in frame members from design load cases

    c. Table of base reactions

3. **Structure Load Path Evaluation.** Spreadsheet that checks demands versus capacity of key elements of tower load path

4. **Element Capacities.** Calculations that determine capacities of framing members and connections.

    a. *CIS Column - Concrete Walls*: Sectional capacity of concrete wall segments on north elevation.

    b. *MathCAD - Concrete Walls*: Sectional capacity of concrete wall segments on north elevation.

    c. *MathCAD - L6x6x58*: Compression capacity of L6x6x5/8 column members.

    d. *MathCAD - L6x6x38*: Compression capacity of L6x6x3/8 diagonal brace members.

    e. *MathCAD - Connection Capacities:* Capacity of member-to-member and foundation connections.

Purpose

To calculate the gravity and wind loads to apply to the tower.
To check base reactions from the finite element analysis.
To define load combinations considered in evaluation.

References

ASCE 7-10

Legend

Required User Input

Important Information

Assumption or Key Statement

Required User Check

Final Results/Conclusions

Dead Loads

SW = structure element self weight calculated in the finite element program

SDL = superimposed dead loads - add 1000 lbf for stair.

Wind Loads

Based on ASCE 7-10.

Occupancy Category = 2

Exposure = D — open water near tower

$V := 150\text{mph}$ — from Figure 26.5-1A

$K_d := 0.9$ — from Table 26.6-1, approximating as square tank structure

$K_{zt} := 1.0$ — no terrain speed up

$G := 0.85$ — gust effect factor per 26.9.1; structure's natural frequencies are above 1Hz

$z_g := 700\text{ft}$

$\alpha := 11.5$

terrain exposure coefficients from Table 26.9-1

$$K_z(z) := 2.01 \cdot \left(\frac{z}{z_g}\right)^{\frac{2}{\alpha}}$$

Kz term from Table 27.3-1

$$q_z(z) := 0.00256 \cdot K_d \cdot K_{zt} \cdot K_z(z) \cdot \left(\frac{V}{\text{mph}}\right)^2 \cdot \text{psf}$$

stagnation pressure function

$z_{btm} := 38\text{ft}$ — elevation of bottom of concrete structure

$b_{btm} := 12\text{ft}$ — width of bottom portion of concrete structure

$z_{cant} := 46\text{ft}$ — elevation of change in structure width at cantilever slab

$z_{top} := 51\text{ft}$ — elevation of top of concrete structure

$b_{top} := 22\text{ft}$ — width of top portion of concrete structure

$b_{base} := 21\text{ft}$ — width of tower at base

$\boxed{q_z(z_{top}) = 66.07 \cdot \text{psf}}$

Projecting Walls

Model as parapets using Section 27.4.5

$GC_{pn.windward} := 1.5$

$GC_{pn.leeward} := 1.0$

net gust and pressure coefficients for windward and leeward projecting walls

$\boxed{p_{pw} := q_z(z_{top}) \cdot GC_{pn.windward} = 99.11 \cdot psf}$

$\boxed{p_{pl} := q_z(z_{top}) \cdot GC_{pn.leeward} = 66.07 \cdot psf}$

net pressures applied to projecting walls (applied in same direction as wind)

Enclosed Walls

Model as partially enclosed building using Section 27.4.1

$C_{p.ww} := 0.8$

$\boxed{p_{ew} := q_z(\text{mean}(z_{btm}, z_{cant})) \cdot G \cdot C_{p.ww} = 43.44 \cdot psf}$

pressure coefficient and pressure to be applied to windward enclosed walls in same direction as wind

$C_{p.lw} := 0.5$

$\boxed{p_{el} := q_z(z_{cant}) \cdot G \cdot C_{p.lw} = 27.58 \cdot psf}$

pressure coefficient and pressure to be applied to leeward enclosed walls ir same direction as wind

Floor Slab Overhangs

Model as roof overhang using Section 27.4.4

$C_{p.oh} := 0.8$

$\boxed{p_{oh} := q_z(z_{cant}) \cdot G \cdot C_{p.oh} = 44.13 \cdot psf}$

pressure coefficient and pressure for overhanging portion of upper floor slab, applied upward

Ignore effects on bottom floor slab and non-overhaning portion of upper floor slab; assume they cancel roughly cancel out

Wind Loads on Truss Members

Section 29.5 and Table 29.5-3

$A_{trussface.gross} := \text{mean}(b_{base}, b_{btm}) \cdot z_{btm} = 627\,ft^2$ gross area of one face of the truss tower

$A_{trussface.solid} := 2 \cdot 35ft \cdot 6in + 2 \cdot 15ft \cdot 6in + 18ft \cdot 5in + 3 \cdot 13ft \cdot 6in + 15ft \cdot 5in + 2 \cdot 20ft \cdot 3.5in + 6ft \cdot 3.5in + 12ft \cdot 10in = 106.67\,ft^2$

$\varepsilon := \frac{A_{trussface.solid}}{A_{trussface.gross}} = 0.17$ ratio of trussed tower solid are to total projected area

$C_f := 4 \cdot \varepsilon^2 - 5.9 \cdot \varepsilon + 4 = 3.11$ pressure coefficient

$\boxed{p_{truss} := q_z(\text{mean}(0, z_{btm})) \cdot G \cdot C_f = 147.2 \cdot psf}$ average pressure applied to solid area of tower face

Verify SAP Output

Dead Loads

$A_{conc} := 4\cdot(z_{top} - z_{cant})\cdot b_{top} + b_{top}\cdot b_{top} + 4\cdot(z_{cant} - z_{btm})\cdot b_{btm} + b_{btm}\cdot b_{btm} = 1452\,ft^2$

area and weight of concrete framing

$W_{conc} := A_{conc}\cdot 8in\cdot 150pcf = 145.2\cdot kip$

$W_{steel} := 4\cdot 15plf\cdot 120ft = 7200\cdot lbf$ weight of steel elements

$W_{sdl} := 20\frac{lbf}{ft}\cdot 48ft = 0.96\cdot kip$ weight of superimposed dead loads from stair

$\boxed{W_{dl} := W_{conc} + W_{steel} + W_{sdl} = 153.36\cdot kip}$ total dead loads

$\boxed{W_{ll} := 100psf\cdot\left(b_{top}^{\ 2} + b_{btm}^{\ 2}\right) = 62.8\cdot kip}$ total live loads

Wind Loads

$\boxed{W_{lateral.area} := (p_{pw} + p_{pl})\cdot(z_{top} - z_{cant})\cdot b_{top} + (p_{ew} + p_{el})\cdot(z_{cant} - z_{btm})\cdot b_{btm} = 24.99\cdot kip}$

lateral wind load on area elements

$\boxed{W_{vertical.area} := p_{oh}\cdot\left(b_{top}^{\ 2} - b_{btm}^{\ 2}\right) = 15\cdot kip}$

vertical wind loads on area elements

$\boxed{M_{tot.lateral} := (p_{pw} + p_{pl})\cdot(z_{top} - z_{cant})\cdot b_{top}\cdot \text{mean}(z_{top}, z_{cant}) + (p_{ew} + p_{el})\cdot(z_{cant} - z_{btm})\cdot b_{btm}\cdot \text{mean}(z_{cant}, z_{btm}) = 1167.62\cdot kip\cdot ft}$

total moment from wind loads on area elements

$\boxed{W_{lateral.frames} := p_{truss}\cdot A_{trussface.solid} = 15.7\cdot kip}$

total wind load applied to frame members

$\boxed{W_{tot.lateral} := W_{lateral.area} + W_{lateral.frames} = 40.69\,kip}$

total wind loads area plus frames

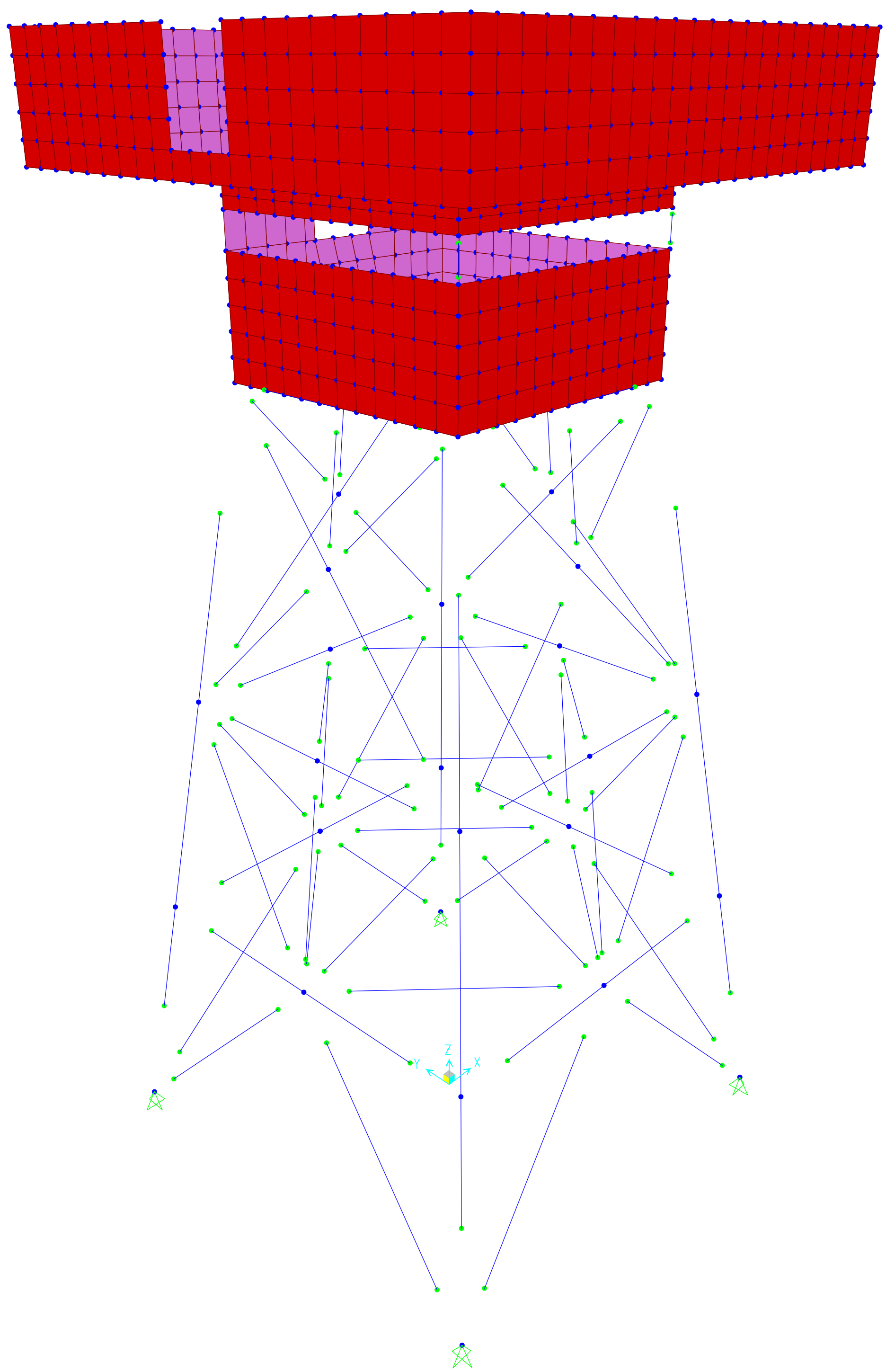
Load Combinations

The following load combinations were used to evaluate the structural framing of the tower.

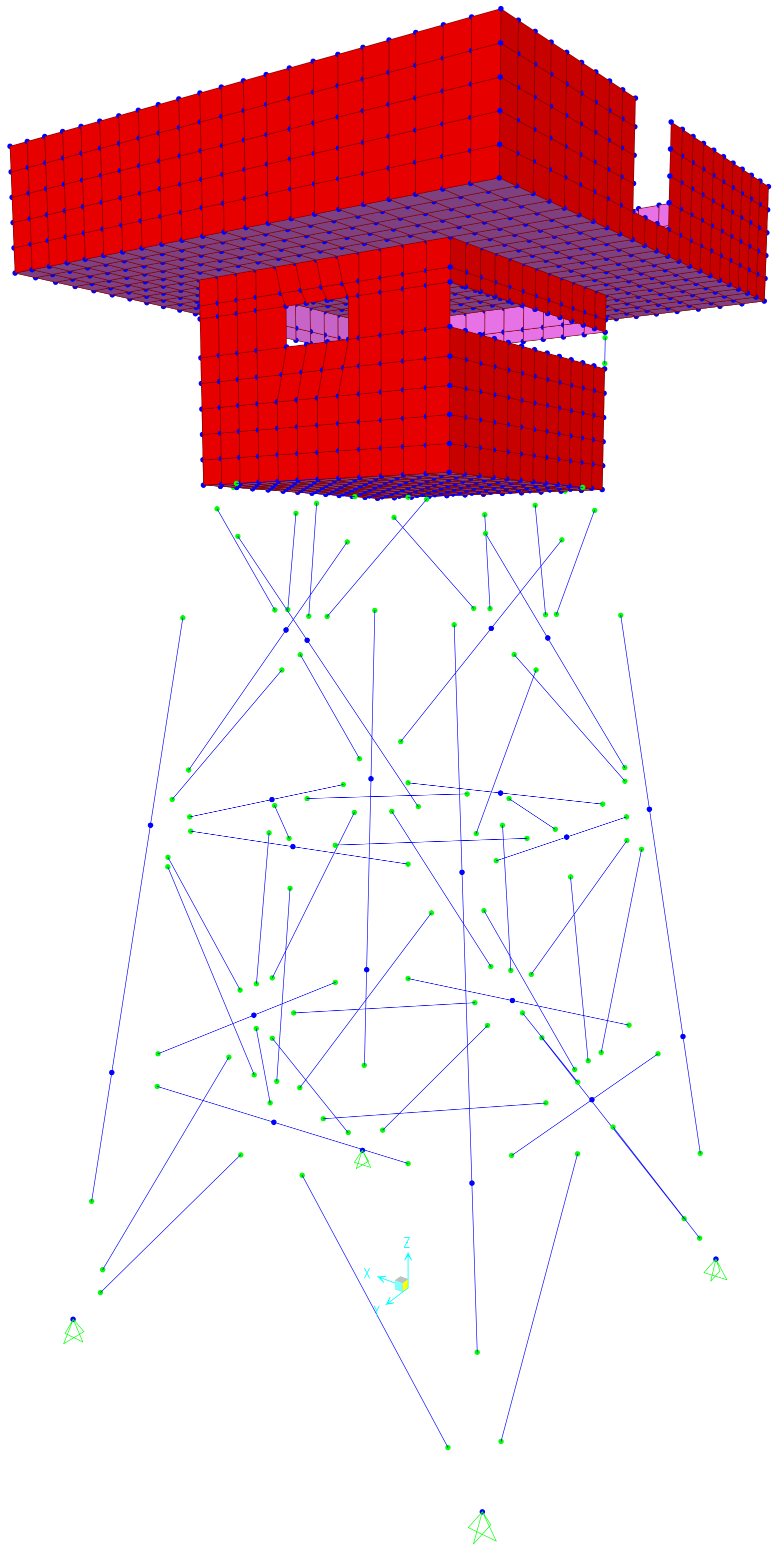
1.4D
1.2D+1.6L
1.2D+1.0W+1.0L
0.9D+1.0W

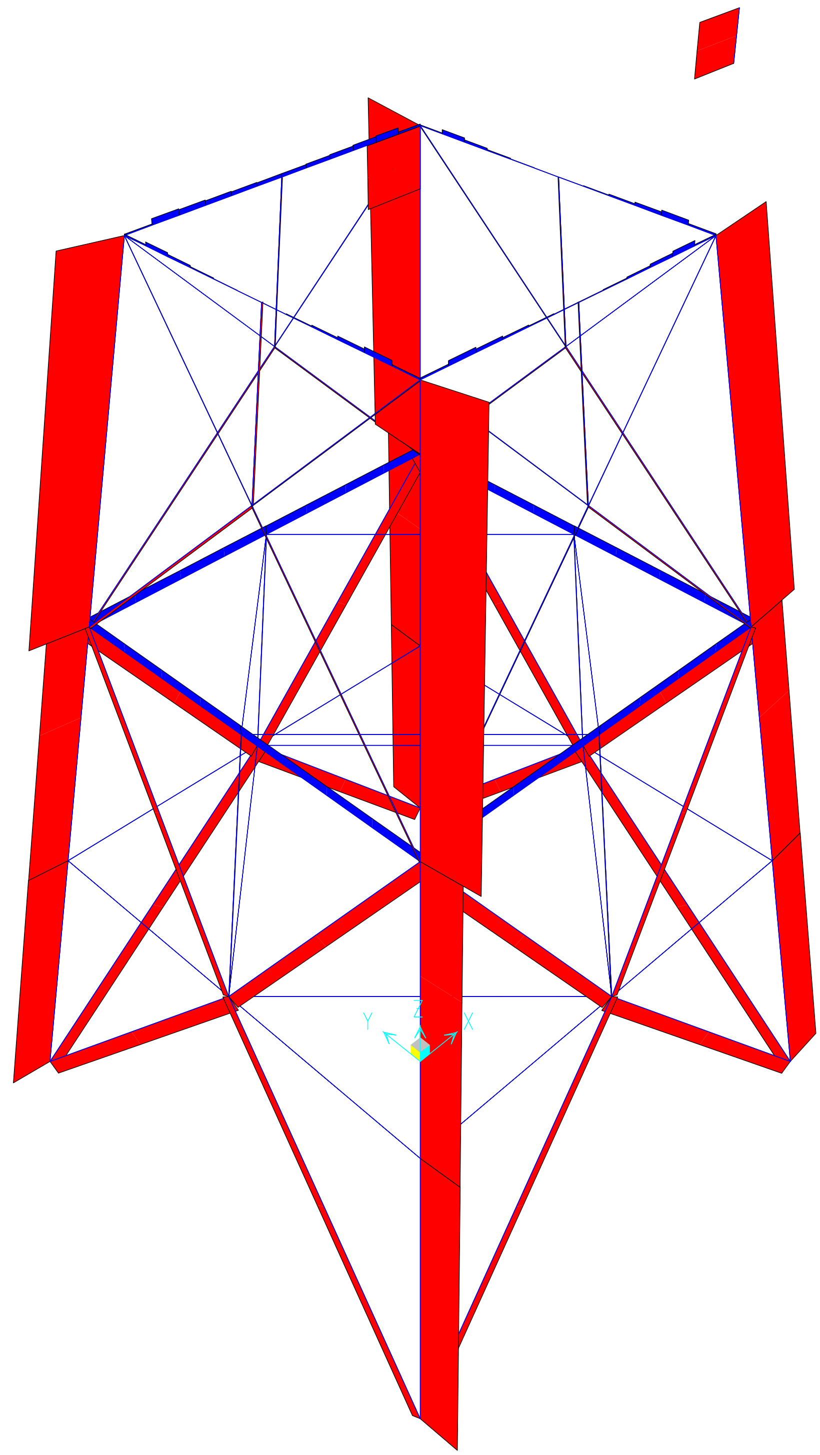
SAP2000

3/13/15 10:13:03

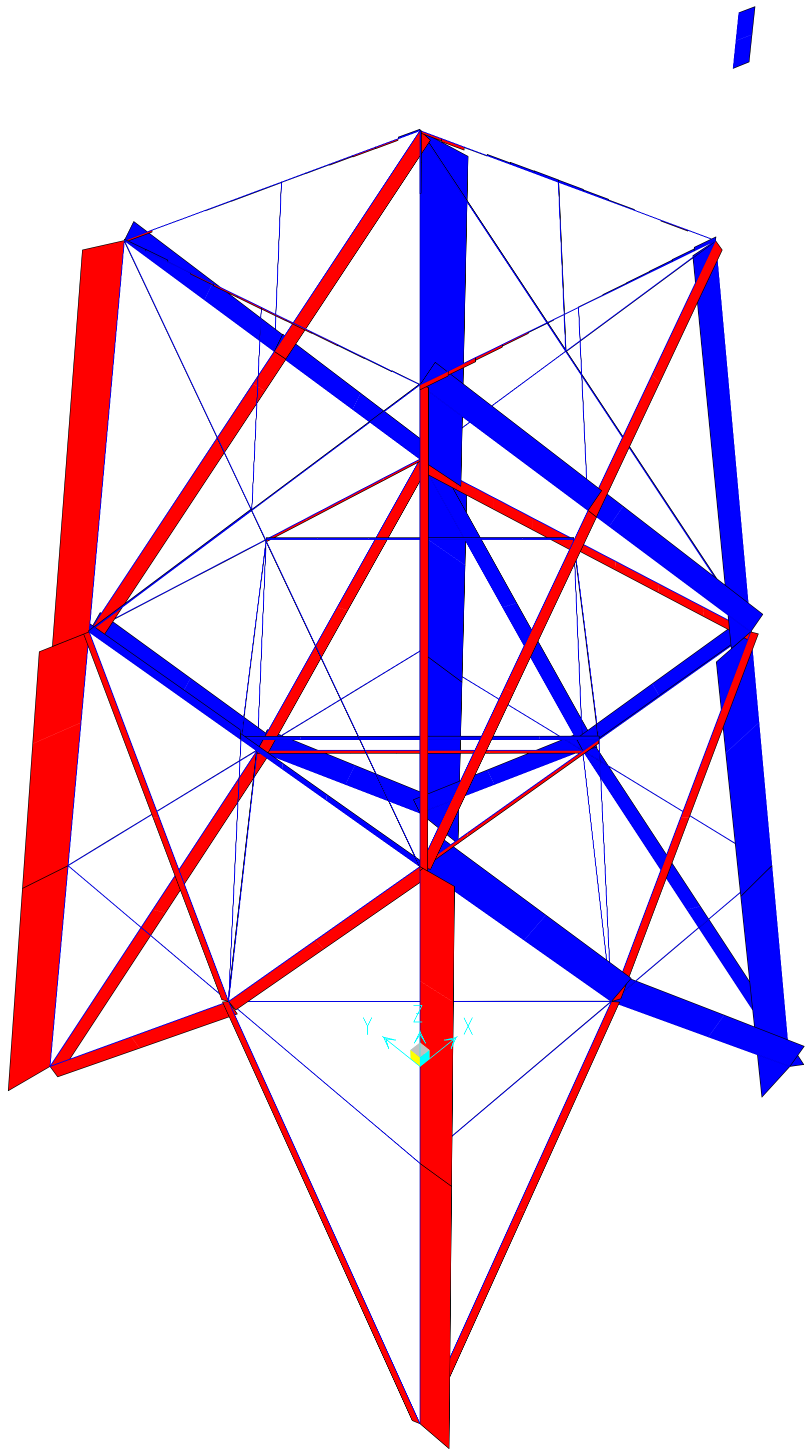


SAP2000 v15.2.1 - File:tower_v1 - 3-D View - Kip, ft, F Units

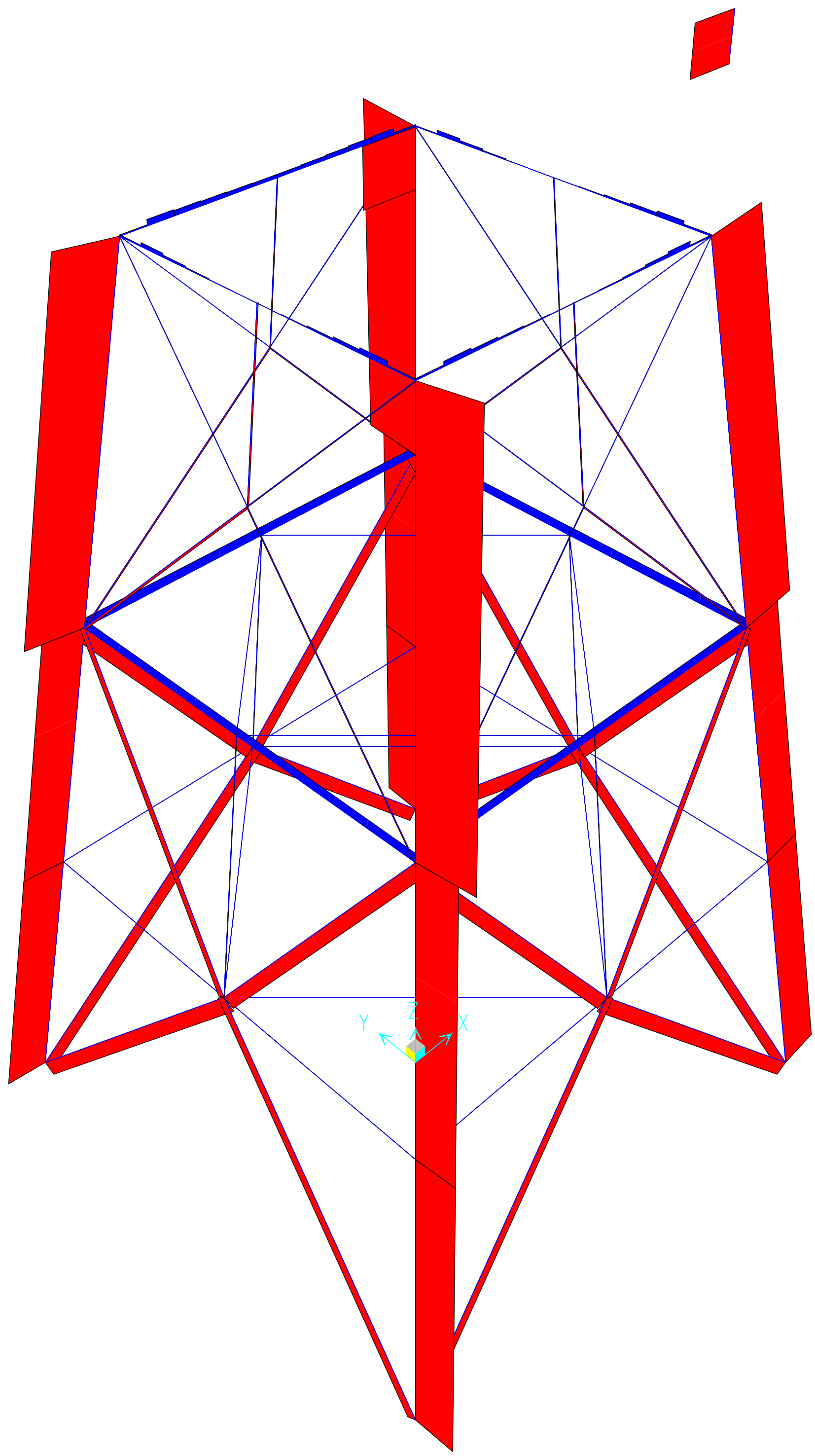

Z
X
Y



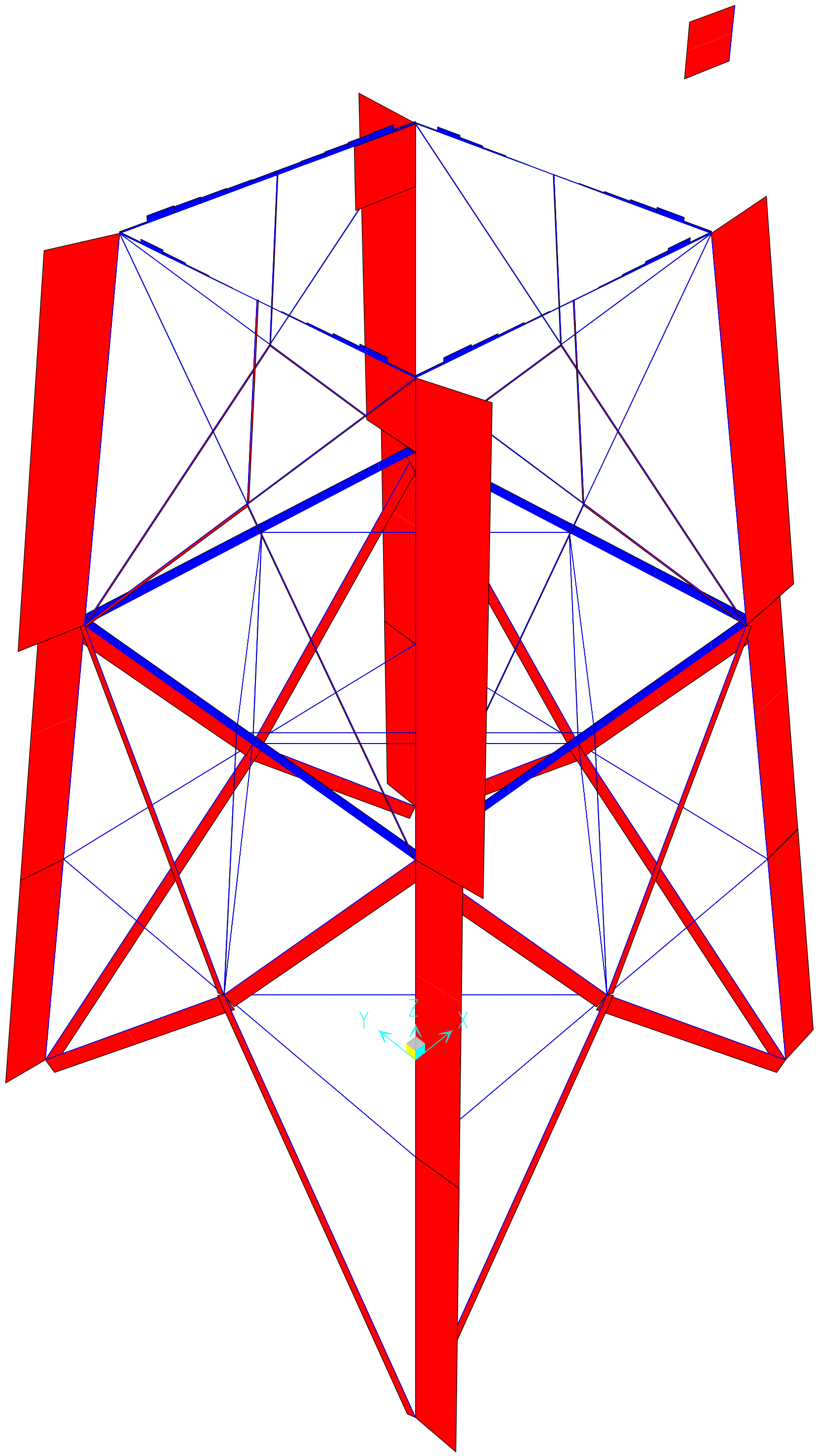
SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (DL) - Kip, ft, F Units



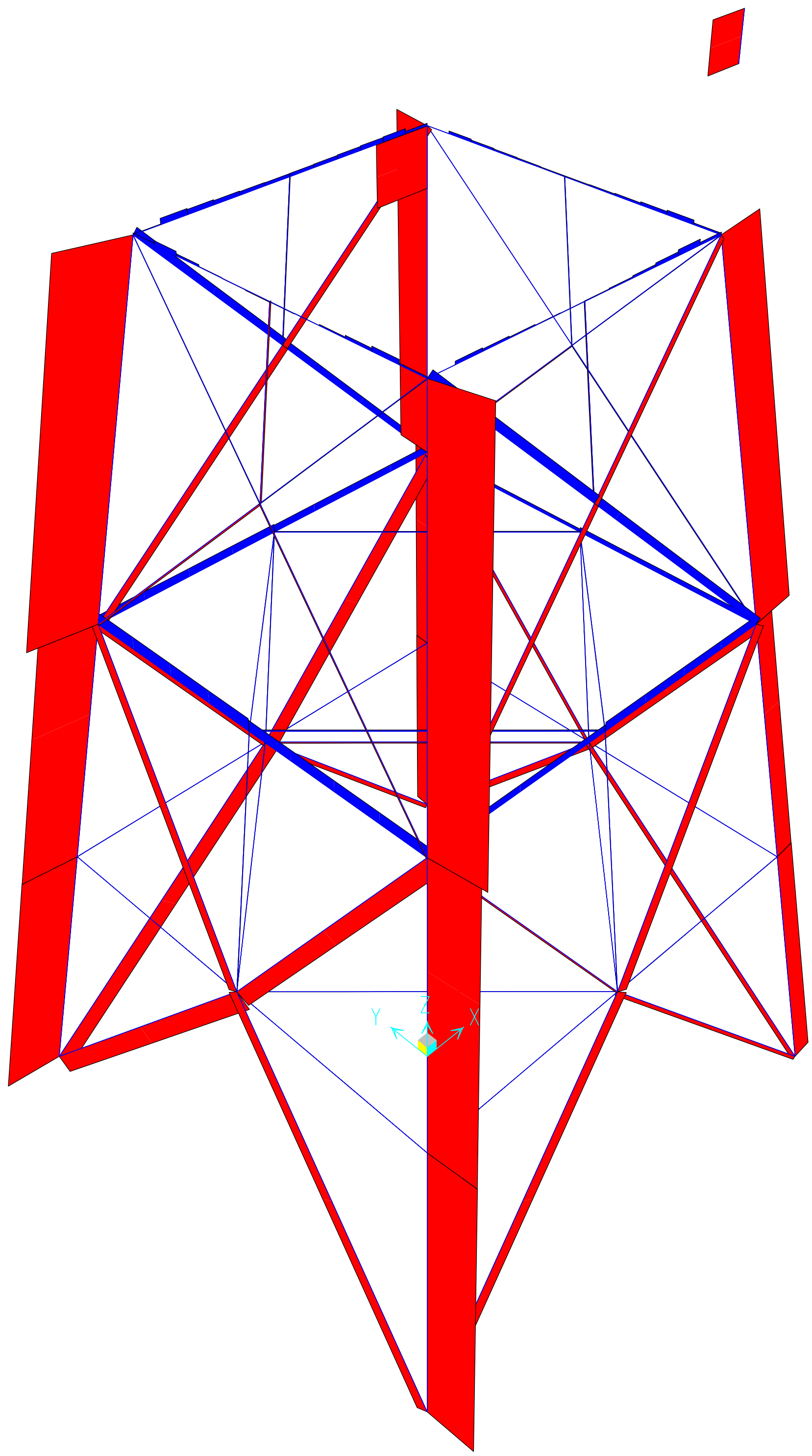
Y
Z
X



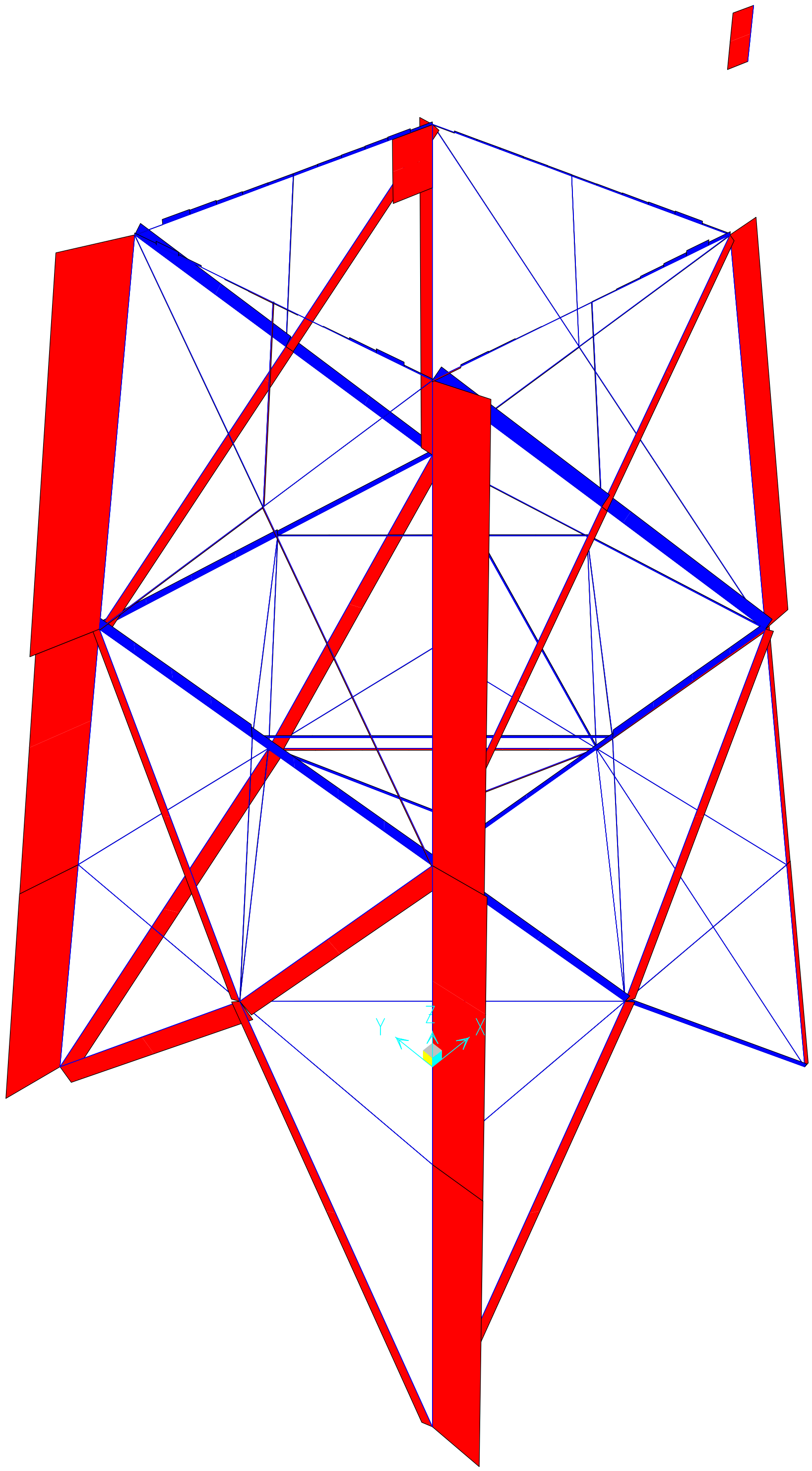
SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (1.4D) - Kip, ft, F Units



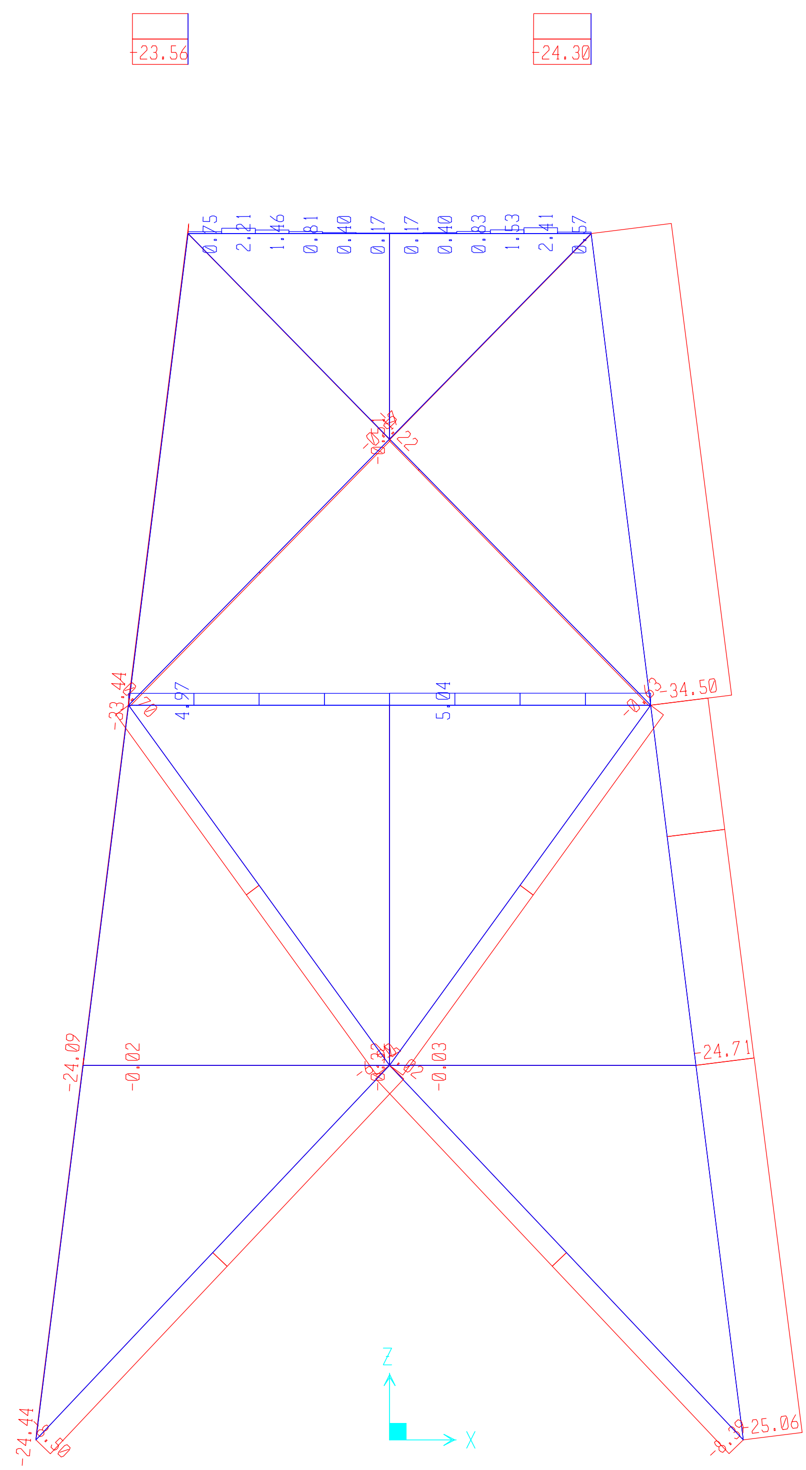
Z
Y
X



SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (1.2D+1.0W+1.0L) - Kip, ft, F Units

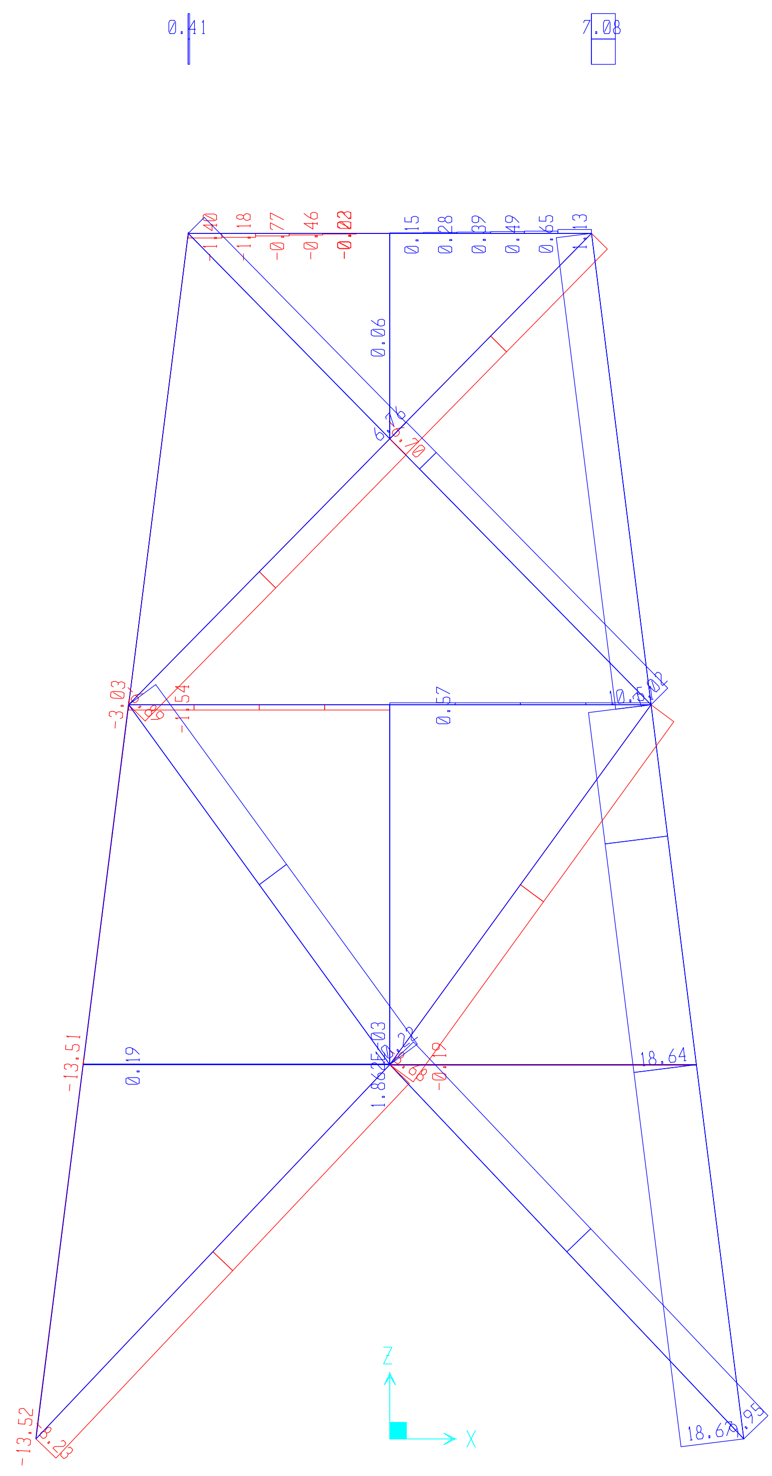


SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (0.9D+1.0W) - Kip, ft, F Units

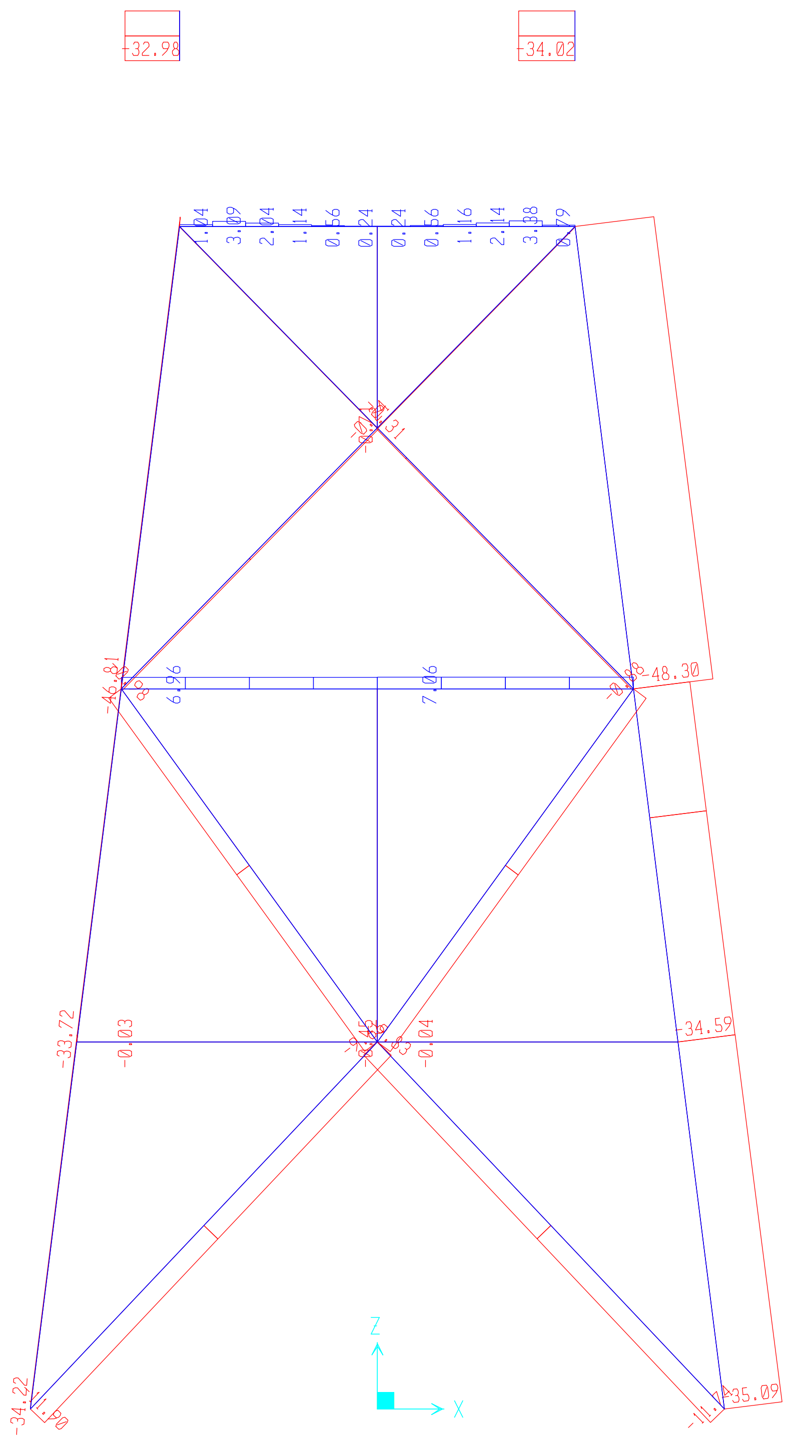


SAP2000

3/13/15 10:24:18

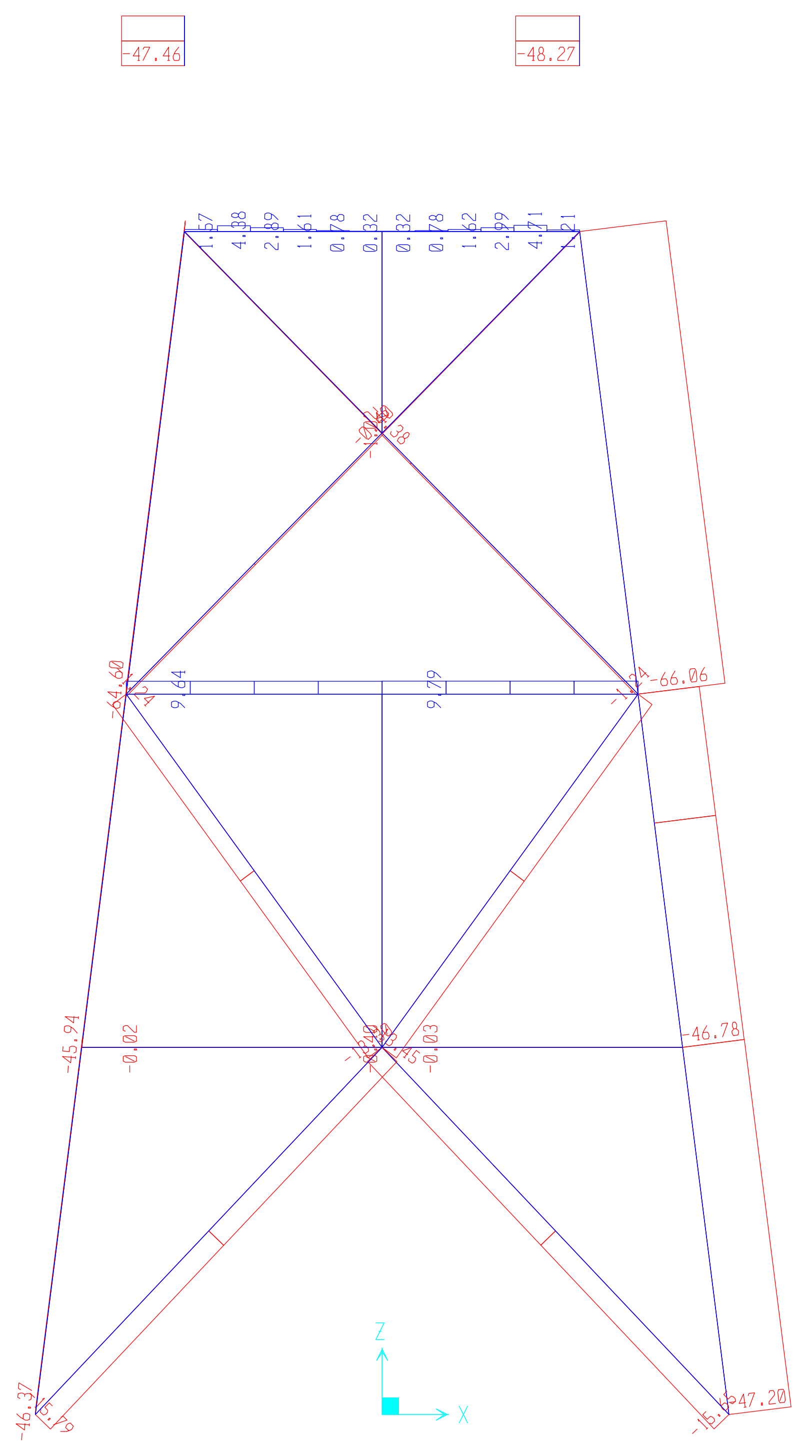


SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (W-East) - Kip, ft, F Units


-32.98
-34.02
1.04
3.09
2.04
1.14
0.56
0.24
0.24
0.56
1.16
2.14
3.38
-48.30
6.96
7.06
-33.72
-0.03
-0.04
-34.59
-34.22
-35.09
Z
X

SAP2000

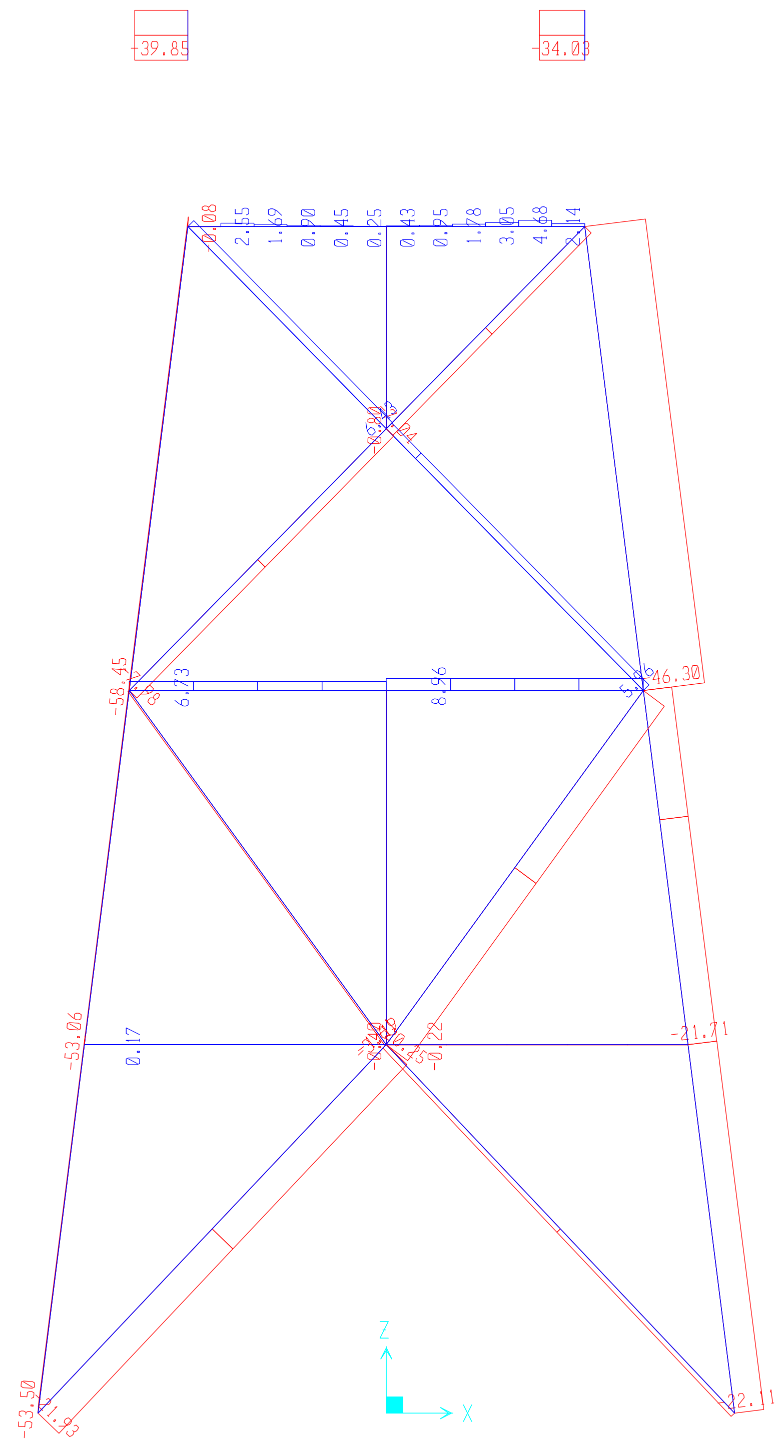
3/13/15 10:19:59



SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (1.2D+1.6L) - Kip, ft, F Units

SAP2000

3/13/15 10:42:07



SAP2000 v15.2.1 - File:tower_v1 - Axial Force Diagram (1.2D+1.0W+1.0L) - Kip, ft, F Units

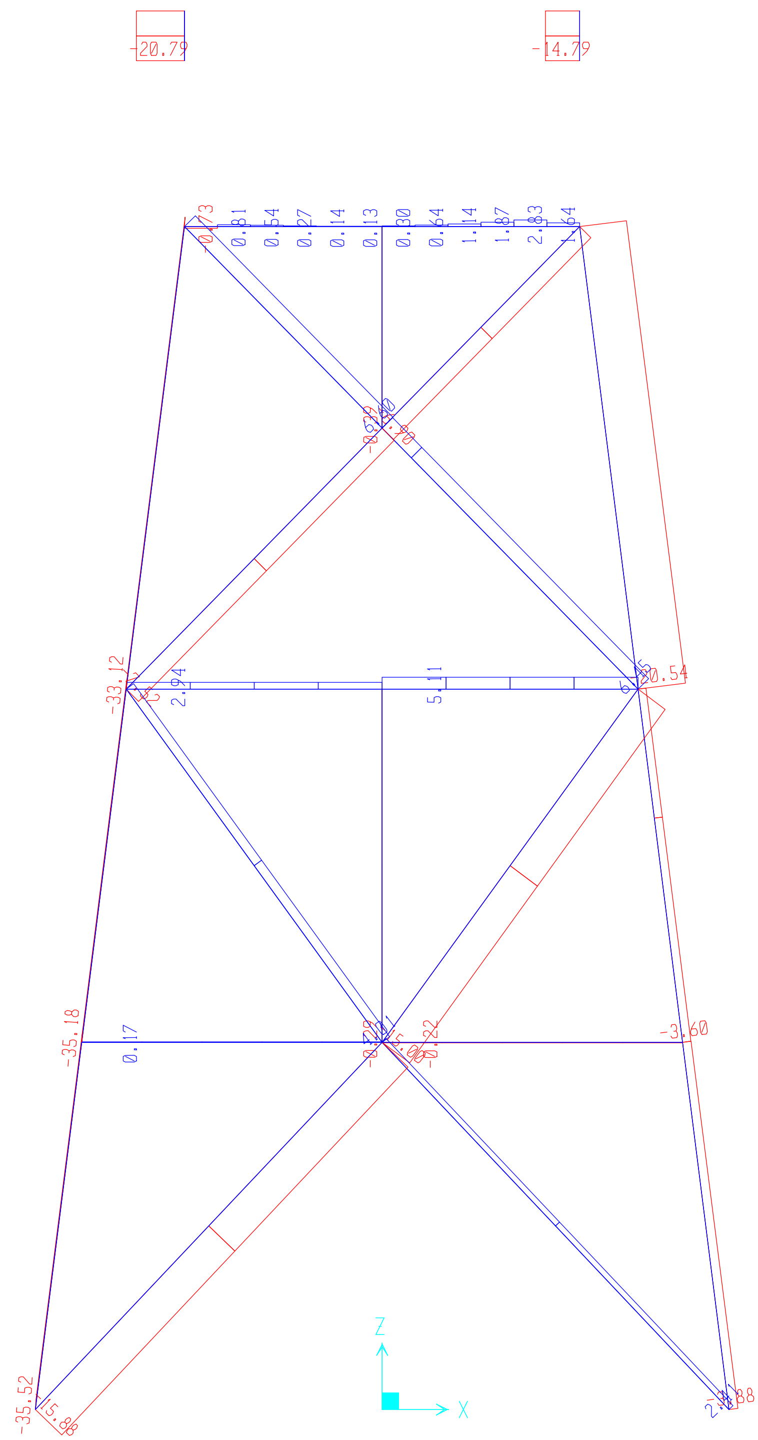

-20.79
-14.79
0.73
0.81
0.54
0.27
0.14
0.13
0.30
0.64
1.14
1.87
2.83
1.64
-33.12
2.94
5.11
0.54
-35.18
0.17
-3.60
-35.52
15.88
Z
X

TABLE: Base Reactions						
OutputCase	**GlobalFX**	**GlobalFY**	**GlobalFZ**	**GlobalMX**	**GlobalMY**	**GlobalMZ**
Text	Kip	Kip	Kip	Kip-ft	Kip-ft	Kip-ft
DL	0	0	148	7	-12	0
W-East	37	0	-15	1	1244	1
1.4D	0	0	207	10	-17	0
1.2D+1.6L	0	0	277	9	-15	0
1.2D+1.0W+1.0L	37	0	225	10	1229	1
0.9D+1.0W	37	0	118	8	1233	1

Structure Load Path Evaluation

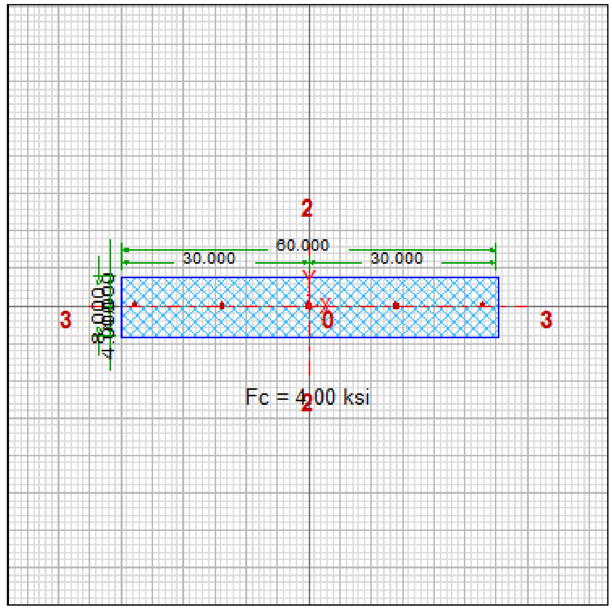
Element	Limit State	Applied Force	Units	Controlling Effect	Capacity	Units	Demand/ Capacity	Calculation Reference (attached)	Notes
Typical concrete framing walls	Flexure and shear			Gravity loads	9999		0.00		Okay by inspection; applied forces are low
Wall segment surrounding window on north elevation	Strong-axis flexure	60	kip-ft	Winds from EW	120	kip-ft	0.50	CSI Column - Concrete Walls	Reinforcing in wall is unknown; conservative amount assumed
	Weak-axis flexure	8	kip-ft	Winds from NS	17	kip-ft	0.47	CSI Column - Concrete Walls	Reinforcing in wall is unknown; conservative amount assumed
	Shear	8	kip	Winds EW	20	kip	0.40	MathCAD - Concrete Walls	
C10 Channel	Flexure				9999		0.00	Flexure is neglibile; cocnrete framing delivers load to columns directly	
	Connection to Columns	35	kip	Gravity Max + Wind	42	kip	0.83	MathCAD - Connection Capacities	Force transferred through end of each channel
L6x6x5/8 Column	Compression	70	kip	Gravity Max + Wind	104	kip	0.67	MathCAD - L6x6x58	
L6x6x3/8 Diagonal Braces	Compression	22	kip	Gravity Max + Wind	50	kip	0.44	MathCAD - L6x6x38	
Diagonal Brace Connections	Tension	16	kip	Gravity Min + Wind	21	kip	0.76	MathCAD - Connection Capacities	Tension force in diagonal braces in third level from ground, which are assumed to carry no compression because of their slenderness.
	Compression	22	kip	Gravity Max + Wind	28	kip	0.79	MathCAD - Connection Capacities	Governing compression force in diagonal braces in lower two framing levels.
Gusset Plate	Shear	30	kip	Gravity Max + Wind	41	kip	0.73	MathCAD - Connection Capacities	Governing shear force in gusset plates connecting diagonals to columns.
Column Bottom Connection	Compression	60	kip	Gravity Max + Wind	110	kip	0.55	MathCAD - Connection Capacities	Applied force is force entering base connection from one column member only.
Connection to Foundation	Tension	2	kip	Gravity Min + Wind	9999	kip	0.00		Uplift values are neglible compared to strength of bottom connection and bolts connecting to footing.
	Shear	24	kip	Gravity Max + Wind	35	kip	0.69	MathCAD - Connection Capacities	Shear transfer from bottom connection into footing.
Foundation Uplift	Tension	2	kip	Gravity Min + Wind	2.4	kip	0.83	None	Capacity is weight of 4 feet square by assumed 1' deep (conservative estimate) footing.

CSI Column - Concrete Walls

Section:Column1

Section Properties:

Number of Shapes	= 1	
Total Width	= 60.00	in
Total Height	= 8.00	in
Center, Xo	= 0.00	in
Center, Yo	= 0.00	in
X-bar (Right)	= 30.00	in
X-bar (Left)	= 30.00	in
Y-bar (Top)	= 4.00	in
Y-bar (Bot)	= 4.00	in
Concrete Area, Ac	= 480.00	in^2
Transformed Properties:		
Area, A	= 480.00	in^2
Inertia, I33	= 2,560.0	in^4
Inertia, I22	= 1.44E+05	in^4
Inertia, I32	= 0.00E+00	in^4
Torsional, J	= <No Calc.>	
Principal Angle	= 0.00E+00	Deg
Inertia, I33'	= 1.44E+05	in^4
Inertia, I22'	= 2.56E+03	in^4
Modulus, S3(Top)	= 640.00	in^3
Modulus, S3(Bot)	= 640.00	in^3
Modulus, S2(Left)	= 4,800.00	in^3
Modulus, S2(Right)	= 4,800.00	in^3
Plastic Modulus, Z3	= <No Calc.>	
Plastic Modulus, Z2	= <No Calc.>	
Shear Area, A3	= <No Calc.>	
Shear Area, A2	= <No Calc.>	
Radius, r3	= 2.309	in
Radius, r2	= 17.321	in



Section Diagram

Basic Parameters of Rectangular Shape

Main Material	= Concrete
Sub Material	= fc' = 4.0 ksi
Modulus E	= 3,600.0 ksi
Rebars	= 5-#5

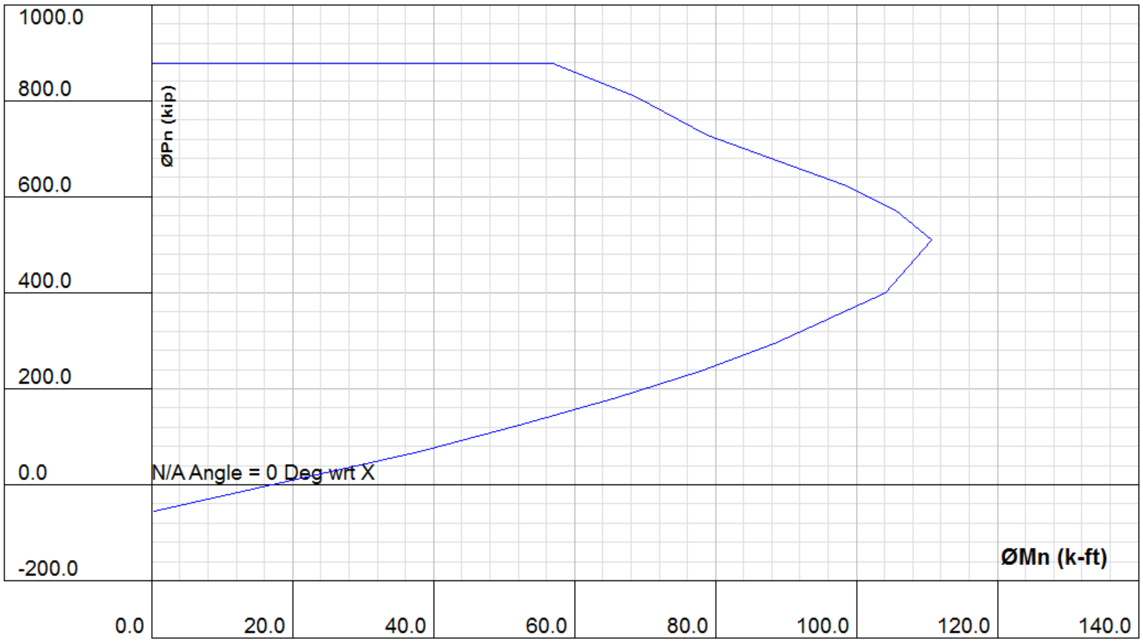
Dimensions of Rectangular Shape

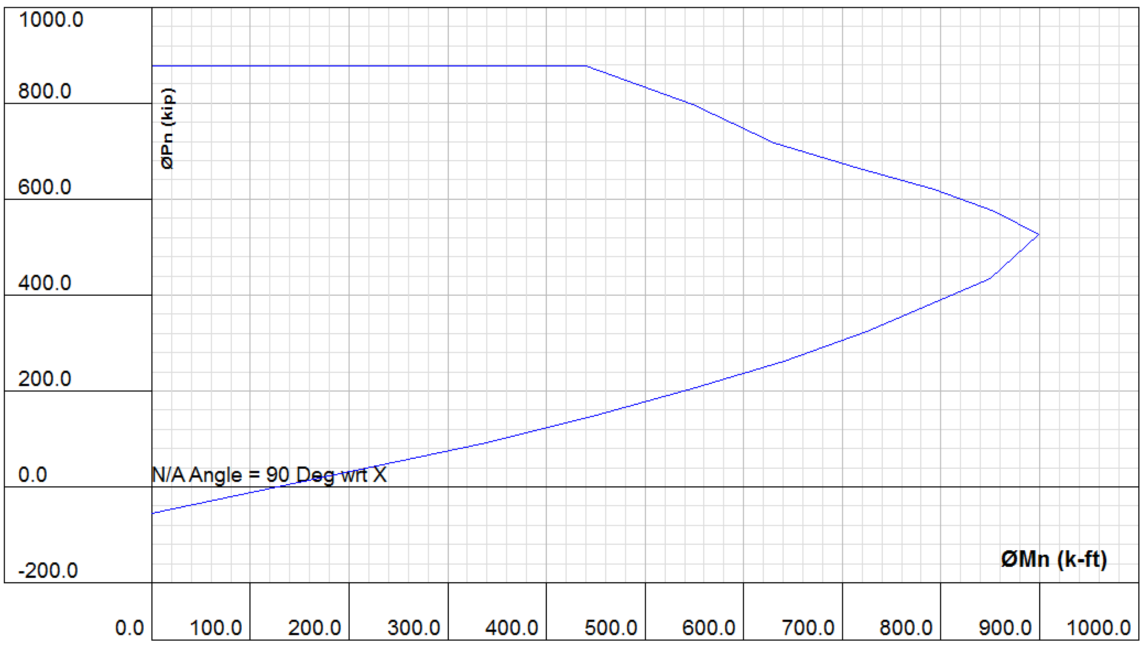
Sr.No	Dimension	Value	Unit
1	Dim-b	60.00	in
2	Dim-h	8.00	in

Rebar Coordinates (wrt bottom-left corner of Shape

Sr.No	Designation	Cord-X	Cord-Y

CSI Column - Concrete Walls





Purpose

To calculate the flexural and shear capacity of the concrete wall segements on the north elevation.

References

ACI 318-11

Legend

Required User Input

Important Information

Assumption or Key Statement

Required User Check

Final Results/Conclusions

Wall Strength

$b := 5\text{ft}$ — wall length

$t := 8\text{in}$ — wall thickness

$dia_s := \frac{5}{8}\text{in}$ — bar size

$n_s := 5$ — number of bars in each wall segement

$A_s := n_s \cdot \frac{\pi}{4} dia_s^{\,2} = 1.53 \cdot \text{in}^2$ — area of steel

$d := \frac{t}{2} = 4 \cdot \text{in}$ — flexural depth - assume worst case one layer of steel in middle

$f_y := 40\text{ksi}$ — yield strength

$f'_c := 3000\text{psi}$ — concrete strength

$\boxed{\phi V_n := 0.75 \cdot 2 \cdot \sqrt{\frac{f'_c}{\text{psi}}} \cdot \text{psi} \cdot b \cdot d = 19.72 \cdot \text{kip}}$ — shear strength

$a := \frac{A_s \cdot f_y}{0.85 \cdot f'_c \cdot b} = 0.4 \cdot \text{in}$

$\boxed{\phi M_n := 0.9 A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 17.48 \cdot \text{kip} \cdot \text{ft}}$ — flexural strength

Purpose

To calculate the compression capacity of the above-referenced single angle member.

The single angle member meets the following requirements:
- compact
- equal angle legs, or connected through longer leg via welded or min two-bolt connections
- connected to gusset plates with other members framing in, both in-plane and out-of-plane (box truss)

References

AISC 360-05

Legend

Required User Input

Important Information

Assumption or Key Statement

Required User Check

Final Results/Conclusions

Geometry

Axis 1 is parallel to Leg 1, which is the longer leg connected to the gusset plate at both ends of the member.
Axis 2 is parallel to Leg 2, which is the shorter, non-connected leg.

$b_1 := 6in$	leg 1 width
$b_2 := 6in$	leg 2 width
$t := \frac{5}{8}in$	thickness of legs
$l_1 := 12ft$	unbraced length for buckling in the 1-direction (about the 2-axis)
$l_2 := 12ft$	unbraced length for buckling in the 2-direction (about the 1-axis)
$r_1 := 1.84in$	radius of gyration about 1-axis
$r_2 := 1.84in$	radius of gyration about 2-axis
$A := 7.13in^2$	area of section

Materials

$f_y := 36ksi$	steel yield strength
$E := 29000ksi$	steel modulus

Compression Capacity (AISC E5)

$\phi := 0.90$

Local Buckling (AISC B)

$\lambda_{leg} := \max\left(\frac{b_1}{t}, \frac{b_2}{t}\right) = 9.6$ leg slenderness

$\lambda_p := 0.54 \cdot \sqrt{\frac{E}{f_y}} = 15.33$ compact limit

$\frac{\lambda_{leg}}{\lambda_p} = 0.63$

Global Buckling (AISC E5)

$\lambda := \frac{l_2}{r_1} = 78.26$ global slenderness about axis 1

$\lambda_{mod} := \begin{vmatrix} 60 + 0.8 \cdot \lambda \text{ if } \lambda < 75 \\ \min(45 + 1 \cdot \lambda, 200) \text{ otherwise} \end{vmatrix} = 123.26$ modified global slenderness about axis 1

$F_e := \frac{\pi^2 \cdot E}{\lambda_{mod}^2} = 18.84 \cdot ksi$ buckling stress

$F_{cr} := \begin{vmatrix} 0.658^{\frac{f_y}{F_e}} \cdot f_y \text{ if } F_e \geq 0.44 \cdot f_y \\ 0.877 \cdot F_e \text{ otherwise} \end{vmatrix} = 16.18 \cdot ksi$ critical stress

$\boxed{\phi P_n := 0.9 \cdot F_{cr} \cdot A = 104 \cdot kip}$ compression strength

Purpose

To calculate the compression capacity of the above-referenced single angle member.

The single angle member meets the following requirements:
- compact
- equal angle legs, or connected through longer leg via welded or min two-bolt connections
- connected to gusset plates with other members framing in, both in-plane and out-of-plane (box truss)

References

AISC 360-05

Legend

Required User Input

Important Information

Assumption or Key Statement

Required User Check

Final Results/Conclusions

WJE Wiss, Janney, Elstner Associates, Inc. 330 Pfingsten Rd., Northbrook, Illinois 60062	MADE BY "BMA"	SHEET NUMBER 2 of = 3
"Single Angle Member Compression Strength" "L6x6x38"	CHECKED BY ""	PROJECT NUMBER "2014.3591"
	DATE "03.12.15"	

Geometry

Axis 1 is parallel to Leg 1, which is the longer leg connected to the gusset plate at both ends of the member.
Axis 2 is parallel to Leg 2, which is the shorter, non-connected leg.

$b_1 := 6in$ leg 1 width

$b_2 := 6in$ leg 2 width

$t := \frac{3}{8}in$ thickness of legs

$l_1 := 15ft$ unbraced length for buckling in the 1-direction (about the 2-axis)

$l_2 := 15ft$ unbraced length for buckling in the 2-direction (about the 1-axis)

$r_1 := 1.87in$ radius of gyration about 1-axis

$r_2 := 1.87in$ radius of gyration about 2-axis

$A := 4.38in^2$ area of section

Materials

$f_y := 36ksi$ steel yield strength

$E := 29000ksi$ steel modulus

Compression Capacity (AISC E5)

$\phi := 0.90$

Local Buckling (AISC B)

$\lambda_{leg} := \max\left(\frac{b_1}{t}, \frac{b_2}{t}\right) = 16$ leg slenderness

$\lambda_p := 0.54 \cdot \sqrt{\frac{E}{f_y}} = 15.33$ compact limit

$\frac{\lambda_{leg}}{\lambda_p} = 1.04$

Global Buckling (AISC E5)

$\lambda := \frac{l_2}{r_1} = 96.26$ global slenderness about axis 1

$\lambda_{mod} := \begin{cases} 60 + 0.8 \cdot \lambda & \text{if } \lambda < 75 \\ \min(45 + 1 \cdot \lambda, 200) & \text{otherwise} \end{cases} = 141.26$ modified global slenderness about axis 1

$F_e := \frac{\pi^2 \cdot E}{\lambda_{mod}^{\ 2}} = 14.34 \cdot ksi$ buckling stress

$F_{cr} := \begin{cases} 0.658^{\frac{f_y}{F_e}} \cdot f_y & \text{if } F_e \geq 0.44 \cdot f_y \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 12.58 \cdot ksi$ critical stress

$\phi P_n := 0.9 \cdot F_{cr} \cdot A = 50 \cdot kip$ compression strength

Purpose

To calculate the capacities of the typical connections in the tower framing.

References

AISC 360-05

Legend

Required User Input	Important Information	*Assumption or Key Statement*
Required User Check	Final Results/Conclusions	

Materials

$f_y := 36ksi$ steel yield strength

$f_u := 58ksi$ steel ultimate strength

$E := 29000$ steel modulus

$f_{u.rivet} := 60ksi$ rivet strength

Geometry

$dia_{rivet} := \frac{5}{8}in$ rivet diameter

$t_{gusset} := \frac{3}{8}in$ gusset plate thickness

$ed_{rivet} := 1.25in$ smallest edge distance or rivet spacing

Rivet Strength

AISC J3

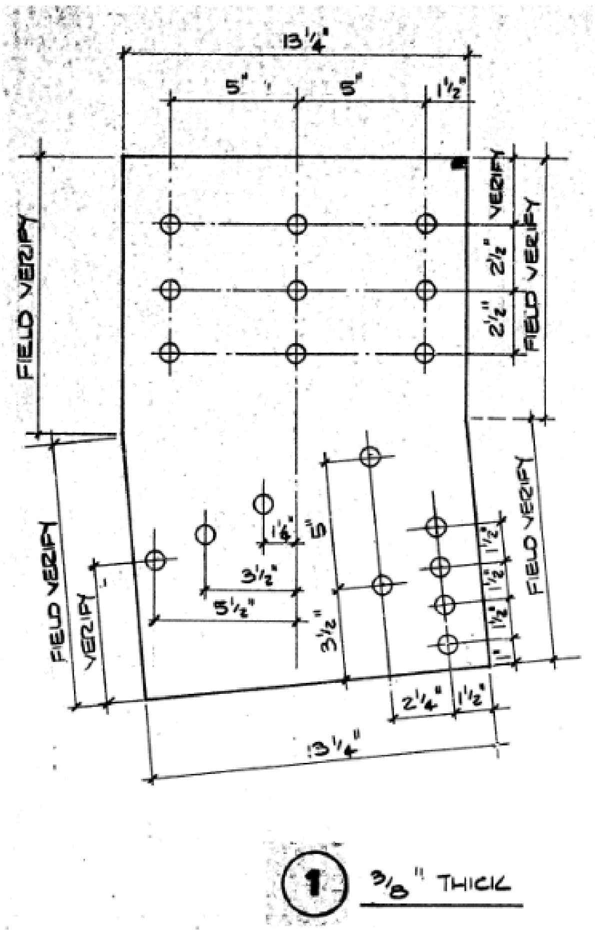
$\phi := 0.75$

$R_{n.riv.shear} := 0.50 \cdot f_{u.rivet} \cdot \frac{\pi}{4} dia_{rivet}^{\ 2} = 9.2 \cdot kip$ nominal shear strength

$R_{n.riv.bearing} := \min\left[1.5 \cdot \left(ed_{rivet} - \frac{dia_{rivet}}{2}\right) \cdot t_{gusset} \cdot f_u, 3 \cdot dia_{rivet} \cdot t_{gusset} \cdot f_u\right] = 30.59 \cdot kip$ nominal bearing strength

$\boxed{\phi R_{n.rivet} := \phi \cdot \min\left(R_{n.riv.shear}, R_{n.riv.bearing}\right) = 6.9 \cdot kip}$ governing strength of one rivet

C10 Connection Capacity



$n_{riv} := 6$

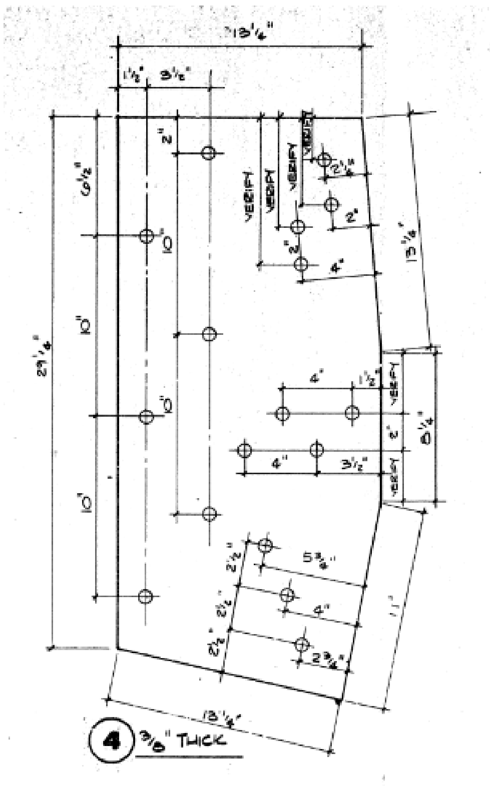
number of rivets, lesser of 7 connecting ends of channel to gusset plate and 6 connecting gusset plate to column angle

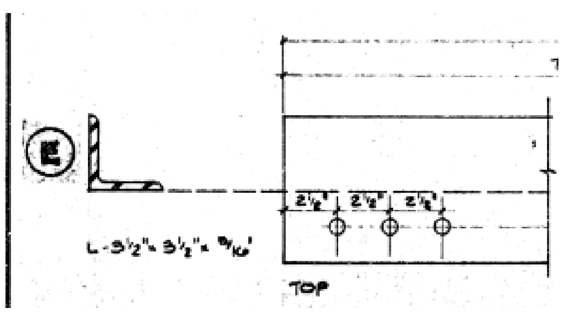
$\phi R_{n.channel} := n_{riv} \cdot \phi R_{n.rivet} = 41.42 \cdot kip$

WJE	Wiss, Janney, Elstner Associates, Inc. *330 Pfingsten Rd., Northbrook, Illinois 60062*	MADE BY "BMA"	SHEET NUMBER 4 of = 8
"Connection Capacities" ""	CHECKED BY ""	PROJECT NUMBER "2014.3591"	
	DATE "03.12.15"		

Diagonal Brace Connections

Tension Braces at 3rd Level





$n_{riv} := 3$ number of rivets

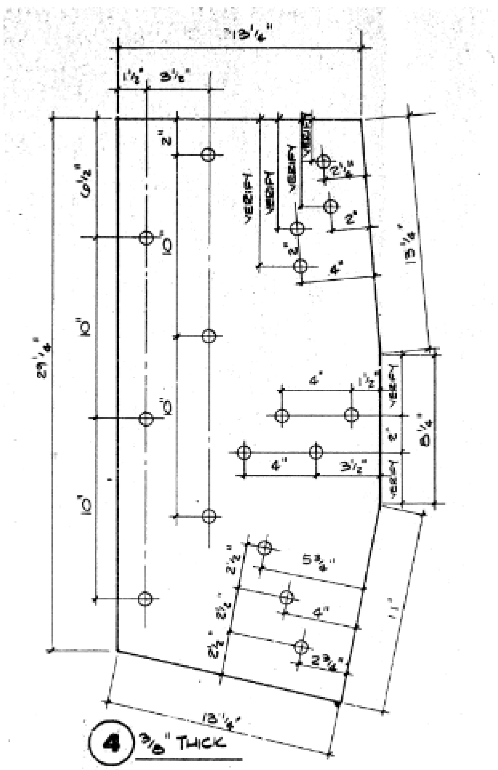
$\phi R_{n.riv} := n_{riv} \cdot \phi R_{n.rivet} = 20.71 \cdot kip$ riveted strength

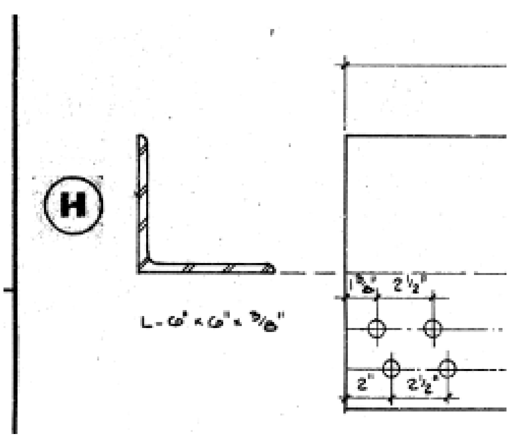
$$\phi R_{n.shear} := 0.75 \cdot \left[\left(2.5in - \frac{dia_{rivet}}{2} \right) + 2 \cdot \left(2.5in - dia_{rivet} \right) \right] \cdot t_{gusset} \cdot 0.6 \cdot f_u = 58.11 \cdot kip$$

conservative estimate of shear rupture strength

$\phi R_{n.diag.tens} := \min\left(\phi R_{n.riv}, \phi R_{n.shear}\right) = 20.71 \cdot kip$

Compression Braces below Third Level





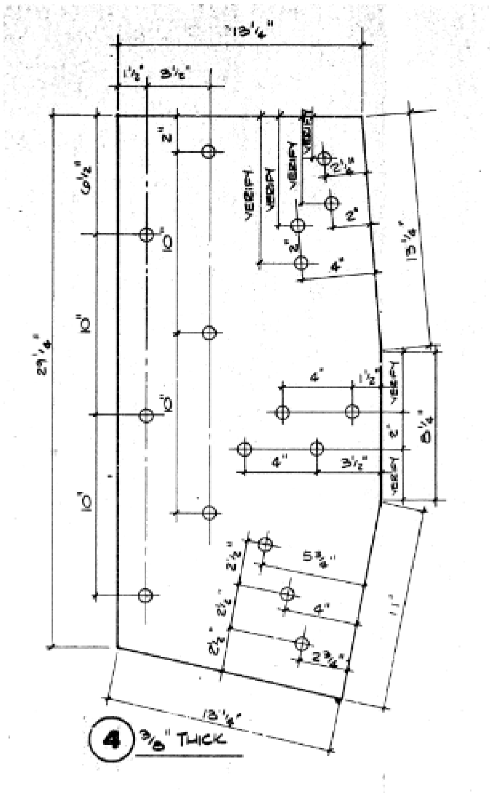
$n_{riv} := 4$ minimum number of rivets in diagonal brace conection

$\phi R_{n.riv} := n_{riv} \cdot \phi R_{n.rivet} = 27.61 \cdot kip$ riveted strength

$\phi R_{n.shear} := 0.75 \cdot \left[\left(1.625in - \frac{dia_{rivet}}{2} \right) + 2 \left(2.5in - dia_{rivet} \right) \right] \cdot t_{gusset} \cdot 0.6 \cdot f_u = 49.55 \cdot kip$ conservative estimate of shear rupture strength

$\boxed{\phi R_{n.diag.comp} := \min\left(\phi R_{n.riv}, \phi R_{n.shear} \right) = 27.61 \cdot kip}$ limiting strength of compression diagonal connections

Gusset Plates



$dim_{gusset} := 10in$ — minimum approx. dimension of shear resistance

$\phi R_{n.shear} := 0.75 \cdot 0.6 \cdot f_y \cdot dim_{gusset} \cdot t_{gusset} = 60.75 \cdot kip$ — minimum plausible shear strength of plate

$n_{riv} := 6$ — number of rivets transfering force to column

$\phi R_{n.riv} := n_{riv} \cdot \phi R_{n.rivet} = 41.42 \cdot kip$ — strength of rivets tranfsering loads to column

$\boxed{\phi R_{n.gusset} := \min\left(\phi R_{n.shear}, \phi R_{n.riv}\right) = 41.42 \cdot kip}$ — strength of typ. gusset plate

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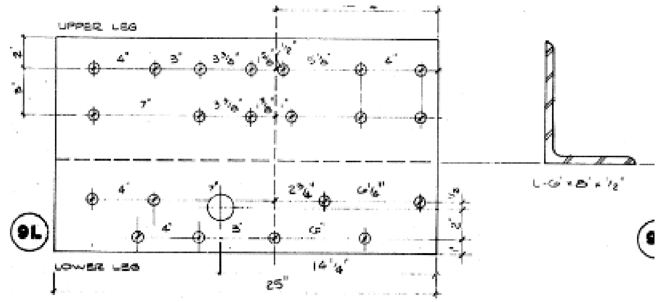
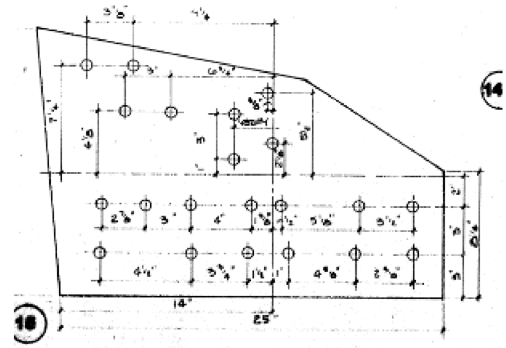
"Connection Capacities" ""	CHECKED BY	PROJECT NUMBER "2014.3591"
	DATE "03.12.15"	

Tower Base Connection





Column to Plate Connection

$t_{basegusset} := \frac{1}{2}in$ — thickness of base connection gusset plates

$dim_{gusset} := 14in$ — minimum approx. dimension of shear resistance

$\phi R_{n.shear} := 2 \cdot 0.75 \cdot 0.6 \cdot f_y \cdot dim_{gusset} \cdot t_{gusset} = 170.1 \cdot kip$ — minimum plausible shear strength of both plates combined

$n_{riv} := 16$ — number of rivets transfering force from column

$\phi R_{n.riv} := n_{riv} \cdot \phi R_{n.rivet} = 110.45 \cdot kip$ — strength of rivets tranfsering loads to column

$\phi R_{n.gusset} := \min(\phi R_{n.shear}, \phi R_{n.riv}) = 110.45 \cdot kip$ — strength of typ. gusset plate

Plate to Foundation Connections

$n_{bolt} := 2$ — number of bolts connecting to footing

$dia_{bolt} := 1in$ — estimate of bolt size

$f_{u.bolt} := 60ksi$ — conservative estimate of bolt strength

$\phi R_{n.shear} := 0.75 \cdot n_{bolt} \cdot 0.5 \cdot f_{u.bolt} \cdot \frac{\pi}{4} \cdot dia_{bolt}^{2} = 35.34\,kip$ — base connection shear capacity

Shear in plates and angles no less than this capacity by inspection.

$\phi R_{n.tension} := 0.75 \cdot n_{bolt} \cdot .75 \cdot f_{u.bolt} \cdot \frac{\pi}{4} \cdot dia_{bolt}^{2} = 53.01\,kip$ — tension capacity of bolts

Bending capacity of angle legs may be less than this. Uplift values are very low, so okay by inspection.