Hydrofoil Pioneers...

Charles R. Denison and *HS DENISON*

by John R. Meyer, Jr.

(Last Update 3 Feb 02)

Sparked by the commercial application of hydrofoils in Europe and the research being sponsored by the US Navy in the 1950s, the Maritime Administration (MARAD) started a project leading to the *HS DENISON*.

The Marad Coordinator of Research, Charles R. Denison, was enthusiastic about the future commercial potential of the hydrofoil and in 1958 sponsored an extensive parametric study carried out by Grumman Aerospace Corporation and its affiliate Dynamics Developments, Inc. The purposes of the study were to determine the type of hydrofoil craft best suited to future express-cargo and passenger applications and to establish design criteria for such craft. Speeds of 50 to 200 knots, displacements from 100 to 3,000 tons, and ranges from 400 to 3,600 nautical miles were considered. Foil section shapes and arrangements, power plants and propulsors, hull form, and control systems were treated including several preliminary designs for oceangoing ships. Based on the favorable results of this study, MARAD contracted with Grumman in 1959 for design studies for two test craft. One was to have a conventional power plant and the other a provision for a lightweight aircraft nuclear power source when such a system became available.

In January of 1960, MARAD placed a contract with Dynamic Developments, Inc. to build an experimental hydrofoil capable of speeds up to 60 knots with gas turbine engines. Provision was made for a second phase where the subcavitating foils would be replaced with supercavitating foils. The intent was to achieve speeds up to 100 knots with the same power plant. Unfortunately, Charles Denison, whose vision and enthusiasm was in great part responsible for the program, suffered an untimely death before the ship got beyond the early design stage. It was in his memory that the ship was later christened *HS DENISON*.

Although MARAD had contracted with Dynamic Developments, Inc. to build *DENISON*, Grumman Aircraft Engineering Corporation, because of expanding interest in hydrofoils, purchased interest in and eventually acquired all of Dynamic Developments, Inc.

DENISON was launched by Grumman on 5 June 1962 at Oyster Bay, Long Island, and began sea trials only four days later. The 95-ton *DENISON* had a unique foil system. The forward surface-piercing foils carried 85% of its weight, and a single fully-submerged tail foil aft carried the remaining 15%. The ship's length overall was 104.6 feet, maximum hull beam was 23 feet, and maximum draft hullborne with its foils extended was 15.4 feet.

It is significant that the main propulsion for foilborne operations was provided by a General Electric gas turbine engine rated at 14,000 horsepower. It was a marine version of GE's J-79 aircraft jet engine. MARAD had obtained two J-79 engines from the Navy and then bailed them to GE who then provided the marine version by the addition of a so-called free power turbine to take energy out of the jet. This arrangement was interesting in that it was accomplished for the total sum of one dollar. This proved to be a wise long-term investment on the part of the General Electric Company because it was the basis for their later so-called LM series of marinized gas turbine engines which are extensively used in Navy ships today.

The above financial arrangement was not entirely unique on the *DENISON* program because although MARAD contributed $1,500,000 for design and construction, Grumman and 73 other companies invested from $5M to $7M of their own funds!

The design of a propulsion system capable of putting 14,000 hp into the water through a single high speed propeller was a considerable challenge at the time. Power was transmitted from the gas turbine engine through a right-angle bevel-gear drive to a supercavitating propeller mounted at the bottom of the aft strut. The spiral bevel gears, 20 and 21 inches in diameter and turning at 4,000 rpm, were designed and built by General Electric Company and represented the most stringent requirement of any which previously had been manufactured.

A series of trials were carried out at speeds of 50 to 60 knots as the ship demonstrated its ability to be stable and highly maneuverable. *DENISON* was also a good performer in rough water under high winds and low temperatures. The temperatures on some tests were below freezing, but no icing problems were encountered during either hullborne or foilborne operations. In comparison, it was reported that a 30-foot escort boat was unable to proceed out of sheltered waters during that time due to heavy icing on its deck and superstructure.

Following these trials, the U.S. Navy and MARAD had planned to proceed with the next high-speed phase of the *DENISON* program incorporating a supercavitating foil system. All seemed to be on track when the Navy decided to change course and proceed with the design of their own high speed foil research craft, designated *FRESH-1*. Since the Navy withdrew their financial support, MARAD decided to terminate the program and not pursue development of commercial hydrofoils any further.

It has been said that the MARAD program, and more particularly the *HS DENISON*, contributed in large measure to the growing technology base for the design of hydrofoils. Many of the *DENISON's* subsystems were at the leading edge of the state-of-the-art, and knowledge gained was invaluable in further developments by the US Navy. It is unfortunate that it did not also fulfill the bright future originally forecast for the employment of commercial hydrofoils in US service.

Correspondence about *DENISON*

DENISON Take Off Speed

[3 Feb 02] Regards the *DENISON*, could you throw out a thread asking what the take off speed was. I need that to get an idea of what kind of HP I need to get it up and out. I am looking at the *DENISON* at this time as an intermediate craft for new buyers. It is simpler in configuration than the *PLAINVIEW*, with the fixed front foils. The configuration is what I am interested in, and the information will be very useful. At this time, I am working on the elusive mystery of going from subcavitating to supercavitating, without having to drop a different set of foils. Step at a time... I am also looking for the inside layout of the *DENISON* , including engine location, tank location, tank size, etc. -- Vladimir Algin (v.algin@businesstalkfrance.com)

Responses...

[3 Feb 02] I assume you are referring to *HS DENISON* built for the US Maritime Administration in the early 1960s? I have a copy of an article by E.K. Sullivan and James A. Higgins titled "Test and Trials of the *HS DENISON* " published in *Hovering Craft and Hydrofoil* journal Vol.3, No.2&3 November-December 1963 (pp 30-34) which indicates: "The maximum operating displacement is 95 tons, which includes 42.8 tons for useful load. Design speeds are 60 knots with a 5 ft hull clearance while foilborne, and 10 knots during displacement operation. Take-off at the maximum foilborne gross weight is approximately 27 knots... Foilborne propulsion is provided by a single General Electric MS-240 gas turbine engine rated at 14,000 shp continuous." I guess that your question is in relation to the proposal for a luxury hydrofoil. Good luck with that venture. -- Martin Grimm (seaflite@alphalink.com.au)

[3 Feb 02] In the Hydrofoil Design Data log, Page 567-81, (Figure 567-11) The *HS DENISON* Foilborne Performance Chart at 80 tons shows take off speed near or at 30 knots. The shaft horsepower was 15,000. -- John Monk (marymonk@msn.com)

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