FLAGSTAFF (PGH-1)

(More *FLAGSTAFF* Photos are in the Gallery)

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(Revised 8 Feb 03)

History

Beginning in 1952, the US Navy sponsored a research & development program to construct & evaluate a number of hydrofoil test-craft. As a result of this program, in April 1966, the Navy's Bureau of Ships awarded contracts for two competing hydrofoil gunboats, the PGH-1 to the Grumman Corporation, and the PGH-2 to the Boeing Company. The PGH-1 was completed in March 1968 and christened *FLAGSTAFF* in honor of Flagstaff, Arizona. She completed acceptance trials and was delivered to the Navy Amphibious Force Pacific on November 7, 1968. In November 1969, *FLAGSTAFF* was transported to South Vietnam and deployed as a patrol craft for river operations out of Danang in Operation Market Time. In 1970, after completing her Vietnam tour, she was returned to San Diego for operations with Boat Support Unit One, Amphibious Forces Pacific.

On November 4, 1974, she was loaned to the U. S. Coast Guard on the West Coast for a period of testing to evaluate the utility of a hydrofoil craft as a Coast Guard cutter. This testing continued until February 1975 when *FLAGSTAFF* was returned to the Navy.

On September 29, 1976, the Coast Guard again took possession of *FLAGSTAFF* to enable the Service to do a long-term evaluation in an actual operational environment. The ship was dispatched to Boston, MA where she underwent repairs and cold weather modifications. On March 2, 1977, at the Coast Guard Support Center in Boston, wearing Coast Guard colors, *FLAGSTAFF* was formally commissioned as the Coast Guard cutter (WPGH-1). Lt. Terrance Hart assumed command of the cutter and her crew of 12 enlisted personnel. On July 17, 1977 she was placed in active status and home-ported in Woods Hole, MA. She operated out of her homeport for a period of 16 months. As part of the Coast Guard Fleet, *FLAGSTAFF* performed duties of law enforcement, search and rescue operations, and enforcement in the new 200-mile fisheries economic zone.

FLAGSTAFF was decommissioned on September 30, 1978. This decision was based, in part, on the cost of needed repairs and the fact that the Coast Guard felt that sufficient information on the use of hydrofoil craft had been derived from the evaluation program.

FLAGSTAFF and the other Navy R&D hydrofoil ships and craft served to lay a solid technology foundation for the design and deployment of a squadron of six Navy Patrol Hydrofoil Missile (PHM) ships that were later built by Boeing.

FLAGSTAFF Characteristics

- Length………….………………73 feet
- Beam…………………..…….…21.5 feet
- Draft, Foils Retracted……..……4 feet, 4 inches
- Draft, Foils Extended…………18 feet
- Displacement………………..…69.5 long tons
- Design Speed, foilborne……..…45 knots
- Design Speed, hullborne………..8 knots
- Propulsion Systems:
  - Hullborne: Two General Motors Diesels with waterjet pumps.
  - Foilborne: Rolls Royce Tyne gas turbine with super-cavitating propeller.

-- Wm. M. Ellsworth, P.E.

The US Coast Guard first evaluated *FLAGSTAFF* from Nov 74 thru Feb 75

USCG Official Photos

In Sep 76, USCG again took possession of *FLAGSTAFF*

Correspondence

Condition of *FLAGSTAFF*

[18 Jul 00] I have viewed *FLAGSTAFF* and shot 4 rolls of film. The ship is in very good condition. Does not have 2 diesels for generators, 2 main diesels for propulsion or the jet drive units for HB operation. The turbine is present and seems untouched since it was surplused. The flagstaff only has one turbine. At the time it didn't occur to me to get the numbers off its data plate. The hull/deck is sandblasted 85%. The plumbing has been completed about 80%. The wiring needs a good electrician but the majority is intact. Foils are in good shape, although the rear foil might need a bearing housing. Front foils have minor rust. John Altoonian (father) accomplished quite a bit. Sand blasting, cleaning and painting would be very light except for the propulsion room, generator/jet drive room and manual hydraulic room. For the money asked, US$30,000.00, the ship is worth at least that. Unfortunately, Mr. Altoonian (son) has set a firm 1 Aug 00 scrapping date. -- Duane A. Leiker, Pres/CEO; International Submarine Museum, 4230 Trumbo Ct.; Fairfax VA 22033; phone: (703) 359-7266 (DLeiker@cox.net)

Classic Thunder...

[18 Aug 98, updated 22 Nov 00] Just noticed that *FLAGSTAFF* is being sold as a partnership and will be used as a promotional gimmick for boat shows and races on the East Coast of the USA. -- Ken Plyler (Kfppfk@aol.com) *[project discontinued due to death of the owner - Editor]*

Go to the Posted Messages Bulletin Board

Back to Top of This Page

This Page Prepared and Maintained By...

International Hydrofoil Society

PO BOX 51 - CABIN JOHN MD 20818 - USA

webmaster@foils.org

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USS FLAGSTAFF (PGH-1)

GENERAL: The FLAGSTAFF is a 74.5 foot high performance (hydrofoil) watercraft built by Grumman Aerospace Corporation for the U.S. Navy. Specifications of FLAGSTAFF are contained in enclosure (1). FLAGSTAFF was on loan to the Coast Guard from 8 November 1974 through 18 February 1975, during which time it was tested and evaluated in both actual and simulated Coast Guard missions. These tests indicated that a high speed vessel, such as a hydrofoil, had definite potential in a general law enforcement/fisheries law enforcement environment. Because of this, when the Navy indicated that FLAGSTAFF would be decommissioned on or about 30 September 1976 and would be available for transfer to the Coast Guard, the Commandant decided that it would be desirable to acquire FLAGSTAFF for extended operational employment (approximately 1 year) as a Coast Guard unit having ELT as its primary mission. It was determined that the New England area would provide the best all around proving grounds for FLAGSTAFF and, with this in mind, Woods Hole was selected as the most feasible homeport. Enclosure (2) contains a number of scenarios prepared by the Operations Analysis Division of Grumman Aerospace Corporation utilizing FLAGSTAFF in the fisheries law enforcement mission of the Coast Guard. It should be noted that, although Grumman visualizes five-day at sea periods for FLAGSTAFF, it is the general concensus that in most cases at sea periods would not extend beyond three days.

TRANSPORT: It is envisioned, that upon acceptance of FLAGSTAFF, the Coast Guard will make arrangements for transportation of FLAGSTAFF from its current west coast homeport to the east coast. The most probable and economical mode of transportation appears to be via Military Sealift Command vessel. The FLAGSTAFF would be transported with its entire suite of spare parts inventory. After debarkation on the east coast (Boston being the preferred port) FLAGSTAFF would undergo approximately two weeks dockside availability, another two weeks of shakedown and then be RFS and the accomplishment of missions. Enclosure (3) contains a rough breakdown of the latest report of the material condition (as of May 1976) of FLAGSTAFF and some cost estimates of operating costs.

HOMEPORT/LOGISTICS: Informal contact has been made with Group Woods Hole requesting the advisability of homeporting FLAGSTAFF at that command. It was indicated by the Executive Officer of Woods Hole, after conferring with the Commanding Officer, that at the present time dock space was at premium. However, an unrelated request/recommendation has been sent to the Chief of Staff, First Coast Guard District (CO, Woods Hole ltr 4000 dtd 22 APR 76) asking that either a WPB or bouy tender be transferred to another district location. Affirmative action on this letter would relieve dockside congestion and provide more than ample space for FLAGSTAFF. FLAGSTAFF's "package" includes two necessary floats (camels) to enable her to moor [see para.5.B.10. encl. (3)]. Shore tie at Woods Hole is compatible with FLAGSTAFF electrical system utilizing a transformer that is also included with the package [see para.5.B.6. encl. (3)]. FLAGSTAFF does not have sewage abatement equipment or capabilities for pumping sewage ashore. Contact with LCDR EHRMAN (CGRDC), Project Manager for FLAGSTAFF evaluation, has indicated that facilities to remove sewage dockside could be installed at a minimum cost (less than $1000), and that it could and should be done during the initial dockside availability.

Woods Hole indicated that warehouse space for spare parts is not available at Woods Hole proper, but it was felt that more than adequate space is available at CGAS Cape Cod. Space is available for the two vans that would come with FLAGSTAFF. Berthing and messing is not available. Group Woods Hole personnel are on S&Q; it is felt that FLAGSTAFF would be also. Housing for married personnel may be available at Cape Cod.

PERSONNEL: A message has been sent to CNO requesting that certain key Navy personnel be retained on board FLAGSTAFF during the USN-USCG transition period. Additionally, a memo has been drafted to Chief, Personnel Division delineating the proposed Coast Guard complement for FLAGSTAFF and the proposed qualifications for the personnel involved. There are some personnel, previously assigned to FLAGSTAFF, that have informally indicated assignment to FLAGSTAFF would be desirable. The names of these personnel are included in the memo to G-P.

Personnel assigned to FLAGSTAFF would receive PCS orders directly to the vessel. However, administrative control would rest with Group, Woods Hole and operational control with CCGDONE(o). Group Woods Hole would maintain all personnel service records and CCGDONE would maintain pay records. Group Woods Hole has indicated that they have adequate personnel on board to handle the increased work load. Currently they handle approximately 400 service records and the increase of 18 or more was not felt to be a burden.

ADMINISTRATION/OPCON: Under normal circumstances, operation of FLAGSTAFF would be very similiar to that of a WPB [OPCON of District (o)]. However, because of the unusual nature of FLAGSTAFF, it is envisioned that Headquarters will have a vested and active interest in her scheduling and the types of operations that she is charged with.

At some period during the employment of FLAGSTAFF, she will be deployed to the Seventh Coast Guard District for an extended stay (3-4 mos) in order to establish the feasibility of utilizing hydrofoils as a general law enforcement vessel dealing with the drug traffic problems associated with that operating area.

Encl: (1) FLAGSTAFF Specifications
(2) Grumman Ops Analysis: FLAGSTAFF in Fisheries Law Enforcement
(3) Material Condition of FLAGSTAFF

DEPARTMENT OF TRANSPORTATION

COAST GUARD NEWS

PUBLIC AFFAIRS OFFICE
First Coast Guard District
150 Causeway Street
Boston, MA 02114

Release No.: 272-76
Contact: PA1 Richard S. Griggs
(617) 223-3610

Date: 4 October 1976
Time of Release: General

HYDROFOIL JOINS COAST GUARD FLEET

The U. S. Navy Hydrofoil FLAGSTAFF is now wearing the distinctive Coast Guard stripe and has a new name--the U. S. Coast Guard Cutter FLAGSTAFF.

The Coast Guard received the 73-foot hydrofoil from the Navy on September 30 of this year. She will be homeported at Woods Hole, Massachusetts next March after undergoing engine overhauls and cold weather modifications.

The FLAGSTAFF's usefulness in Coast Guard missions will be evaluated for one year. Special emphasis will be placed on her role in enforcing the new 200 mile fisheries economic zone.

Riding on her foils, the vessel is powered by a Rolls Royce gas turbine engine and is capable of speeds approaching 50 knots. With foils retracted, she is powered by two General Motors diesels and has a maximum speed of eight knots.

Delivered to the Navy in 1968, FLAGSTAFF was deployed to South Viet-Nam after initial testing. She returned to the United States in 1970 and was assigned to the Pacific Fleet. In 1974, FLAGSTAFF underwent two months of testing and evaluation by the U. S. Coast Guard on the West Coast.

(more)

Her tour of duty in the Northeast will enable the Coast Guard to further evaluate the vessel under different conditions.

Hydrofoils use winged surfaces or "foils" to give them lift. Because air is a very light medium, airplanes need relatively large wings to get the lift needed to become airborne. Operating in water, a much denser medium, hydrofoils can be relatively small and still develop enough force to lift the ship out of the water.

DEPARTMENT OF TRANSPORTATION
COAST GUARD NEWS

Public Affairs Office
Eighth Coast Guard District
500 Camp St., Rm 1122
New Orleans, LA 70130

Release No.: Octagon
Date: 15 October 1976
Time of Release: Immediate

Contact: SA Jim Morrison
(504) 522-5917

EIGHTH DISTRICT RCC CONTROLLER TO COMMAND FLAGSTAFF

Lieutenant Terry Hart, now a Rescue Coordination Center Controller in New Orleans, will soon be assuming command of the FLAGSTAFF, a hydrofoil transferred to the Coast Guard from the Navy. The Coast Guard took possesion of the vessel on September 29th in San Diego, California.

The cutter FLAGSTAFF, which is capable of speeds approaching 50 knots, will be assigned to Woods Hole, Massachusetts where she will be utilized in law enforcement, fisheries patrol, and search-and-rescue operations.

Built by the Grumman Corporation in 1968, the FLAGSTAFF saw service in Viet Nam until 1970. The vessel was then assigned to the Amphibious Forces, Pacific Fleet until she was turned over to the Coast Guard.

The hull of the FLAGSTAFF is 73 feet in length, with the overall length of the ship (including struts and foils) measuring 82 feet. When hullborne, the FLAGSTAFF uses two General Motors diesels with water-jet pumps to obtain a speed of 8 knots. When the ship rises on her three foils (two forward and one

- more -

aft), a Rolls Royce gas turbine engine and a supercavitating propeller give her speeds of 45 to 50 knots. The vessel has a beam of 21 feet, 6 inches and displaces 69.5 tons.

Lieutenant Hart graduated from the U.S. Coast Guard Academy in New London, Connecticut in 1970. He then served two years aboard the cutter ESCANABA, which was based in New Bedford, Massachusetts. Hart then took command of the 95-foot cutter CAPE HORN out of Woods Hole until July of 1974. He then came to the Eighth Coast Guard District headquarters in New Orleans, Louisiana, where he has been serving as a controller in the district's Rescue Coordination Center.

Lieutenant Hart, his wife Barbara, and their two children plan to live at Otis Air Force Base, Massachusetts when he takes command of the cutter FLAGSTAFF and its 12-man crew early in 1977.

- USCG -

Lt Boetig CG

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6
UNITED STATES GOVERNMENT

Memorandum

5441

TO : District Commander
Via: District Chief of Staff

DATE: 30 NOV 1976

FROM : Chief, Operations Division

SUBJECT: CGC FLAGSTAFF (WPGH-1) Meeting, 18 November 1976

1. The meeting was held at 0900 on 18 November 1976 in the First District to discuss the acquisition and operation of the hydrofoil FLAGSTAFF. Personnel in attendance are listed in enclosure (1).

2. CAPT Knapp from Commandant, Ocean Operations gave a brief statement on the reasons how the Commandant acquired FLAGSTAFF. It is the intent that the Coast Guard will operate FLAGSTAFF one year, operation to be primarily in the First Coast Guard District. It is the intent that FLAGSTAFF be an additional asset for the First Coast Guard District, similar to the forthcoming additional HU16s, or any other operating facility. With the operation of the FLAGSTAFF in First Coast Guard District waters, and with the proper type of reports, it is expected that the Coast Guard will be able to establish a position with regard to the utilization of high performance hydrofoil craft within the Coast Guard, knowing full well that, if it can operate under adverse weather conditions of the First Coast Guard District, it will be more than adequate in the waters of the Seventh District.

3. It is proposed that the FLAGSTAFF will operate out of Woods Hole, Massachusetts, with operational control vested in the First District. It should be treated as a boat, as it doesn't have habitability and will not support onboard living. Engineering support will be furnished by the District and funding furnished by Headquarters. Due to the operating parameters and short duration of time that the vessel will be out, it is considered best that the primary operational control of the vessel remain with the District. As further operational experience is gained, coordination with the Area will be required in performance of the ELT Mission.

4. The desirability of a sistership being available when the FLAGSTAFF proceeds offshore was discussed. It was decided that no firm policy could be formed on the availability of a sistership because of the many variables to consider. However, it was felt that, because of the inherent nature of the FLAGSTAFF itself and the presence of OFP vessels offshore, this would not pose a problem.

5. Mr. Peter Ehrman talked briefly about his experience when he was the Program Manager during the R&D evaluation of the FLAGSTAFF in the Eleventh District. He likened its operation to the firehouse concept, with the FLAGSTAFF in a BØ condition one would jump on the boat and be able to obtain an honest 40 to 50 knots in very rough seas departing to the scen

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5010-110

He likened it to a helicopter in its rapid response but stated it was much better in that it could sit on its hull when reaching the scene. He further stated the FLAGSTAFF has capabilities and it also has limitations, such as its slow speed when operating on its hull, only has one turbine, is slow returning when it's on a hull mode, requires precise piloting in collision avoidance, is a deep draft vessel, and is not equipped for winter running. He further stated that its speed envelope must be fully understood. The FLAGSTAFF can operate 0 to 8 knots hull borne and possibly up to 12 to 15 knots with the use of the turbine. After that, you can't go 18 or 20 knots but must fly it at 38 or 40 knots. You can't throttle back.

6. The First District stated they contemplated use of the vessel to be mostly offshore. They plan to utilize a WPB and/or a helicopter in conjunction with the FLAGSTAFF when dispatching it on actual missions so that a more actual comparison may be made.

7. Again, the availability of a sistership offshore was brought up. The degree of safety to the FLAGSTAFF was discussed and it was considered to be very minimal in case of a turbine failure offshore because FLAGSTAFF would still have two types of propulsion remaining. It it does require assistance offshore, it will be another SAR case.

8. The capability of the FLAGSTAFF to do law enforcement boarding was discussed. With the FLAGSTAFF having no boat at the present time, it was stated that the District would procure a Zodiac type rubber boat and suitable outboard motor. Work will be coordinated with District Naval Engineering to provide launching and retrieval capability and storage of the boat.

9. Status of the collision avoidance system was discussed at some length. It was brought out that the price of the previous collision avoidance system was $100,000 to open the crates and install, with no reliability guaranteed. Although some type of system is desired, no reasonably cheap and reliable system is known at this time. Commandant (G-EEE) will evaluate suitable avoidance systems or radar and any other suitable system for use.

10. Crew training can be accomplished partly while the boat is undergoing dockside availability. The crew has already attended a two week Gurman school. The District Intelligence and Law Enforcement Branch will provide the training in fisheries and other law enforcement related items. There still remains the requirement to have qualified training for the crew so that they can fly the boat and operate the autopilot, which is the most critical phase of the boat operation. Commandant (G-OOO) will attempt to have one or two of the former Navy crew as instructors when this phase of the training is required.

Subj: CGC FLAGSTAFF (WPGH-1) Meeting, 18 November 1976

11. Headquarters Naval Engineering Personnel were concerned when they heard about placing the boat in Woods Hole, due to its lack of cold weather habitability. It is planned to install electric heaters to improve this situation.

12. The injection of ice and water into the turbine was also voiced as a concern but this was rejected when the design of the turbine air inlet was made known.

13. Due to the FLAGSTAFF being weight critical, the addition of some required equipment was cause for concern. To assist in reduction of weight, it was agreed upon to remove the fresh water evaporator and only operate with the fresh water tank.

14. It was proposed by some that the FLAGSTAFF be given special treatment and not be placed on a standby. It was the First District's contention that the FLAGSTAFF would be treated like any other WPB and would be assigned a regular standby schedule, taking into consideration crew rest, crew liberty, and required maintenance. In view of the FLAGSTAFF being assigned as a District unit, as previously stated, it was felt that this is a District prerogative.

15. Armament for the FLAGSTAFF was discussed, with no commitment made and requires further study.

16. JP5 fueling for the FLAGSTAFF was also discussed and the First District stated that that is their problem for them to resolve and they are working on it.

17. Painting of the vessel was brought up and the pros and cons of a standard white Coast Guard vessel versus an icebreaker orange or red was discussed. Commandant, Ocean Engineering will make and/or obtain the decision on its color.

18. The possibility of installing a strobe light was also discussed.

19. Housing of the crew was brought up and it was decided no problem would arise in this regard.

20. Funding for the FLAGSTAFF was discussed and, although the District has received OG 45 funds, at present no OG 30 funds have been received. Commandant (G-OOO) will provide the necessary budget information to the District. The entire amount of money available for FLAGSTAFF operation was discussed. Although no firm figure was stated, it was pretty much decided that the amount of money that would be made available for FLAGSTAFF operations would be dependent upon how well the FLAGSTAFF worked into Coast Guard operations, the amount of additional money required, and the reason for the requirement.

Subj: CGC FLAGSTAFF (WPGH-1) Meeting, 18 November 1976

21. Enclosure (2) is the First District proposed concept of operations. Enclosure (3) is the agenda items for this meeting.

22. The meeting adjourned at 1130.

T H Carter

T. H. CARTER

Encl: (1) List of Attendees
(2) First District Proposed Concept of Operations
(3) Agenda Items

Copy to:
Each Attendee

CGC FLAGSTAFF

CONCEPT OF OPERATIONS

1. CGC FLAGSTAFF will be assigned Vineyard Sound SAR Patrols (VSSP) concurrently with the regularly assigned vessel. The FLAGSTAFF will be utilized in conjunction with the VSSP vessel whenever it is assigned a mission. Whenever a helo is utilized for a mission utilization of the FLAGSTAFF will also be considered.

2. The purpose of sending the VSSP vessel or helo and FLAGSTAFF on missions is to provide a known response to measure FLAGSTAFF against. The FLAGSTAFF will not be utilized as sole response to any mission involving possible loss of life or property due to her unknown capabilities and reliability at this time. In all SAR cases FLAGSTAFF is assigned to if she arrives on scene first she will carry out the mission, however, the VSSP vessel or helo assigned will remain on scene and be responsible for prosecution of the case in the event of FLAGSTAFF being unable to complete it.

3. FLAGSTAFF will be assigned to perform all Coast Guard missions which will include but not be limited to the following:

a. Offshore oil spill investigations.
b. Search and Rescue cases
c. Contiguous Fisheries Zone patrols (if we remain in ICNAF)
d. Checking buoy positions and emergency correction of outages
e. Offshore fisheries surveillance and identification patrols
f. Gear conflict investigations
g. Parts delivery to offshore vessels
h. Fisheries boardings
i. Boating safety boardings
j. Other maritime law enforcement patrols

4. In the event of special circumstances involving law enforcement operations during FLAGSTAFF's patrol period she will be utilized as a sole response if possible.

5. In all offshore cases where FLAGSTAFF is utilized for Fisheries or other offshore work, she will be utilized for one day patrols in the beginning until her capabilities and crew response is evaluated. She will then be used for two day overnight patrols to determine what her endurance will be for more extended patrols away from home port.

Enclosure (2)

United States Coast Guard . . . .

Since 1790, the U.S. Coast Guard has been serving country and humanity. Established August 4, 1790 by the first Congress, under the sponsorship of Alexander Hamilton, the Revenue Marine, as it was known then, was designed to combat smuggling in the young republic. It now operates as an administration of the U.S. Department of Transportation.

Over the years, the Coast Guard's work has broadened steadily and now is our country's chief agency for promoting maritime safety and maritime law enforcement. Its duties include an intensive merchant marine safety program, maintenance of a network of more than 42,000 navigation aids, search and rescue, oceanographic research, port security, military readiness, environmental protection and the operation of the International Ice Patrol. It has approximately 40,000 officers and enlisted personnel who are assigned around the globe, including the Arctic and Antarctic, the Atlantic and Pacific, the Caribbean and Mediterranean.

The Coast Guard has come a long way since those first small cutters were launched more than 186 years ago. But its spirit is still summed up in its motto

'Semper Paratus — Always Ready'

DEPARTMENT OF TRANSPORTATION

●

UNITED STATES COAST GUARD

COMCGDONE INST P5723.31
8 FEBRUARY 1977

Welcome Aboard

UNITED STATES COAST GUARD CUTTER

FLAGSTAFF (WPGH-1)

CHARACTERISTICS

LENGTH	73 feet
LENGTH OVERALL	82 feet
BEAM	21 feet 6 inches
DRAFT, FOILS RETRACTED	4 feet 4 inches
DRAFT, FOILS EXTENDED	18 feet
DISPLACEMENT	69.5 long tons
DESIGN SPEED, FOILBORNE	45 plus knots
HULL BORNE	8 knots
PROPULSION SYSTEMS:	
Hullborne:	Two General Motors diesels with water-jet pumps.
Foilborne:	Rolls Royce Tyne gas turbine with supercavitating propeller.
CREW	1 Officer 12 Enlisted

About the

FLAGSTAFF

The FLAGSTAFF (WPGH-1) was acquired from the NAVY for further evaluation by the United States Coast Guard. The FLAGSTAFF was first evaluated by the Coast Guard for operations conducted off the Southern California Coast in September 1974. The FLAGSTAFF will now be called upon to operate in the adverse weather conditions off the New England Coast. The Coast Guard's Research and Development Center is further evaluating the usefulness of Hydrofoils in the Coast Guard missions.

Wearing Coast Guard colors and manned by a select Coast Guard crew, the cutter FLAGSTAFF is utilizing its 45-knot cruising speed as she responds to the Coast Guard missions in the areas of Search and Rescue, Enforcement of Laws and Treaties (Customs and Fisheries), Marine Environmental Protection (OIL pollution response), Aids-to Navigation surveys and Port Safety and Security.

The crew of the FLAGSTAFF were picked because of their professional background and training. Unlike any other cutter these men have served aboard, the FLAGSTAFF has an airplane configuration. She is equipped with one steerable foil strut aft and two foils forward, with the forward foils carrying seventy-percent of her weight. She is flown through the water on her foils with a pilot at the controls instead of a helmsman as in a conventional cutter.

CG-4541 (6-67)

DEPARTMENT OF TRANSPORTATION
COAST GUARD
NEWS

PUBLIC AFFAIRS OFFICE
First Coast Guard District
150 Causeway Street
Boston, MA 02114

Release No.: 73-77
Contact: SN Dale R. Gardner
(617) 223-3610

Date: 2 March 1977
Time of Release: General

Hydrofoil joins Coast Guard Fleet

Boston, March 2, 1977-- The Coast Guard Cutter FLAGSTAFF was formally commisioned Tuesday, March 2, 1977 in ceremonies at the U.S. Coast Guard Support Center in Boston. Lieutenant Terrance Hart formally assumed Command of the only hydrofoil in the Coast Guard fleet.

Rear Admiral James P. Stewart, Commander of the First Coast Guard District, was present at the ceremony and remarked upon the FLAGSTAFF's new missions. Among the cutters new jobs, as part of the Coast Guard Fleet, are Law Enforcment duties and Search and Rescue operations. In both of these activities, speed is of the essence, and the FLAGSTAFF is very capable of meeting the requirement. When foilborne, the vessel can reach speeds of up to forty-five knots.

The Coast Guard received the FLAGSTAFF in September of 1976. She will be homeported in Woods Hole, Massachusetts. The vessel will be transferred from Boston to Woods Hole sometime this spring.

The FLAGSTAFF was built in 1968 for the Navy. After initial tests, the vessel was sent to South Vietnam for patrol duty. In 1970, the vessel returned to the United States, where it became part of the Pacific Fleet.

-more-

This is not the first time that the FLAGSTAFF has been part of the Coast Guard Fleet. In 1974, the Coast Guard utilized the craft for two months of testing on the West Coast.

While on duty here, the FLAGSTAFF will be evaluated to determine if a hydrofoil-type vessel is suitable to perform Coast Guard missions in the New England area.

-end-

G-000

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
COMMANDER (o)
FIRST COAST GUARD DISTRICT
150 CAUSEWAY STREET
BOSTON, MASS. 02114
617-223-3635

9094

27 OCT 1977

From: Commander, First Coast Guard District
To: Commandant (G-O)

Subj: CGC FLAGSTAFF (WPGH-1) Evaluation

Ref: (a) Commandant (G-000) ltr 5441 of 2 March 1977
(b) CO, CGC FLAGSTAFF (WPGH-1) ltr to Commandant (G-000) 5320 of 23 May 1977

1. As you know, CGC FLAGSTAFF (WPGH-1) has been beset with an inordinate number of material casualties which have virtually eliminated any meaningful evaluation since she has been assigned to this district. The situation has been exceedingly frustrating to everyone concerned. I must make it absolutely clear, however, that our inability to get more operating time from FLAGSTAFF in no way reflects on her crew. They are dedicated and have made incredible efforts to keep the vessel operating. However, in spite of these efforts, we have been able to manage only 305.2 hours of operating time, including only 71.6 hours of foilborne operations, since arrival of the vessel at Woods Hole on 26 May 1977. I am now convinced that the FLAGSTAFF experiment should be reevaluated and, if it is determined that it should continue, significant changes in the management of the effort should be made.

2. From an operational viewpoint, we can only offer subjective comments at this juncture but I feel they are germane to the reevaluation. FLAGSTAFF does not seem well suited to SAR missions. She is difficult to maneuver when hull borne and she must tow in this mode. It is difficult to launch and retrieve her small boat (i.e., rubber Zodiac type with outboard engine) and she is somewhat handicapped in foil borne operations due to the lack of a collision avoidance system. Except for this last feature, these drawbacks are inherent in this particular hydrofoil and they do not appear correctable. These defects may be correctable in a different design however. On the few occasions we have been able to use FLAGSTAFF on ELT missions, she seems to be a much superior surveillance vehicle to either class of WPBs. Unfortunately, she has not been available for a comparison with an HH-52 helicopter in joint operations with an OLP vessel yet. She has been scheduled several times for such an evaluation, but mechanical problems have forced cancellation on each occasion. Intuitively, it is felt she will be equal to a helicopter and, if a collision avoidance system were provided, she may be superior to a helicopter under certain weather conditions (i.e., reduced visibility). Whether she is a cost effective alternative to a helicopter in these operations is another matter and I am not in a position to comment on this important consideration at this time. This particular hydrofoil is

somewhat limited in certain sea conditions (i.e., seas of six feet or greater), although we have been advised by Grumman informally that some improvements are possible with longer struts. We are also advised that longer struts are available. She also appears to be somewhat limited in endurance, primarily due to crew fatigue, but to a lesser extent also by fuel considerations. However, we have not really had any meaningful evaluation of her endurance because of her mechanical difficulties. We believe she will be useful in offshore oil spill investigations, AtoN support and boating safety missions, although again the inability to keep her operational prevents comparison with more conventional ways of performing these tasks. Finally, her foil configuration makes mooring to conventional docks impossible and the platform arrangement we have had to resort to creates some additional maintenance handicaps for her crew when inport.

3. From an engineering and maintenance aspect, FLAGSTAFF has been a disappointment. The systems aboard are complex, the installations frequently are not in conformance with instruction books and plans and the design of a substantial portion of the vessel makes many routine maintenance activities excessively difficult and incredibly time consuming. There are extensive electrohydraulic and electromechanical systems in FLAGSTAFF which have been particularly susceptible to failure. These systems require maintenance not normally associated with waterborne craft and this has demanded unusual attentiveness on the part of her engineers. In a real sense, FLAGSTAFF is more "airplane than ship" and this has posed difficult challenges, in spite of the fact that a resident representative from Grumman is present. In general component spares are available, although we have not made acceptable progress in inventorying spares which were provided originally. This has somewhat handicapped maintenance but is not considered to be a major factor in maintenance problems to date. Procurement of "consumable" items, particularly those associated with hydraulic systems have introduced some maintenance delays, however. At this time, we are in receipt of $150,000 in OG-45 funds for overhaul of a spare gas turbine. I have directed this fund not be obligated pending referral of the whole question of the evaluation to you.

4. My concern is that we have not made a substantive evaluation of FLAGSTAFF and, in my opinion, if we are to do so, major changes in the effort are needed. Unless we are willing to provide the resources necessary to do this, I do not believe we should proceed further. Specifically, we believe that the following is needed:

a. Installation of a collision avoidance system to allow maximum foil borne operation in restricted and debris infested waters.

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b. Approximately $150,000 in additional funds to repair and/or replace selected systems and components.

c. An additional four (4) man assist team to improve maintenance and logistic support procedures. This assist team was previously requested in reference (b). No answer has been received. Additional support personnel are considered essential if any meaningful evaluation is to be achieved. Informal discussions with Grumman indicate that a formal proposal to provide additional resident consultants at their expense will be made to the corporation's top management. At the same time, Grumman will apparently also consider a proposal to recommend to us a series of modifications to FLAGSTAFF to improve her performance and reliability. I cannot comment on the liklihood of Grumman proceeding with either of these actions and, in any event, do not feel they should delay this reevaluation.

d. Realignment of the existing personnel allowance for FLAGSTAFF. This is considered to be a logical change based on the experience we have gained to date with the vessel. A resume of the proposed realignment is enclosed herewith.

5. We have not made the progress desired in this evaluation and I am convinced we will not unless we are willing to put these additional resources into the effort. Unfortunately, I cannot guarantee success, even if the requested resources are provided. FLAGSTAFF is a difficult vessel to maintain under the best circumstances. I must caution against any notion that a move of the vessel to another location will change this condition. I believe firmly that this district provides a better overall environment upon which to base long term decisions than any other. FLAGSTAFF shows promise, particularly as a surveillance vehicle, but you would be mislead if you were not advised of the risks and costs. If the decision is to continue the evaluation, I urge you to provide the necessary resources. I will be happy to provide any additional information you may need to complete your reevaluation, but I request it be given early attention.

E. L. [illegible]

Encl: (1) Proposed realignment of crew and assist team

Copy to:
Commander, CG Atlantic Area
Commander, CG Group Woods Hole
Commanding Officer, CGC FLAGSTAFF (WPGH-1)

EVALUATION OF THE HYDROFOIL CONCEPT FOR USE IN THE UNITED STATES COAST GUARD AS DETERMINABLE BY THE OPERATION OF USCGC FLAGSTAFF (WPGH-1)

INTERIM REPORT

T. P. HART LT, USCG
COMMANDING OFFICER
USCGC FLAGSTAFF (WPGH-1)
6 FEB 1978

SECTION 1 - OPERATIONS

1.1 GENERAL. Operations using FLAGSTAFF were conducted from 7 July 1977 to date with a concept of utilizing the vessel in as many unplanned operations as possible. Unfortunately, the inability to maintain the vessel in a continuous ready status (due to frequent engineering casualties) reduced the overall positive intent of this concept. FLAGSTAFF's concept of operations was subsequently changed to the utilization of the hydrofoil in independent patrols as much as possible while the vessel was operational. Appendix I is a breakdown of FLAGSTAFF operations by mission categories, and reflect underway, standby, and repair time. Repair time is further quantified as discussed later under engineering.

1.2 SAR.

1. GENERAL. FLAGSTAFF was able to take part in very few SAR cases during the evaluation period. These cases were two evacuations of personnel, and an aborted medivac. The two actual evacuations accomplished were not of an emergent nature. The following dissertation is intuitive in scope based on eight months experience aboard.

2. SEARCHES, INCLUDING ON SCENE COMMANDER. The hydrofoil is potentially an outstanding search vehicle for non-fogbound searches. The ability to respond to the scene quickly, remain on scene for potentially long periods of time, and search a large area in a relatively short period of time makes the vessel highly desirable for searches. Visibility from FLAGSTAFF's bridge is outstanding, with 360 degree visibility and, when foilborne, a height of eye above that of any WPB. In clear (not necessarily calm) weather situations it would not be unreasonable for a hydrofoil to employ five to seven sets of eyes for searching, which places it on a par with a WPB-95, and above a WPB-82, HH3 or HH52.

As an OSC platform, FLAGSTAFF is potentially better than any WPB or helicopter. The installed IC system, which allows for voice radio communications at several positions on the vessel, is identical to that used in aircraft, and further allows for the monitoring of virtually all primary communications required in a search. The bridge arrangement of FLAGSTAFF is less cluttered than a WPB, permitting smooth coordination of search units, while simultaneously allowing FLAGSTAFF to act as an effective search unit. My previous experience as a WPB CO, and as an RCC controller has shown that designating a WPB or helicopter as on scene commander drastically reduces the effectiveness of either unit as a search vehicle.

During poor visibility the hydrofoil is no more effective than any other vessel. Fog preempts foilborne operations due to safety considerations. The installation of a FLIR system (as discussed in section 4) provides potential for a more effective search unit in fog.

3. MEDIVACS AND MEDICOS. Response to scene faster than any other vessel is probably the single factor that would make a hydrofoil a good MEDIVAC vehicle. The major drawback to the hydrofoil as compared with a WPB is the inability to maneuver alongside for a personnel transfer (due to the delicacy of the forward struts). Several variables are involved in an analysis of the hydrofoil versus the WPB as a MEDIVAC unit. The WPB can maneuver alongside any vessel in relatively calm weather. Both vessels would require use of their small boats in approximately a three foot sea.

The best MEDIVAC vehicle the Coast Guard operates is the helicopter. Speed is usually important, and the HH52 and HH3 cruise at better than twice the speed of a hydrofoil, and are both capable of delivering the victim directly to many emergency medical facilities. The hydrofoil can be considered better than the HH52 in some instances due to the restrictions placed on this helicopter for operations. The only time a hydrofoil might be considered a better vehicle than an HH3 would be in heart attack cases, where the aircraft's altitude could aggravate the victims condition.

4. TOWING. The basic design of FLAGSTAFF is not conducive to towing operations. Design modifications for a hydrofoil (as discussed in chapter 3) could make a hydrofoil a good to excellent towing vehicle. FLAGSTAFF's major drawbacks are:

(1) The weight of a 900 foot hawser on a vehicle which is weight critical, and

(2) The need to rig a towing bridal to circumvent the after strut.

(3) Poor hullborne propulsion.

Structural design modifications should be able to overcome these problems. The need for a hawser can easily be designed into the hydrofoil's payload capability. Design placement of a towing hawser that would allow the hawser to clear the after strut would eliminate the need for a towing bridal. Redesign of the hullborne propulsion system as discussed in section 3 would give the vessel sufficient towing power. With these design changes, the hydrofoil could be considered a better towing vehicle than a WPB due to its ability to complete the case faster than a WPB by virtue of the hydrofoils speed to scene.

5. SINKING VESSELS. As in MEDICO cases, speed to scene is important in cases involving sinking vessels. The helicopter has the definite speed advantage once again, but the hydrofoil has distinct advantages over the helicopter. The hydrofoil would take roughly twice as long to reach scene as an HH3 (one third the time as a WPB), but has the capability of remaining on scene much longer, and the ability to place a team aboard the distressed vessel to assist in salvage efforts. The hydrofoil also routinely carries more pumps than the helicopter, and could tow the vessel to safety if required (see section 1, paragraph 4).

6. FIRES AT SEA. The comparative ability of a hydrofoil versus the WPB or the helicopter when responding to a vessel on fire at sea is dependent upon the type of vessel, type of fire, weather, and distance offshore. As with any Coast Guard unit, the hydrofoil could be designed with firefighting capability, and (intuitively) would be a good unit to respond to such an incident, but the variables would be the dictating force behind the type of unit that would be best utilized for each incident.

1.3 ENFORCEMENT OF LAWS AND TREATIES.

1. GENERAL. With the Coast Guard's increased emphasis on its historic role as a law enforcement agency, the need for high speed units for surveillance and intercept has become more pronounced. FLAGSTAFF conducted several law enforcement missions in the fisheries and boating safety fields, and on several occasions (while the vessel was inoperative) was desired for use in drug enforcement missions. The following sections are based on actual experience and intuitive insight.

2. FISHERIES. The hydrofoil is potentially the best general fisheries enforcement unit in the Coast Guard. The hydrofoil, combining speed with the boarding ability of a WPB, provides a unit that is more effective than any in its ability to:

(1) Spot vessels; including the observation of gear in use and provide a complete vessel description.

(2) Cover a large area in a relatively short period of time. And

(3) Make an immediate boarding when violations are observed or suspected.

The hydrofoil can effectively patrol in any sea state that a New England (US) fishing vessel can operate. Although boardings would be subject to sea state, this would be true of any unit. The hydrofoil can also remain on scene for long periods of time simply by securing the turbine and operating the diesel engines.

3. GEAR CONFLICT. The hydrofoil again is a more useful vessel overall than either a helicopter or a conventional vessel. The helicopter can respond to scene faster to identify conflicting parties, but the hydrofoil has the additional capability of conducting boardings, ascertaining facts, gathering evidence, and reporting required data for a more expedient resolution of the conflict.

4. DRUG AND CUSTOMS LAW ENFORCEMENT: The potential advantage of the hydrofoil in law enforcement Re: customs laws is its ability to combine the capabilities of other units. With a standard speed of 45 knots, the hydrofoil can outrun most potential smuggling vessels. The few having greater speed are generally designed with very little cargo carrying capability and/or tend to lose their speed advantage in the slightest sea height. In addition to intercept speed, the hydrofoil is capable of covert surveillance at slow speed, and, upon halting a suspect, is able to dispatch a boarding team. Unlike a helicopter, the hydrofoil presents an armed deterent that can pursue, overtake, halt and board most vessels.

5. BOATING SAFETY. For boating safety patrols, the hydrofoil's only advantage would be the ability to cover large areas in a short amount of time plus conduct boardings. This one advantage could be offset by large concentrations of boats which could preclude foilborne operations due to safety considerations.

1.4 AIDS TO NAVIGATION.

A single aids to navigation mission was conducted by FLAGSTAFF during the evaluation period. The mission was a simple delivery of parts and was conducted in conjunction with engineering tests. Hydrofoils are no more suited for ATON missions that WPBs. The single advantage to the use of hydrofoils in this mission area would be the determination as to whether an aid is on station, when the data is needed quickly. The hull configuration is generally not suited for working aids, although a "hot pack" might possibly be performed in an emergency situation. ATON logistics runs are possible, but the payload might be less than desired due to weight considerations.

1.5 PORT SAFETY/SECURITY.

Hydrofoil usage in a port safety or port security function would be severly limited due to the generally confined waters in which such operations are conducted. The speed available would be advantageous in isolated incidents and locations. One probable location a hydrofoil could be useful would be in the Eighth Coast Guard District on the Mississippi River, where river accidents/incidents frequently require quick response from a WPB to proceed moderate distances to scene as a traffic control vessel.

1.6 MARINE ENVIRONMENTAL PROTECTION.

In an MEP mission area the hydrofoil would be useful in isolated incidents only. The advantage of the hydrofoil would be in its ability to respond to an open ocean spill, obtain samples, and return them for processing and analysis quickly. It could also be used to intercept suspected offenders. Due to weight considerations, the vessel would not be able to usefully transport an ADAPTS system, and transport of other required cleanup materials would be limited by amount and weight.

SECTION 2 - OPERATIONAL LIMITING FACTORS

2.1 GENERAL. The previous section outlined the theoretical and actual capabilities of a hydrofoil in specific mission areas. During the evaluation of FLAGSTAFF, several factors have surfaced that tend to limit the vessels usage in some mission areas. This section tends to point toward the negative side of hydrofoil, with constructive comments on the ability to "design out" any of these negative factors.

2.2 WEATHER FACTORS

1. GENERAL. While operating FLAGSTAFF some data relative to performance in varied weather conditions has been obtained. As with all vessels, the most enjoyable periods of operation were during calm, warm weather, but FLAGSTAFF proved capable of operating in rough weather. Grumman has indicated they believe the longer struts available would increase the vessel's sea keeping capabilities. These struts should be installed in the near future to allow for comparison testing.

2. LOW VISIBILITY. Operation of a high speed vessel in night time or fog conditions is an extremely dangerous situation. Even with an excellent radar, target acquisition is virtually non-existant for such low-lying hazards as logs, whales, etc. The installation of a FLIR (as discussed in section 4) may be able to increase safety in nighttime foilborne operations.

The primary disadvantage to working in foggy conditions is the necessity to return to the hullborne mode. When in fog and restricted waters, I was more comfortable with the turbine on the line until the vessel cleared all restricted waters. The thrust from the turbine tended to negate the excessive set and drift that is often encountered under diesel engine power, due to FLAGSTAFF's diesel propulsion system design. This need to overcome set and drift by using the turbine has two immediate drawbacks - the inability to reverse the propellor to stop the vessel quickly, and a much higher fuel consumption, which drastically reduces cruising range if required for long periods of time. Fuel consumption information is available in appendix II. The inability to satisfactorily overcome set and drift under diesel waterjet propulsion could be easily remedied by a design change using twin Schottel drive units in lieu of the waterjet system for hullborne propulsion. This is discussed further in section 3.

3. COLD WEATHER OPERATIONS. FLAGSTAFF has been unable to collect a full range of cold weather data due to engineering casualties. One day of foilborne operations during icing conditions has allowed some intuitive insight into future cold weather operations. During that day FLAGSTAFF experienced "slush icing" on forward structures and all lifelines during takeoff, and some slush icing on the exterior of the hull during foilborne operations. The slush ice did not accumulate more than three-quarters of an inch thick,

and fell off the hull immediately upon landing. It is believed that one of the major reasons ice could not build up on the hull is the lack of interior insulation, allowing a large amount of through-hull heat loss. It is not believed that icing will be a dangerous factor during actual foilborne operations, but during initial takeoff into rough seas, ice accumulation could be a hazard. Once foilborne, only a small amount of spray is taken on the main deck (aft of the deck house). On a hydrofoil with proper insulation, should ice accumulate on the hull exterior, it would merely increase weight factors to the point of overcoming turbine thrust, and land the boat safely. In the event that future rough weather foilborne operations cause an icing problem topside, it is believed that the computer would be able to maintain platform stability, but the probable detrimental factor would once again be excessive weight causing the boat to land. Once hullborne, the struts give the vessel draft characteristics of a deep draft vessel. To date no turbine air inlet icing has been experienced. Inlet icing is not anticipated in calm weather foilborne operations, but turbine inlet icing is plausible during takeoffs and while foilborne in rough seas.

4. HIGH WINDS AND SEAS. Winds specifically have no isolated adverse affects on a hydrofoil with the exception of the increase in wind/chill factors experienced by any topside personnel and movement of personnel on deck. FLAGSTAFF has been able to maintain foilborne attitude in 12 foot seas, and was capable of operating in a 15 Foot sea until a secondary swell in a confused pattern forced a landing. Further data is necessary to obtain accurate, complete, and consistant results concerning FLAGSTAFF's sea keeping capabilities. To date, much of the data has been inconsistant due to casualties, improper performance of varied inter-related systems, and a lack of sufficient rough weather underway time.

2.3 CREW CONSIDERATIONS

1. GENERAL. The single most evident limiting factor for extended operation of FLAGSTAFF is crew considerations. A combination of underway fatigue factors, lack of habitability, and manning requirements place a large strain on personnel aboard. This section will attempt to explain those factors.

2. FATIGUE. The factors causing abnormal fatigue aboard FLAGSTAFF are as follows:

(1) High vibrations caused by high speed

(2) Attentiveness to instruments required for the pilot and engineer

(3) Attentiveness to the vessel's positioning and situation required of the Conning Officer, pilot, and navigator

(4) Constant "holding on" to compensate for possible erratic operation

(5) A seven to eight man watch is required during foilborne operations in restricted waters or at night.

(6) High total volume of noise from installed equipment.

The combination of these fatiguing factors tend to make continuous foilborne operations for more than 8 hours (approximately) in rough weather hazardous due to excessive fatigue. These factors are reduced somewhat as weather factors improve, or if the vessel has extended periods of hullborne time.

3. HABITABILITY. FLAGSTAFF's design, in so far as creature comforts are concerned, is not conducive to a good working or living atmosphere. Galley and mess deck spaces are cramped, poorly equipped, and add nothing to the reduction of crew fatigue factors. Provisions for messing consist of a single microwave oven, refrigerator, and some recently purchased electrical cooking appliances. Hot meals must be provided and prepared by the individual, since no provisions have been made for a dedicated cook aboard, nor is equipment adequate for preparing meals on a large scale. Berthing areas are cramped, crowded and have many obstructions alongside bunks that tend to disallow relaxation underway for offwatch personnel. All interior traffic flow on the unit passes through the bridge, and no provisions were made for onboard office or engineering work spaces.

Sanitary facilities are available aboard, however, no waste disposal holding tank has been installed. Fresh water is limited to the 110 gallon holding tank, and the fresh water producing system was removed due to extreme inefficiency.

Habitability systems could be designed into a hydrofoil as recommended in section 5, however, it must be remembered that a hydrofoil is "weight critical" and some habitability features may have to be less than desired out of necessity.

In its present state, FLAGSTAFF's lack of creature comforts tends to be counter-productive to increased operating time and crew initiative by removing a basic foundation block from the "Hierarchy of Needs" as purported in the theory of A. H. Maslow.

2.4 DESIGN CONSTRAINTS

1. GENERAL. By virtue of its specialized design, a hydrofoil has "built-in" limiting factors that tend to reduce some capabilities automatically. These factors are many, varied, and somewhat complex, but can be condensed into two major catagories, weight and configuration.

2. CONFIGURATION. Hydrofoil configurations are basically two primary types, Canard and airplane, of which FLAGSTAFF is the latter. Airplane configuration in general terms means two struts forward, one strut aft, with 70% of the effective vessel payload being supported by the forward struts. The Canard design is generally the reverse (one strut forward and two aft) with the preponderance of the weight supported by the after struts. The U. S. NAVY has opted for the Canard design in its PEGASUS class hydrofoil program, and different manufacturers lean toward different designs; Boeing favors the Canard, while Grumman favors the airplane configuration. Each has advantages and disadvantages, and any hydrofoil program in the Coast Guard would have to select a design based on these factors.

The Canard design major advantages appear to be:

(1) Lack of protrusions laterally from the molded hull.

(2) Symmetrical broaches when they occur.

(3) Slightly greater foilborne maneuverability.

The advantages of the airplane configuration are:

(1) Comparative ease of strut maintenance.

(2) A single main propulsion turbine is required, thereby reducing turbine maintenance time.

(3) Reduced safety hazards in the event a strut is sheared.

The "advantages/disadvantages" argument will be a continuing source of discussion within the hydrofoil industry, and proponents of each design have been attempting to eliminate any disadvantages to their proposed vessels. Installation of an anti-broach system (as installed aboard FLAGSTAFF) appears to de-emphasize the broach argument. The forward retraction of the single forward strut of the USS PAGASUS has allowed somewhat easier maintenance than that required aboard USS HIGHPOINT, where divers were required to perform maintenance under water.

3. MAIN PROPULSION SYSTEMS. Proponents of the Canard design, in order to reduce maintenance, have succeeded in developing a turbine powered waterjet propulsion system wherein it is purported that a single turbine can develop sufficient power to allow the vessel to remain foilborne should one turbine become inoperative. This is accomplished by splitting the water flow developed by one turbine through both after struts. The advantages of a waterjet system are twofold, lack of reduction gears, transmission gears, and controllable pitch propeller systems that would require maintenance and monitoring, and a reduction in weight caused by these systems. It is rumored, hoever, that the waterjet system has its own problems, of which the inability to attain or sustain speeds reached by FLAGSTAFF is one primary difficulty. Other problems are the required maintenance of two turbines and waterjet pump casualties. The controlable pitch propeller system aboard FLAGSTAFF has been fairly reliable, but reduction gears and in-strut gear boxes have been a source of consternation. Required attached systems for lubrication of gear box sensing equipment have been sources of down time for repairs.

4. WEIGHT. A constant requirement is placed upon the crew of hydrofoils (of all designs) for reduction of introduced weight aboard. Hydrofoils are generally designed in such a way that only a small reserve is allowed for addition of weight over designed loads. This generally means that the boat outfit must be maintained at a minimum, large excesses of personnel are not allowed (nor generally desired), on board spare parts must be kept to a minimum, and any factor that might in fluence vessel weight must be closely watched.

Operations aboard FLAGSTAFF have been jeopardized at different times by added weight caused by:

(1) introduction of a full load of fuel, then attempting to "take off" in rough seas.

(2) Broken salt water lines adding weight to the bilge area.

(3) Ice build up.

(4) Excessive personnel aboard.

Excessive weight is predominatly a factor only in the "take-off" of the vessel, since maximum thrust is applied at take-off, and a lengthy time to become foilborne (caused by excess weight) tends to over-temp critical engineering machinery. Once foilborne, problems are rarely encountered since weight is being reduced by fuel consumption at a rate of 1600 pounds per hour. Weight could be added, however, due to items (2) or (3) above.

The reason emphasis is placed on the weight aspect of hydrofoil operations is to remind all involved that any introduction of weight over designed structural weight must be compensated for by a corresponding reduction in weight in order to operate. Since very little reduction can be accomplished structurally, the item generally reduced is fuel, which brings about a corresponding reduction of endurance.

2.5 MAINTENANCE.

1. GENERAL. Consistant with all vessels, a certain amount of maintenance must be performed on a regular basis to insure reliability of operations. Much of the data for this section should be solicited from Grumman, since they have historical data relative to require major parts replacement. Routine day-to-day maintenance in general will be addressed in this section. The SINGLE MOST CRITICAL FACTOR that must be remembered in the entireanalysis process relative to the possible acquisition of hydrofoils for the Coast Guard is that A HYDROFOIL IS A HIGH PERFORMANCE VESSEL. ANY HIGH PERFORMANCE VEHICLE, BE IT AUTOMOBILE, AIRCRAFT, OR VESSEL REQUIRES MORE CONTINUING MAINTENANCE THAN ITS CONVENTIONAL COUNTERPART.

2. TURBINE MAINTENANCE. Periodic routine maintenance of the turbine is generally limited in scope to maintaining a clean plant. This requires water washes for every 10 hours of operating time, and kerosene soak washes for every 50 hours of operating time. Fuel and lubricating systems must also insure the introduction of clean fluids, therefore three in-line fuel filters must be changed approximately every 20 turbine operating hours, and 6 lube oil filters must be changed every 50 operating hours. The total time for turbine maintenance averages approximately 10 hours every 5 operating days.

3. DEISEL ENGINE MAINTENANCE. The hullborne propulsion plant is a fairly standard diesel engine (GM 6V53) with modifications requiring no more maintenance than any other diesel plant the Coast Guard has aboard vessels. Maintenance hours for the deisel engines average 6 hours per week, and include the standard lube oil analysis program.

4. SUBSYSTEMS MAINTENANCE. Most of the vessel subsystems require maintenance on an as needed basis, or, if casualties arise. Included here will be subsystems that could be improved upon in future hydrofoil designs. Among them are:

(1) Low battery capacity; the lead acid batteries have about a six month service life due to frequent charge and discharge. Nickel-Cadmium (NICAD) batteries would be far more practical, and, in the long run, more economical.

(2) Foilborne transmission cooler failures have been a continuous problem and resulted in many hours of work and down time. The units (of all aluminum construction) corrode quickly due to the thin materials used in construction. A recent design change to correct this problem was incorporated, but did not work.

(3) Lack of an auxiliary hydraulic system for dockside testing of foilborne systems has precluded the implementation of a good planned maintenance system for the hydraulics, and has resulted in lost time and missions due to casualties. Present testing of the system requires that the turbine be running, and any casualty related to the turbine propulsion system precludes such testing.

(4) The fire and bilge pumps originally installed aboard FLAGSTAFF were marginal at best, and troublesome. A "jury rigged" clutch being run off the main deisels caused many maintenance problems. Emergency bilge and fire pumps run by electricity would be far more efficient.

(5) FLAGSTAFF's installed window wipers are aircraft type, perform no better than marine types, are much noisier (which adds to the already high vessel noise level), and parts are non-existant. A marine wiper would be less expensive and more easily repaired.

5. HULL AND STRUT MAINTENANCE. In comparison to most conventional vessels, hull maintenance aboard a hydrofoil is less time consuming. The reduction in maintenance is due to structural considerations, but is founded in the need to maintain weight at a minimum. Standard practice aboard most Coast Guard WPB's is to paint the hull twice a year, and clean and touch up paint as required. This practice maintains WPB's in a very clean appearing state, and assists in the development of pride in a crew's "good looking" unit. Unfortunately, a single coat of paint will add undesireable weight to a hydrofoil. Hull maintenance is reduced to yard period removal of old paint and reapplication of the desired thickness of new coats, and the periodic cleaning of dirt and spot touch-up of bare metal.

Time consuming structural maintenance aboard a hydrofoil is concentrated on maintaining the hydro-dynamic qualities of three struts and foils. Excessive time is required aboard FLAGSTAFF to apply the required epoxy dent repair system, allow it to cure, sand and finish to original design, and apply a protective coating of paint over the repair. Dents, knicks, and gouges occur aboard FLAGSTAFF with alarming frequency due to small objects in the water, and cavitation at high speeds. The need for continuous downtime for strut repair could be greatly diminished in a new hydrofoil by insuring the use of all welded construction in lieu of the presently used fastener and riveted struts. After ten years the fasteners are sources of trouble because:

(1) They tend to loosen, thereby causing stress bulges, eventual chipping and pitting, and loss of hydro-dynamic qualities.

(2) By nature of the design, a large amount of filler must be applied to smooth out all areas. This filler is much more susceptible to cracking, pitting, and dents than would be molded steel.

(3) Corrosion of the original steel fastners has led to failure and or the inability to remove them for repairs. Replacement with stainless steel fasteners at this time would be cost prohibitive.

2.6 ENDURANCE AND FUEL CONSUMPTION

As with all vessels, a hydrofoil's endurance is based on fuel carried and consumption rates. Unlike conventional vessels, fuel carried becomes more a function of total vessel weight than storage space. Foilborne consumption aboard FLAGSTAFF is approximately 235 gallons per hour, with normal present fuel capacity in the vicinity of 2800 gallons. Rated maximim pressed fuel capacity for FLAGSTAFF is 3800 gallons, while design rated nominal fuel capacity for foilborne operations is 3300 gallons.

Careful design considerations for future hydrofoils can always insure that the vessel can carry maximim fuel allowed, and still be able to get foilborne immediately. This would require a reasonable difference between maximum full load weight allowed by design, and actual maximum weight at which point the turbine cannot overcome drag to provide foilborne status. Should periodic weight changes over the life of the vessel occur, endurance should not be affected.

Appendix II shows FLAGSTAFF fuel consumption information, and can be utilized as desired to figure economical crusing under different scenarios (i.e. total foilborne operations, combined foilborne/hullborne on turbine or diesels, etc). A loss of endurance will definitely result under any condition where it is deemed necessary to use the turbine while hullborne.

2.7 SAFETY. Advances in technology today have increased the safety aspect of high speed vessel operations. Unfortunately, very few of these advances are available aboard FLAGSTAFF. Many safety items should be planned for any future Coast Guard hydrofoils, and include anti-broach systems (see article 4.2) and safe navagation systems (article 4.3 and 4.4). The personnel error factor in safety of hydrofoil operations cannot be fully designed out of a system and the need for total alertness on the part of the crewmembers can never be understated. Safe navagational practices are charged to the conning officer and the navigator. Safety of individuals topside while foilborne is of paramount importance, and has been enhanced by the required use of lifejackets, the "buddysystem", and the use of the lookout watchstander as more of a safety watch on topside personnel than a lookout per se. Some safety factors could be structurally designed into a new hydrofoil by the introduction of a weatherproof shield or booth for the lookout, and the limiting of main deck "trip" hazards. The alertness required of personnel does increase fatigue, which is why habitability becomes an important design criteria.

SECTION 3-ENGINEERING SYSTEMS

3.1 GENERAL. No attempt will be made in this section to fully analuze all engineering systems for a hydrofoil. Much of the engineering analysis has been accomplished by the Coast Guard Research and Development Team that operated FLAGSTAFF and HIGHPOINT during 1974-1975. Results of these tests can be found in:

(1) Operational Evaluation of the Hydrofoil Concept for U.S. Coast Guard Missions, Phase II Report of Additional Operations with USCGC FLAGSTAFF (WPBH-1). (Report No. CG-D-149-75).

(2) Operational Evaluation of the Hydrofoil Concept for U.S. Coast Guard Missions, Phase II Report of Additional Operations with USCGC FLAGSTAFF (WPBH-1). (Report No. CG-D-191-75).

(3) Operational Evaluation of the Hydrofoil Concept for U.S. Coast Guard Missions, Report of Operations with USCGC HIGHPOINT (WMEH-1). (LMSC Report No. D458145).

(4) Operational Evaluations of the Hydrofoil Concept for U.S. Coast Guard Missions-Executive Summary. (Report No. CG-D-14-76).

The need to include engineering systems in this report is to allow an overview of all aspects of hydrofoil systems as they pertain to the operational analysis.

3.2 TURBINE/FOILBORNE PROPULSION. FLAGSTAFF's turbine is a Rolls Royce Tyne Marine 621/10 capable of a maximum operational power of 3600 shaft horsepower at 14,500 low pressure shaft RPM at sea level conditions with an ambient air temperature of 80F. Problems with the Tyne turbine have been incurred:

(1) Due to limited quantities of the engine. At the present time only two of these turbines are available, and one of those two is installed in FLAGSTAFF.

(2) No test stand exists for this engine, thereby requiring all adjustments and tuning to be made in place aboard the unit.

(3) Spare attached parts are scarce for the turbine, available only through Rolls Royce of Montreal, and no contractual arrangements with Canadian or U.S. Customs has been made to insure ease and speed of shipping parts.

(4) Performance and maintenance manuals are generally incomplete, inaccurate, or out of date.

FLAGSTAFF's foilborne propulsion systems that are coupled to the turbine (via reduction gears) are a hull mounted gear box, upper bevel gear box in the after strut, lower bevel gear box in the after strut, and planetary gear box in the pod. These are linked to a Kamewa 3 bladed; 45 inch diameter controllable pitch propeller. Difficulties experienced with this portion of the main propulsion system have been:

(1) Lack of readily procurable spare parts.

(2) High cost of spare parts due to uniqueness of equipment.

(3) Lack of accessibility to any part of the system contained within the after strut.

(4) Lack of a fully suitable platform for working on the after strut.

(5) Difficulty with hydraulic hose connections from the transom to the after strut.

Most of the difficulties experienced with the items listed in this section could be overcome in a new hydrofoil by:

(1) Contractual assurances of spare parts availability at reasonable cost.

(2) A standard production turbine with an available test stand.

(3) Use of solvent firms for all parts manufacture to insure future availability.

(4) Purchase of a stock of centrally located spare parts.

(5) Use of U.S. manufacturers, or foreign manufacturers with U.S. representatives readily available.

(6) Use of readily purchased "off shelf" auxiliary equipment.

3.3 DIESELS/HULLBORNE PROPULSION. FLAGSTAFF has two Detroit 6V53 GM aluminum block diesel engines for hullborne power coupled through reduction gears to twin waterjets. As in any waterjet system, propulsion efficiency is greatly lost aboard FLAGSTAFF when traveling hullborne. Although design rated at 8 knots, the installed system has never developed much over 7 knots, and was producing only 3 knots when received from the Navy.

The diesel engines themselves have been of no real trouble to FLAGSTAFF. The hullborne waterjet system lacks efficiency and power, thereby greatly reducing maneuverability and reasonable speed in virtually any sea state. For Coast Guard use, extended hullborne range, efficiency, maneuverability, and power for towing would be better available using a twin Schottel-drive system for hullborne propulsion. This would greatly enhance the mission capabilities of a hydrofoil, especially if design constraints would allow hullborne speeds of 12-15 knots. The 12-15 knot speed would be especially useful in the Coast Guard mission of towing as discussed in section 1.

3.4 HYDRAULICS. The installed hydraulic systems aboard FLAGSTAFF combine aluminum hardlines, aeroquip hoses, and flexible lines for operation of the foils and struts. Hydraulic pressure of 3000 PSI is available via pumps off the diesels for the raising of struts, and a separate 3000 PSI system is driven off the turbine for foilborne operations of hydraulic actuators to the foils and steering.

Virtually all the hydraulic problems aboard FLAGSTAFF can be attributed to:

(1) Age of the vessel.

(2) Poor installation practices allowed by Grumman and the Navy of a sub-contractor (for example - mixing aluminum lines with steel fittings).

(3) Improper repair practices by Navy crews.

(4) Lack of preventive maintenance by Navy crews.

(5) Poor location of lines, accessories, etc.

3.5 ELECTRICAL SYSTEMS. Main electrical power is provided aboard FLAGSTAFF by two 50kw GM 453 generators with no parallel capability. Full electrical heaters are energized to allow for a relative degree of comfort aboard the unit. Difficulties with the generators themselves are rare with the exception of the requirement for continuous replacement of raw water impellors and shafts caused by high raw water pressure resulting from high foilborne speeds.

The vessel also has a 400 cycle MG set for power to the engineers control panel sensing equipment and other electronic equipment.

The major difficulty with the unit's electrical system is the 3 phase delta, 120 volt wiring system, which is unique enough to cause parts replacement or repair of electrical equipment to be more expensive and require more time for procurement or repair of electrical equipment to be more expensive and require more time for procurement or repair. Future hydrofoils should use a more standard electrical arrangement, and insure that the designed main switch board allows for both parallel and split plant operation.

3.6 STRUTS AND FOILS/ELECTRO-MECHANICAL. The lowering of all struts is accomplished by the release of manual and hydraulic uplocks, and gravity lowering. Hydraulic downlocks are used to hold the struts in the down position, The foils react by:

(1) An electronic analysis from the computer of input information (see section 4).

(2) An electrical impulse from the computer to the servo valve.

(3) A mechanical signal from the servo to the hydraulic actuator.

(4) A hydraulically activated mechanical impulse rod to the foils.

Problems have been encountered in this system due to:

(1) Failure of servos due to salt water corrosion shorting leads.

(2) Failure of servo actuators requiring replacement.

(3) Breakage of actuator yokes due to fatique.

(4) Parts procurement of needed items due to uniqueness.

(5) Spare parts procurement due to contractual difficulties.

(6) Mis-alignment of downlock plates due to breakage of yokes causing an inordinate stress.

(7) Long repair time required to open up strut access plates (100+ bolts), and reseal including curing time of sealant.

Most of the down time due to the above problems can be overcome through more standard parts, readily available spares, periodic (yard) scheduled inspection, repair or replacement of worn parts, and designed access plates with much fewer bolts. Additionally, problems have been encountered due to crimping of through-hull hoses leading to the after strut. This could be alleviated by design modifications or hoses equipped with high pressure swivel fittings.

3.7 MONITORING/SENSING EQUIPMENT. Monitoring and/or sensing equipment is provided for most of the engineering systems aboard with additional equipment available for fire and bilge flooding detection.

The engineering equipment monitoring system should have more remote instrumentation for measuring pressure and temperatures. This would include more pressure gauges in various systems and individual gauges for temperature monitoring. With the use of these extra gauges, troubleshooting problems would become easier and much quicker, and documentation over a period of time would lead to better historical knowledge and a faster diagnosis and repair of casualties.

3.8 STEERING SYSTEMS. Hullborne steering is accomplished via manually (Cable) controlled directional buckets that divert the waterjet flow to provide directional control of the vessel. Difficulties in this system have been:

(1) Incorrect bucket adjustments caused by ballbearing migration resulting in a loss in reversing efficiency.

(2) Slippage of the steering wheel drive belt.

(3) Replacement of the steering wheel drive belt.

(4) Operator fatigue due to the amount of exertion necessary to make even small steering compensations.

The problems encountered could well be overcome in a new hydrofoil by use of a coordinated hydraulic steering system. With a change in hullborne steering, and the recommended change in hullborne propulsion, a hydrofoil would be much maneuverable on the hull.

Foilborne steering is accomplished using the same steering wheel, which activates a sending unit to the 3000 PSI hydraulic system, allowing the aft strut to move approximately three degrees either side of amidships. Problems with this system have been few and limited to a change out of the sending unit and air in the hydraulic lines resulting in a partial loss of steering.

The foilborne steering system is basically a sound system, but requires vigilance in insuring air is not allowed in the hydraulic lines, and, if found, is purged immediately.

3.9 FUELING SYSTEMS. Fuel used aboard FLAGSTAFF is JP-5 for the turbine, generators, and diesel engines. The use of a common fuel for all systems is a good concept, and should be continued in future hydrofoil designs. The fuel system aboard FLAGSTAFF is basically very good, and only minor problems have been encountered with pumps. Maintenance and replacement of fuel filters is a constant task due to the need for clean fuel, and requires approximately 4 manhours of work every 20 turbine operating hours.

The only major difficulty that has been encountered with fuel is the lack of sources of supply of JP-5. It is my understanding that this problem exists almost exclusively in New England. It is recommended that future hydrofoils use turbines that can operate on diesel fuel, since diesel fuel acquisition and storage is more common in the Coast Guard.

SECTION 4 - ELECTRONIC SYSTEMS

4.1 GENERAL. FLAGSTAFF's electronics suite was almost exclusively aircraft equipment when the vessel was received from the Navy. Conversion of some of this equipment to Coast Guard electronics items was accomplished, would be planned into any future hydrofoils, and therefore requires very little amplification in this section. Generally speaking the hydrofoil electronics suite can be divided into four main areas: autopilot, communications (interior and exterior), navigation, and anti-collision.

4.2 AUTOPILOT/COMPUTER. The autopilot system can be divided into three sections, input sensors, computer, and output power servos. The sensors, which consist of rate gyros, accelerometers, verticle gyros, and height sensors (sonic and radar), supply stabilization information by measuring height, roll, pitch, and yaw while foilborne. Sensor information is sent to the computer where it is analized and compared. The computer then sends command signals to the power servo units (which activate the foils) to maintain the incidence attitude of the boat.

To date, no failures have occurred in the sensing units, and only minor problems have arisen with the computer. Major problems have been encountered with the servo actuator units, namely salt water corrosion of servo leads and servo valve failure. Problems in these two areas have caused long down times due to parts procurement, and difficulty in access to the servo unit as mentioned in section 3.

The final section of the autopilot system is a broach recovery system which utilizes water pressure sensitive switches in the forward struts to indicate if the forward struts are "flying out" of the water. The lack of water pressure sends information to the computer which signals the forward foils to "dive". This system is extremely effective and a must for any future hydrofoil with an airplane configuration.

Overall, the autopilot system is a very good system, and advanced models are available updating the installed system aboard FLAGSTAFF. Difficult with the system once again relate to the "one of a kind" status, making spare parts unavailable, and overhaul of parts very expensive. In a new hydrofoil, the availability of sufficient, reasonable priced spares should be a contract item.

4.2 COMMUNICATIONS. FLAGSTAFF's external communications equipment consists of UHF, HF, MF and VHF-FM units. Any external communications equipment compatible with Coast Guard mission requirements that can be patched into the vessels internal communications system can be used aboard a hydrofoil.

FLAGSTAFF's internal communications (IC) system consists of eleven LS-540/SIC units connected by shipboard wiring. These units are basically the same as utilized in Coast Guard aircraft, contain primary and secondary IC channels, and can have three external remote radios patched into the system. The overall system is relatively maintenance free with the exception of headset repair and replacement, and is a must aboard hydrofoils due to:

(1) Constant interior communications requirements to maintain operations and keep all hands informed of those operations.

(2) Amplification of voice is required to overcome noise levels.

(3) The need for external communications at three different internal positions to overcome excessive personnel movements and confusion.

Sound powered phone circuits should be installed as a back-up emergency system. Another major advantage of the installed IC system is that it presently contains four loudspeakers, which allow this single unit to replace the need for a seperate PA system aboard.

4.3 NAVIGATION. Six pieces of navigational equipment are presently installed aboard FLAGSTAFF, Loran C, radar, gyro compass, magnetic compass, fathometer, and ADF. When one compares safe navigation of a hydrofoil with that of a helicopter or a conventional vessel, the need for more advanced equipment becomes apparent.

A helicopter's basic "safe navigation" is in actuality collision avoidance, and pertains more to avoiding other aircraft than fixed structures unless the helicopter's installed collision avoidance equipment is supplemented by an air traffic controller who assists in traffic separation.

Aboard a conventional Coast Guard Cutter, safe navigation is two fold; clearing subsurface obstructions, and avoidance of surface contacts. The conventional vessel's collision avoidance, although important, is relatively easy due to relative speeds encountered.

Aboard a hydrofoil, high speed collision avoidance combined with safe navigation around subsurface obstructions requires more continuous attention to the positioning of the unit than that required of a helicopter or a conventional vessel.

Any type of advanced navigational equipment, such as a real time display system, that will increase navigational safety and reliability should be utilized.

4.4 COLLISION AVOIDANCE. As discussed in the previous section, collision avoidance is directly related to navigational systems aboard a hydrofoil. Aboard FLAGSTAFF, no collision avoidance system per se is installed, which relegates collision avoidance to use of radar and visual avoidance including the use of stabilized optics. Stabilized optics are required aboard any hydrofoil due to high speed "shakes" which make conventional optical devices useless while foilborne. These stabilized optics make acquistion and identification of contacts possible during daylight within reasonable maneuvering time constraints.

Placement of a collision avoidance system (as now available through commercial sources) aboard FLAGSTAFF would be useful, but in no way all inclusive for operational needs. Collision avoidance systems are only as good as the radar they are linked to, but generally give a reasonable picture of how to avoid other vessels. A good and prudent sailor has no absolute need for such a system, since he will take early action to avoid placing his vessel in extremis. The usefullness of these systems is in relieving this same sailor of the need for quick thinking in night time or low visibility situations where the targets actual movements are not easily discernable. It basically removes a degree of human error from good seamanship. The speed of a hydrofoil is itself a useful tool in collision avoidance, providing action is initiated early enough.

The portion of navigation that is the most hazardous to the hydrofoil sailor, and cannot be improved by a radar related collision avoidance system, is the nighttime or low visibility avoidance of small, low lying hazards that are not picked up on radar. These generally are considered to be "deadheads" (logs, etc), very small wooden craft, and marine mammals. The single item of equipment that may be able to reduce or eliminate these hazards is a forward looking infra red (FLIR) device, properly focused at a reasonable distance ahead of the vessel, and trainable when necessary. This would provide acquisition and identification of hazards in sufficient time to take avoiding action. FLIR devices are becoming more available through commercial sources, and attempts are being made to procure, test, and evaluate one such device aboard FLAGSTAFF.

In order to insure safe navigation and collision avoidance aboard any future hydrofoils, a real time navigational device and a FLIR should be planned into the electronics suite.

SECTION 5 - GENERAL DESIGN RECOMMENDATIONS

5.1 GENERAL. The process for designing a Coast Guard hydrofoil is a function of mission requirements, desired capability, and current rules and regulations. The following recommendations are in addition to all previously mentioned, and not found aboard FLAGSTAFF.

5.2 BOAT HANDLING EQUIPMENT. Future hydrofoils will almost certainly carry a light weight small boat such as the rubber Bonair III presently aboard FLAGSTAFF. Topside design, however, should include a boat boom or fish davit type arrangement that would allow the small boat outfit to be completely attached on deck and the entire unit lowered into the water. Without such equipment, FLAGSTAFF personnel must toss over the rubber boat (which requires lifting the 200 pound boat 4 feet to clear lifelines), have one man lay into the boat, then lower and attach all related equipment such as the outboard, gas tank, etc. This process is both time consuming and dangerous.

5.3 ARMAMENT. Armament requirements will be a direct function of mission requirements, but it must be remembered that any weapon placed aboard requires repair equipment, spare parts, stowage space, and ammunition to be useable. All this equipment adds weight, and, if a hydrofoil is over-equipped, may reduce instead of increasing mission effectiveness.

At the present time, no attempts have been made to man this unit's .50 caliber machine gun while foilborne due to safety considerations. In order to allow weapons manning foilborne, future hydrofoils should either:

(1) Plan for mounting weapons aft of the deck house, or

(2) Plan into deck weapons configuration special safety harnesses, slings, or shooting platforms.

5.4 HABITABILITY. Most habitability items have been previously discussed, but a "trade off" may be required between habitability items and weight considerations. Included in habitability, however, should be sufficient space for messing and berthing, and sufficient compartmentalization of berthing spaces for the mixture of sexes aboard floating units in keeping with the Commandant's policy of equal opportunity.

5.5 SANITATION. Included in any planned hydrofoil should be waste disposal tanks in accordance with marine pollution laws, privacy type head and shower facilities, and more freshwater holding capacity.

5.6 GROUND TACKLE. Ground tackle equipment aboard future hydrofoils should include a power windlass for raising the anchor.

5.7 WORKING SPACES. Sufficient space should be provided aboard any future vessel for "working spaces". The required spaces are similar to a WPB requirement, that is:

(1) Office Space - which like an 82 foot WPB could be incorporated into the CO/XPO stateroom provided it was large enough, and

(2) Machinery working space - which like the 82 or 95 foot WPB is incorporated into the engineroom.

SECTION 6 - PERSONNEL CONSIDERATIONS

6.1 GENERAL. Operationally, there is no "magic" to a hydrofoil. The repair and operation of a hydrofoil can be accomplished by personnel with rates similar to those presently assigned to FLAGSTAFF. The important considerations for specialized manning of a hydrofoil are that individuals be selected for their initiative, motivation, and lack of problematic history. These requirements are based in the fact that a hydrofoil crew must operate as a complete, smoothly coordinated team. Should any individual lack initiative or motivation, or cause personnel problems, the single individual could easily destroy the necessary team concept, thereby greatly reducing unit effectiveness. High motivation and initiative do not mean senior rates or the unit will find itself with too many bosses and insufficient workers.

6.2 TRAINING. Training requirements for hydrofoil crews are not excessive. A manufacturer's training program in systems, capabilities, and operation of the unit is desirable, and any underway time aboard a hydrofoil prior to assignment is useful. Other than that, the present crew of FLAGSTAFF could be used in the future for on the job training of crews.

6.3 SUPPORT. The support concept for future hydrofoils would not necessarily require a shoreside team for each unit, since a new class of hydrofoils would be (hopefully) more reliable and require less maintenance than FLAGSTAFF. Shoreside storage for routine spare parts would be required, but nothing elaborate. The most feasible solution for repairs of major casualties would be a centrally located support center manned by one assist team for an entire class of hydrofoils. This same support team would stockpile large item spare parts and transport the spares and assist team to any hydrofoil with a major casualty. The concept is basically no different from that employed by AR&SC Elizabeth City (for aircraft), with the exception that the hydrofoil would not be transported to the center, but the center's capabilities would be transported to the unit.

SECTION 7 - CONCLUSIONS

My year experience aboard FLAGSTAFF has convinced me that the hydrofoil has great potential for the Coast Guard, and could conceivably outperform any WPB in all aspects of vessel usage. The two most critical questions I have that cannot be answered by operating FLAGSTAFF are:

(1) How reliable can a hydrofoil be made to be? FLAGSTAFF's lack of reliability is largely based on her one-of-a-kind status and age, which make breakdowns prevalent and repair times extended due to parts non-availability.

(2) Will hydrofoils be cost effective as related to WPB's and helicopters? It is anticipated that a hydrofoil will be more expensive to operate than a WPB, and less expensive than an HH3 helicopter, but very little cost data can possibly result from this evaluation.

It is hoped that more data will be gained in the remainder of FLAGSTAFF's operation, and many unanswered points will be resolved in the final evaluation I will submit upon completion of the project. At the present time, a major portion of the knowledge available within the Coast Guard regarding hydrofoils is centered in myself, LTJG HALL, MKC POWER, and ETC STONE. It is requested that between now and submission of the final evaluation, we be detailed TAD to USS PEGASUS for a period of two to six weeks to gain further knowledge that would be useful in the final evaluation.

T. P. HART
LT, USCG
COMMANDING OFFICER
USCGC FLAGSTAFF (WPGH-1)

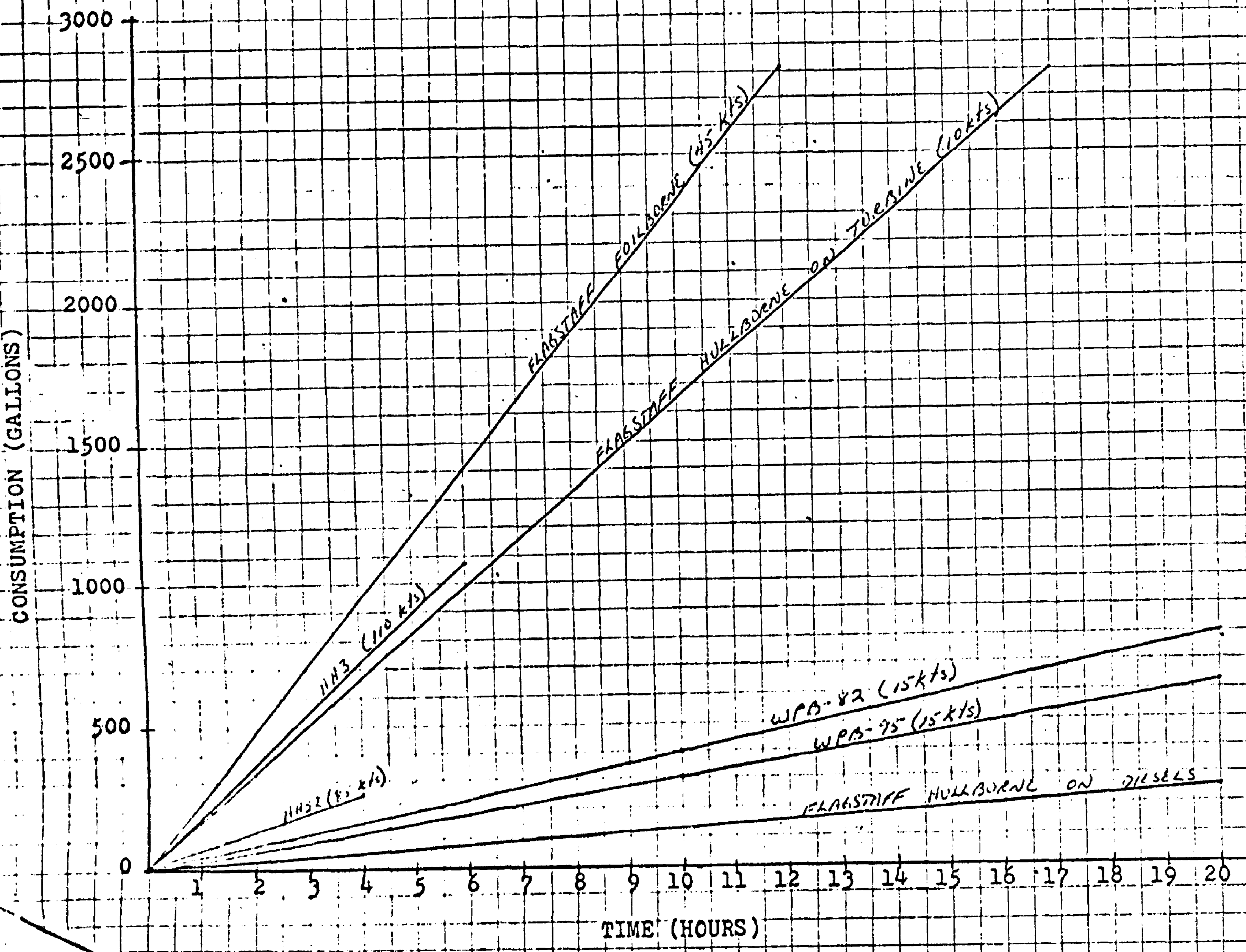
6 February 1978

APPENDIX I

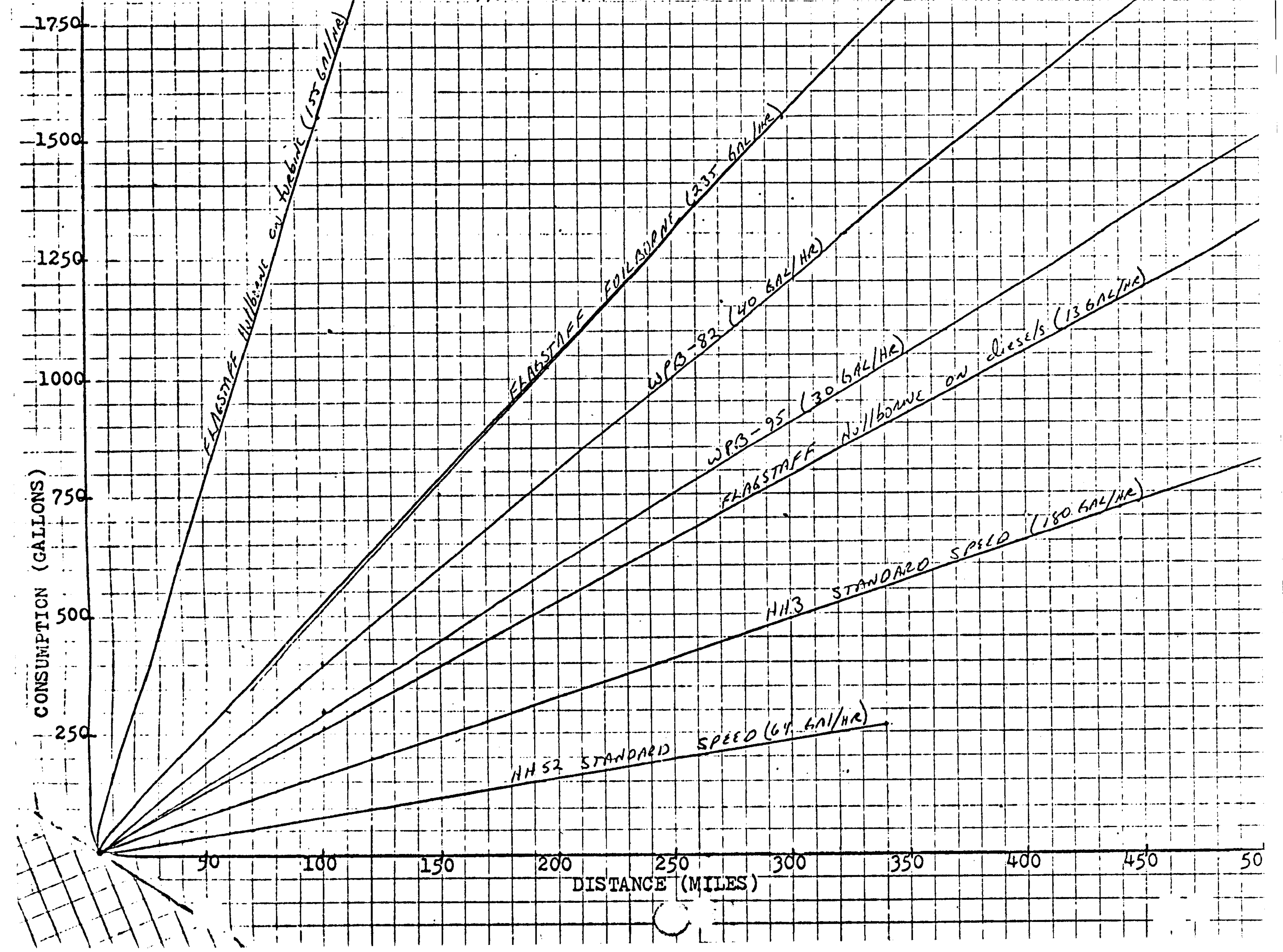
FLAGSTAFF PROGRAM UTILIZATION 7 JULY 1977 -31 DECEMBER 1977

TYPE	MISSIONS	HOURS
Search and rescue	5	31
Enforcement of laws and treaties	14	113
Aids to Navigation	1	4
Training	3	6
Non-program utilization (including VIP trips, engineering trials, etc)	24	64
		218
Standby hours		1415
Maintenance hours: Actual		1783
Awaiting parts		1018
Foilborne hours		67

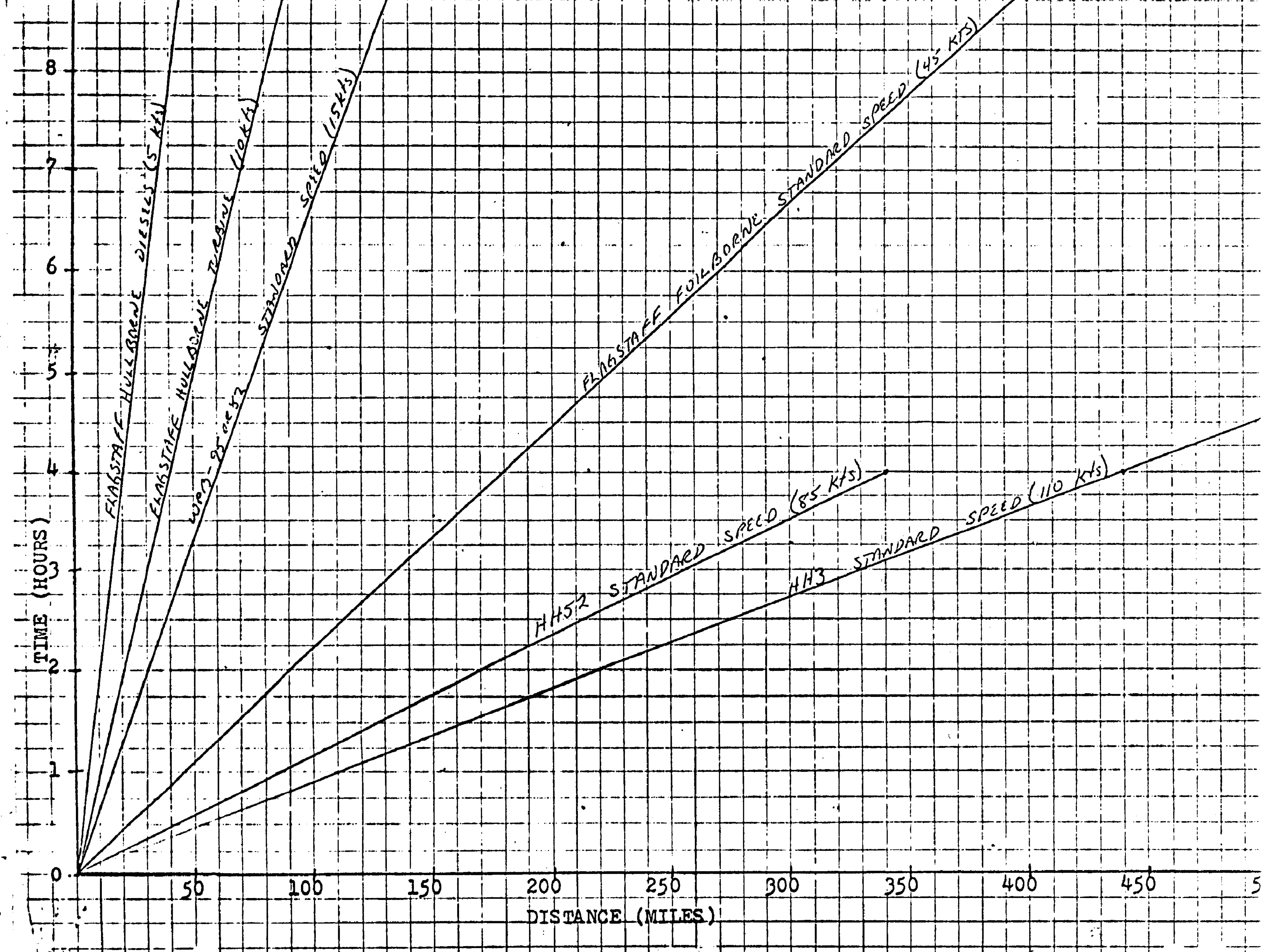
APPENDIX II - A



APPENDIX II-B



APPENDIX II-C



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CGC FLAGSTAFF TO BE DECOMMISSIONED

Boston, September 1, 1978 -- The Coast Guard Cutter Flagstaff will be decommissioned on September 30, 1978. The 75-foot hydrofoil has been operating out of Woods Hole, Massachusetts for the last 16 months as part of an evaluation program conducted by the Coast Guard to determine the feasibility of using hydrofoils in performing Coast Guard missions.

The decision to decommission the Flagstaff is based in part on the cost of repairs to the vessel and the fact that the Coast Guard feels that sufficient information on the use of hydrofoils has been gathered from the evaluation program. The Flagstaff has suffered from mechanical difficulties throughout the evaluation program, and the vessel currently requires an engine replacement due to turbine deterioration.

The Flagstaff, built in 1968 by the Grumman Corporation, was used by the Navy as an experimental vessel. The Flagstaff saw service in South Vietnam during the Vietnam conflict. The ship was later transferred to the

--more--

to the West Coast of the United States. On November 4, 1974 the cutter was loaned to the Coast Guard for research and development testing. This testing was continued until February of 1975. It was determined by this evaluation that the high speed of the hydrofoil would be useful to the Coast Guard in the performance of those missions where high speed would be required (Search and Rescue, Law Enforcement, etc.).

On September 29, 1976 the Flagstaff was transferred to the Coast Guard to enable the service to perform a long-term evaluation of the cutter in an actual operational environment. At the time of the transfer, the ship was inoperative due to numerous systems failures. The ship was dispatched to Boston, Massachusetts where repairs were made; and on March 2, 1977 the cutter was commissioned. After training operations were conducted, the Flagstaff was transferred to Woods Hole. On July 17 of the same year, the cutter was placed in active status and began operations as a unit of the United States Coast Guard. Due to turbine-related casualties and other mechanical problems, the initial evaluation period of 12 months was extended to 16 months.

The Coast Guard will continue its policy of analyzing various high-performance vessels to ensure that the service will be best equipped to carry out its many missions.

Flagstaff/ High Point

Gail -

Here is a run-down of the history of the short-lived Coast Guard hydrofoil program that included CGC Flagstaff (WPGH-1) and High Point (WPBH-1) during the mid 1970's:

In late 1974, the Coast Guard was looking for an inexpensive way to evaluate ~~new~~, high speed vessels to combat the "new" drug smuggling problem. They arranged, through the R&D Center, to operate US Navy hydrofoils that had been used during the later years of the Viet Nam war and that were now going through a "second generation" evaluation. Under Capt Graeme Mann, CO of the R&D Center, an extremely select, hand-picked crew of 13 chosen from through-out the Coast Guard to form the "High Performance Watercraft Test and Evaluation Team".

For the ~~next year~~ 6 months this team evaluated the Flagstaff out of San Diego and up the So. Cal Coast to Oxnard & Port Hueneme(?). Painted in CG colors and with an all-CG crew it showed great success in both anti-smuggling efforts on the U.S/Mexico border and as a rapid-response SAR vessel. Flagstaff, with a top speed of 52 KTS, efforts ended short of completion due to a lack of spare parts for the Rolls Royce gas turbine and an unfortunate collision with a 40 ton California grey whale just outside Pt Loma lighthouse that caused approx $250,000 damage to the aft strut gearing assembly.

After another month putting Flagstaff back together and additional training for the next phase, a 6-man nucleus from the first crew combined with a new CO, XO, QM, and engineering personnel and went to Bremerton

Washington to test out High Point, a Boeing-designed much larger hydrofoil (140 ft vice 78' for Flagstaff). With a top speed of 48 KTS, High Point was the prototype for the Navy's new hydrofoil construction project – the Pegasus Class squadrons highly successful in world-wide ops in the 1980's. Like the Flagstaff, High Point was painted in Coast Guard colors and began evaluation during CG missions in the Puget Sound area – 3 Navy personnel remained aboard the vessel that had been Navy manned at 28 people. The CG operated with 14.

In early 1975 the Coast Guard wanted to see how High Point would do in the San Francisco Bay area so we started the long trip down the Coast, "flying" over the Columbia River Bar on the way down at 45 KTS. As we got into S.F. Bay and preparing to tie up at Treasure Island, the G.E. turbine blew approx 500 yds from mooring. With a repair bill of close to $300,000 that neither the Navy or CG wanted to pay, the CG ended the evaluation program and sent the CG crew (now TAD for over 9 mos) to new assignments. Since the Navy personnel were all actually operating the vessel as it prepared to moor, the Navy ended up paying & then scrapping the vessel.

In 1976 the Navy decommissioned Flagstaff in San Diego and the Coast Guard acquired it. It was shipped to Boston where it remained on a pier over the winter at the Base, then commissioned for service operating out of Woods Hole. With very little money from the Navy for upkeep from 1973 – 1976 and parts even more critical to find, Flagstaff died a slow death for the next year at Woods Hole. Casualty after casualty affected its readiness and the Coast Guard ended the program in 1977 / early 1978. When it was running, it was a great success, but parts & money spelled out axing the program. ~~Many~~

Many individual awards were given out to crew members of both phases of the hydrofoil program (74/75 & 76/77). The initial 13 members of the R&D Center's High Performance Watercraft T&E team also got a unit Commendation. The initial crew-members were:

LT Doug Gehring	ET1 Hall
BMCM Tom Bawden	RM2 Davis
MKCM Jessie Meyer	EM3 —
QMC Riddle	MK2 —
MK1 Gogon	MK3 Craig
EM1 Walsh	SN Dave Lewis
	SA ? —

The large picture enclosed is High Point flying in Puget Sound prior to the trip down the Coast. The small one is Flagstaff in San Diego.

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