EVALUATION OF THE STEAM PROPULSION SYSTEM

OF THE WRECKED FERRY BOAT SIERRA NEVADA

Steven J. Schwartz
Environmental Division
Naval Air Station
Pt. Mugu, California 93042-5000

ABSTRACT

Scheduled to be impacted by a Corps of Engineers' dredging project, the wrecked ferryboat Sierra Nevada was evaluated for eligibility to the National Register. Although the superstructure was in poor condition and not considered eligible, the propulsion system was intact and represented a transitional design in steam engineering. Thus, only the propulsion system was determined eligible for the National Register. As mitigation for project impacts, the Corps of Engineers conducted Historic American Engineering Record documentation of the propulsion system including architectural quality photographs and a detailed technical description. The Corps' evaluation and documentation program are discussed.

BACKGROUND

The Sierra Nevada, originally known as the Edward T. Jeffrey, was launched in 1913; she transported passengers across San Francisco Bay. The ferry was renamed the Feather River about 1931 and became the Sierra Nevada in 1933. She was taken over by the US Maritime Commission during World War II, afterwards passing to the Richmond and San Rafael Ferry and Transportation Company about 1947 where she was converted to carry autos. She served with the ferry company, plying the waters of San Francisco Bay, until it ceased operations in 1956. During her last days, she became a floating waterfront shopping center and arcade at Ports-O'-Call Village in San Pedro. In 1978, she became derelict and was scuttled on the breakwater on the south side of Terminal Island in Los Angeles Harbor.

The vessel was a double-ended ferry of steel construction. A sizable vessel, her over-all length was 230 feet, width across the guards was 62.5 feet, and her depth of 16.6 feet produced a gross tonnage of 1578. A crew of 20 was required to operate her. A single propeller at each end permitted her to steam in either direction with equal efficiency, thereby eliminating the time that would have been wasted in turning around after leaving dock.

CORPS OF ENGINEERS INVOLVEMENT

The Corps of Engineers' dredging of the Main Channel in Los Angeles Harbor in 1980 prompted assessment of shipwrecks in the dredging and disposal areas. The area designated for dredge disposal contained a number of shipwrecks including the Sierra Nevada. The Corps of Engineers commissioned a remote sensing survey and assessment of the wrecked vessels (Hunter and Pierson 1980). The other wrecks in the area were determined to be either too recent, or in too poor condition to be considered significant. The Sierra Nevada, however, was another story. The ship's superstructure was in poor condition; she appeared to have been deliberately scuttled in 1978. By 1980 when the cultural assessment was conducted, she was badly broken up against the rocks. Further evaluation of the vessel, however, revealed that her propulsion system was still relatively intact. This prompted further assessment of the propulsion system. The propulsion system remained as originally installed in 1913. The system consisted of two compound steam engines that were mounted on a common bedplate utilizing a common crankshaft and common propeller shafts. The engines developed 2500 horsepower and weighed just under 100 tons. Physically, the system measured approximately 25 feet long, 15 feet wide, and 20 feet tall.

SIGNIFICANCE

The Sierra Nevada is not of historic significance due to any particular distinction of the vessel; the Sierra Nevada performed long and faithful service, but took part in no great events and marked no milestone of maritime progress. But, the propulsion system represents a very significant stage in the progress of steam engineering--the compound engine.

The first useful reciprocating steam engine was introduced in 1705, but it remained for James Watt to perfect a really versatile steam engine. In 1782 he patented a double-acting design, in which steam was alternately applied above and below a piston to actively drive it in both directions. Watt was also responsible for the introduction of a condenser separate from the engine and for the use of steam expansively, rather than admitting it during the entire length of a piston stroke. The combination of these improvements resulted in the first engines powerful and economical enough for maritime use.

Meanwhile, proposals for propulsion of a vessel by steam had been set forth. A number of experiments took place, and there are conflicting claims for the first steam vessel to actually work. It is generally conceded, however, that William Symington's Charlotte Dundas, built for towing on a Scottish canal in 1802, was the first practical steamer. Commercial success was first achieved by a steamboat with Robert Fulton's Clermont on the Hudson River in 1807.

Steam quickly took hold on inland waters and short coastal routes in passenger service and for transport of compact, high-value cargo. However, early steamers could not effectively compete with the economy and range of sailing vessels on long ocean routes. Steamers could not hope to supplant sailing ships on the high seas until better engines were developed.

The answer was found in the compound engine; expanding steam successively in two separate cylinders. The compound engine held a mechanical advantage, by dividing the work into stages, the range of stresses was held down through the use of relatively smaller working parts and smoother, steadier motion; this, in turn, permitted a relatively lighter construction. Compound engines, therefore, tended to save a certain amount of space and weight and a great deal of fuel. Their introduction at sea reduced average fuel consumption on long voyages by half or more. By the middle of the 19th century, improved boilers permitted considerably higher pressures, and the compound engine's time had come. The first vessel fitted with a compound engine was the Brandon in 1854. Acceptance came somewhat slowly, but compound engines were almost universally chosen for marine use by 1871. Meanwhile, the screw propeller had been patented in 1836, and proved superior in efficiency to paddle-wheels for most applications. Propeller shafts had to be placed low in the hull, so, in 1850, James Nasmyth introduced the inverted-vertical steam engine, placing the cylinders above the propeller shaft.

The advantages of the compound engine could be applied in the direction of greater speed, or lower fuel consumption and greater range. It is not coincidental that the period which saw the acceptance of the compound steam engine is also that during which steamers replaced sailing vessels for all but trades involving low-value bulk cargo on the longest of routes. The compound engine may be said to have fully ushered in the modern age of international maritime transportation.

Progress in marine engineering did not, of course, halt with the compound engine. The triple-expansion engine, which extended the principle of the compound engine by expanding steam in yet another cylinder, was developed by 1862. These engines soon proved themselves even more efficient than the compound engine and largely supplanted it in new construction during the 1880s. Many existing compound engines were converted by the addition of another cylinder.

Charles Parsons patented the first successful steam turbine in 1884. He also was the first to install one in a vessel, the Turbinia in 1897, which achieved spectacular results in speed, leading to the general displacement of reciprocating engines by turbines for fast ships. The direction of development in marine engineering split with the introduction of the diesel internal-combustion engine, patented in 1892.

In summary, the propulsion system of the Sierra Nevada represented a duality of steam engine evolution; the compound engine and the double compound, or tandem unit. This assemblage is rare, and poorly represented in museum displays worldwide. It represents a significant evolutionary stage in the development of steam engines during the industrial revolution. The system further embodies several innovative and refined steam engineering features; the result of the search for greater fuel efficiency. Finally, the propulsion system represents the method by which commerce and transportation carried the world from the industrial revolution into the 20th century.

NATIONAL REGISTER EVALUATION

With this background information, the Corps of Engineers prepared a National Register eligibility determination for the steam engine. The nominated object was the steam propulsion system consisting of a matched pair of two-cylinder compound, inverted, direct-acting, condensing steam engines, with attendant equipment.

DOCUMENTATION

The engine was resting in place aboard the Sierra Nevada. It, however, was slated to be removed as part of the dredge disposal operations. The question then became, what could be done to mitigate the impact of the wreck's removal? A number of possibilities were explored. Foremost, the idea of donating the engine to a maritime museum for public display was pursued. To this end, the engine was carefully removed from the vessel. Unfortunately, after a great deal of effort, no such arrangements could be worked out satisfactorily with a maritime museum. The only mitigating measure which could be worked out, to meet the needs of the Corps of Engineers and its local sponsor, was to complete a full photo-documentation per Historic American Engineering Record (HAER) standards. This involved architectural quality large format photographs from all angles and an accompanying narrative description prepared by a marine engineering specialist (Gilmore 1985). They are the only remaining record of the existence of the engine.

After photo-documentation, the engine was summarily sold for scrap to the highest bidder.

DISCUSSION

Why was a compound engine selected for the Edward T. Jeffrey in 1913, forty years after the first triple-expansion engine, and several years after turbine vessels began appearing in numbers?

The turbine can be dismissed as unsuitable for any harbor or coastal craft that required only moderate speed, but had to frequently slow, stop, and back-up while maneuvering. The turbine was more efficient than any other type at sustained speed, but at low and moderate speeds its fuel consumption was higher than that of a reciprocating engine, while the high speed rotation of the turbine would have required extensive reduction gearing to obtain satisfactory propeller speeds. Furthermore, turbines offered poor maneuvering capabilities in that reversing could not be done directly; a small separate astern turbine was required for that, and it did not provide full power for backing. Reciprocating steam engines, on the other hand, could be reversed directly, almost immediately, and provide full power for steaming astern.

The choice of a compound engine over triple-expansion machinery is a bit more complex to explain, but was in no way unusual. Compound machinery was very often the choice for tugs, ferries, and other types of coastal and harbor vessels, right up to the general acceptance of diesel propulsion for these craft. The degree of advantage of triple-expansion engines over compound ones was not nearly so great as the latter had been over simple steam engines; furthermore, the triple-expansion engine's advantage was confined to the area of fuel efficiency, as a compound engine of a given horsepower was actually more compact, within the range required by the craft that employed them. The question of fuel economy was very important to ocean-going vessels, on grounds of steaming range as much as cost. But tugs, ferries, and the like were almost always within easy range of fuel supplies, while compound engines offered advantages of compactness, lower initial cost, and simplicity with fewer working parts to maintain. The double-compound, or tandem, engine is a special case, however. Although they existed in fair numbers, they never represented more than a fraction of the total marine steam engines in use. They actually had more working parts than a triple-expansion engine, but may, for a ferry, have offered a small advantage in reliability of restarting during maneuvering. Generally, however, it would seem that the double-compound engine was chosen for coastal vessels of fair size, where achieving a fairly high horsepower as compactly as possible was considered more important than maximum fuel economy, a combination of factors which was found more frequently in large ferries than other vessels.

Surviving examples of any form of reciprocating marine steam engine are scarce, due to the length of time that they have been obsolete; most were scrapped long before the maritime preservation movement attained form. The compound engine was undoubtedly the greatest single advance in steam engineering between Watt's invention of the double-acting engine in 1782 and Parson's introduction of the steam turbine in 1897. Furthermore, compound engines remained an important form of propulsion for numerous coastal craft well into this century, until finally supplanted by diesels.

More particularly, the engine under consideration is significant as a very rare example of a double-compound engine. Only one other surviving example is known, that of the ferryboat Major General William H. Hart, built in 1925, and presently owned by the South Street Seaport Museum of New York City. Consequently, specific documentation of the double-compound engine is scarce. In fact, no set of plans for an engine of this type have been located. This type was employed in significant numbers, but was never a predominant form of marine propulsion. It was, rather, a successful adaptation to a very specific set of requirements, notably those of large ferries. Ferries were once a much more important component of the nation's transportation system than presently, due to construction of highway bridges and tunnels. The general attrition of ferryboats themselves, combined with the adoption of diesel propulsion for most of those that remain, has led to the scrapping of nearly all of the double-compound engines that once existed--unfortunately including this one. However, the photographs and written description survive as a permanent record of the propulsion system and its significant features.

This project has also been significant in terms of shipwreck management. First, it has clearly demonstrated the need to assure that significance evaluations address all possible forms of significance. In this case, the propulsion system was determined eligible for the National Register while the rest of the vessel was determined to be ineligible. This precedent can be used to examine shipwrecks in terms of significance for a portion of a wreck, and need not determine that the entire wreck is significant. Surely there are many other instances where the superstructure is so deteriorated that study or preservation of it would be futile. In these cases, however, there may be some shipboard system, or even the cargo that is significant on its own merit. Even shipwrecks which have been partially destroyed by past dredging or construction projects cannot be ruled non-significant without full analysis of all potential forms of significance. Lastly, the project has demonstrated the need for full and up-to-date survey of project areas; even if they have been dredged in the past, or there are no recorded historic shipwrecks. In this case, the Sierra Nevada wrecked in 1978. The wreck occurred only two years prior to the survey effort; the vessel, however, was over 65 years old. When a wreck occurs is not necessarily a determinant of significance. Therefore, unless we bring our inventory efforts up to the present, we cannot be sure that we have fully inventoried the wrecks in a given area. For example, if the area had been dredged even five years prior to the survey, the area still would have contained a significant historic property. Therefore, we should always insure that inventory efforts are as up-to-date and complete as possible.

NOTES

This paper was originally prepared while the author was employed by the Corps of Engineers, Los Angeles District. This is a shortened version of a paper presented at the Society for Historical Archaeology annual meeting in Baltimore, 1989.

Much of the history and description were summarized from the documentation prepared by Larry Gilmore of the Columbia River Maritime Museum. Initial surveys and recordation were prepared by Jack Hunter and Larry J. Pierson. Jack has expended a great deal of energy on this and other projects in Los Angeles Harbor and deserves special recognition for his significant efforts. Archival photographs were prepared by Nicolas Kappes. Rich Macias and Patricia Martz, of the Corps of Engineers, gave a tremendous amount of effort for this project. Ed Paxton should also be recognized for his significant role.

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