Lieutenant Commander Frank L. Shelley and the HH-52A Program

In 1957 an evaluation of Coast Guard Aviation requirements was undertaken in conjunction with a Roles and Mission study. It recommended that in light of the growing complexity of Coast Guard operations that a single long-range plan be developed. A Coast Guard Aviation Development Master Plan was completed and initiated. Basically the aviation plan determined the requirements to perform the projected operational missions of Coast Guard aviation and the proposed funding to provide almost concurrently for (1) the continued acquisition of aircraft needed to replace over-age aircraft; (2) the acquisition of additional aircraft to enable the Coast Guard to accomplish the mission into the future: (3) the necessary modification of existing facilities; and (4) the establishment of those facilities required to accommodate the aviation program; (5) the personnel to man them.

The plan recommended a reduced acquisition of fixed wing aircraft and an increase in the number of medium range helicopters. Over half of the number of operational aircraft required were to be helicopters. It was further recognized that numerous additional helicopter Air Detachments would be required. Due to budget problems it was September 1959 before the first six of a scheduled 96 HUS helicopters were acquired.

On 26 September 1960 two HUS-1G (H-34) helicopters were lost within an hour of each other while in hover during an attempted SAR pickup in Tampa Bay, Florida.. The cause was not determined. The Coast Guard had been less than satisfied with the HUS-1G and as a result of the Tampa Bay incident the Coast Guard decided that they were not going to purchase additional HUS-1G helicopters. The search for a satisfactory Medium Range Helicopter began. Options were limited. The Air Force had limited interest in helicopters at the time; the Army was having development problems with the HU-1 Huey; and the Kaman H-2 Seasprite developed for the Navy was also having development problems. The thinking at the time was that the Boeing Vertol H-46 and the Sikorsky SH-3 were too large. Sikorsky did their homework and recognized the Coast Guard had not yet found a new helicopter that met their needs and proposed the S-62.

With success of the S-61/SH-3 Sikorsky had put together a smaller, FAA certified, civilian amphibian helicopter which turned out to be a commercial bust. Most probably because of costs associated with the GE CT-58 engine. Small jet engines suitable for helicopters were not available at the time. Sikorsky, aware that the Coast Guard was not constrained to purchase milspec, approached the Coast Guard offering their S-62. The aircraft was the desired size, it was amphibious, the airframe was modeled on the S-61, and on paper it met Coast Guard requirements. The Coast Guard had an immediate need for a suitable helicopter and Sikorsky wished to sell the S-62. Sikorsky agreed to finance the test program, fuel, and provide maintenance and logistic support if the Coast Guard would arrange for the use of the Navy's Patuxent River facilities and provide a test pilot. In addition they wished to have an outline of the test program the Coast Guard was going to use. The Coast Guard accepted the offer.

LCDR Frank L. Shelley, who had graduated from Navy Test Pilots School in the fall of 1960, was sent for by CDR Robert "Rip" Emerson, Coast Guard Headquarters, Aviation Division. CDR Emerson briefed him on Sikorsky's offer and explained that an outline of a test program would be needed for forwarding to Sikorsky and time was of the essence. No Coast Guard specifications for the helicopter or its mission existed. LCDR Shelley participated with Aviation Division personnel in a review of both the needs of the Coast Guard and the capabilities of the S-62 as stated by Sikorsky. Mission requirements were established and it was determined that if the S-62 met the Sikorsky performance claims the helicopter should be purchased. LCDR Shelley established the test procedure and prepared an outline for Sikorsky. Sikorsky bought off on the proposal as LCDR Shelley had written it.

The Program Manager

LCDR Shelley reported TAD to the Naval Test Facility at Patuxent River, Maryland in August of 1961. The required tests for the S-62 had to be conducted with two different divisions of the Test Center; Flight Test and Service Test. Flight Test verified contractor performance and control claims and checked them for specifications and contract compliance. Service Test was nuts and bolts. What did it take to maintain the aircraft? How often did stuff break? How easy was it to fix? And did a particular mechanical fix work as intended or not? Rivalry between divisions was bitter and during this same period the Test Center pendulum had swung to an adversarial relationship with all manufactures. Thus Shelley had three entities to deal with and they were not cooperating with each other. It took less than a day for Shelley to start referring to himself as the "Coast Guard Program Coordinator."

A high priority on Frank's agenda was the ground based part of the Service Test phase. "How hard was it going to be for the Coast Guard to maintain this helicopter?" He requested an experienced maintenance officer with helicopter flight experience to assist him. Coast Guard Headquarters said there was no Maintenance Officer immediately available and they would provide a Chief Petty Officer that was highly qualified.

When I asked Frank about this. He said, "They sent Master Chief Aviation Machinists Mate Clayton Roll TAD from Salem. Roll was a textbook example of what a Chief Petty Officer should be; Very striking in appearance, perfect uniform, knowledgeable and a take charge leader. He had a great sense of humor and could talk anybody into or out of anything. Roll had been an Aviation Pilot but had elected out of the cockpit about five years earlier because of family pressure. When he arrived, I noticed he wasn't wearing wings, so I immediately bought a set and told him to wear them all the time (as the uniform regulations allowed.) I told him not to tell anyone that he wasn't still flying as an AP unless he was asked a direct question. Frank said he solemnly assured the Navy powers that yes he was an AP (fact) and yes he was an experienced, qualified helicopter crewman (he was). Without exception they all made the quantum leap to the conclusion that he was another Coastie helicopter pilot. This provided a great deal of freedom from stifling Test Center regulations when we flew after normal working hours (as we did all the time). I have often thought that this decision may have spelled the success of the program. "

Shelly's first order of business as the "Coast Guard Program Coordinator" displayed Shelly's innate leadership ability and persuasive skills. The challenge: -- how to divide up one aircraft between the two divisions. Since Flight Test's check of handbook data was easier in calm air, it was agreed that they would take the morning period and Service Test would fly the afternoons. Shelley would fly any flights for which the individual divisions could not provide test pilots. On the first "Data Day" Shelley and Chief Roll were on the flight line well before 0800. When the Sikorsky crew appeared to get things ready ahead of time they found the Coasties, leaning on the helicopter looking impatient. When the Flight Test people showed up just before 08:00 everyone was standing around looking impatient. This was continued for several days –each time all parties continued to show up earlier until it was finally agreed that "morning" was at 0600 which was as early as the Test Center directives permitted without specific exception. Everyone was soon working together and the Flight Test engineer data reductions and proposed test flight profiles that generally took two days where usually done by mid-afternoon so that the next day's schedule could be planned with this information available.

As a result of the early start hour, after servicing and removal of special test gear, the helicopter became available at Service Test by mid-morning rather than the afternoon. Initially gripes from Flight Test were delaying the turn over to the Sikorsky crew for regular maintenance too late in the day. Not to be outdone Service Test got their act together and were on the flight line in flight gear so they could give the helicopter to Sikorsky by 1300 and finished their flight reports for the day. Again this factored into planning for the following day.

The Sikorsky crew then took the helicopter and did whatever progressive maintenance was required. Chief Roll monitored all maintenance performed on the aircraft. Special tools, cranes, ground power units, hydraulic mules and whatever else was not in the field support kits were procured without any written authorization. Roll just went out and did what Coast Guard Chiefs do. Shelly put together all the flight reports and made a running draft of the Navy Test Report.

When Sikorsky finished, Shelly and Rolls would go out and fly max mission profiles and hover transitions which usually got them back after quitting time. It was this work ethic that lit a fire under all parties. The program was one of the fastest moving ones that ever hit the Test Center and all the previously warring factions seemed to take pride in what they were doing. They saw the Coasties at first light and saw them when they went home. Initially the hierarchy at Sikorsky was upset about the overtime that they were paying out but after two weeks they realized something good was happening and from that point on overtime was not a problem. The Sikorsky "spy system" was both good and unsophisticated. Shelly noticed the rough draft copies of his reports would disappear from the waste basket. Since nothing was classified and it produced good results from Sikorsky, Shelly pretended not to notice.

The S-62, except for the aluminum fuselage/hull modeled on the S-61/H3, was made up of previously proven parts. All dynamic components were S-55/HO4S. The final three planetary stages in the reduction gear box were from this source. The one GE-CT-58 engine was the same as the pairs in the S-61/H-3 and the Boeing107/H-46 which had proven to be reliable. The rotor assembly was design limited to 730 shaft horsepower so the engine was de-rated. This gave the helicopter an extra 500 HP worth of air capacity on the front end which enhanced operations considerably. The Automatic Stabilization Equipment was a 60 percent scale model of the one in

the S-61/H3 and a proposed night hover system that did not proven to be satisfactory. An electromechanical hover/transition to hover system was substituted for evaluation.

The hover part of the system was the same as used on the HSS-1 that held the helicopter over the sonar ball. (not part of the HSS-1 approach and transition) Without going into detail this package, with the addition of gyro stabilization element and a 150 foot of retractable monofilament line with a weight on it, was bolted externally to the airframe. The object was to start at a "gate" (airspeed and radar altitude) with the line and weight extended and then set a specified torque (less than level flight power). The system would then decelerate the helicopter through back trim inputs based on the rearward drag sensed by the trailing line. Since the power was less than level flight, the slower the helicopter got the lower it got until the pilot pulled collective at a predetermined radar altitude. Shelley dubbed it the "Poor Man's Hover Transition System." Shelley further stated the variables that intruded on the theory were too many to list. Shelly with Roll on board flew approach after approach and averaged about one good one out of three or four attempts. To ascertain why they monitored the airspeed and altitudes combinations they were supposed to be hitting on the way down and Shelly would "help out" on the trim if they were not "hitting the points." They continued this exercise recording the data through some 75 to 100 approach and transitions to hover. Results continued to improve. A series of approaches were flown without the weight confirming that transition to hover was a constant power maneuver. They had all the required numbers so there was no reason the approach could not be flown by hand. . Thus the "Beep to Hover" was born. Lord only knows how many people were rescued with this maneuver or how many crewmembers butts were saved because of it.

Note: An appendix describing the theory and procedure for the "Beep to Hover" is attached to this narrative

Even though constructed of proven parts there were difficulties encountered and corrections which had to be made. The most serious was the discovery that when operating at the redline and the primary servo was turned off there was an immediate violent pitch-up and roll to the left. Sudden with all the characteristics of a retreating blade stall. Reaction was immediate. The Test Center grounded the aircraft, Sikorsky sent batteries of experts down and then took the helicopter back to Stratford. The final determination was the auxiliary servo was not strong enough to hold blade pitch steady under the high loads experienced near redline. The blade pitch was oscillating slightly and was just enough to let the retreating blade momentarily exceed critical angle of attack. This was not something that would be fixed right away but Shelley convinced Coast Guard Headquarters and the Test Center to finish the program with a speed restriction. The solution to the problem was to replace the auxiliary servo with a more powerful one. In keeping with design philosophy the servo used for replacement was the servo used to operate the clamshell doors on the H-37. The servo was readily available and proven.

The Test Program was satisfactorily completed in December. The final Test Reports were made up and the NATC chain of command signed off on it. In essence the reports said the helicopter would satisfactorily do what Sikorsky claimed it would do and enclosed was a list of additional items that should be corrected before it was purchased. Sikorsky corrected all of the items and a contract for 99 HH-52 was initiated in January of 1962. The test program from initiation to

contract was less than three months. It was LCDR Shelley's show from start to finish. It was a truly outstanding performance.

Originally designated the HU2S-1G it became the HH-52A. It had a rotor diameter of 53 feet, a range of 474 miles and a top speed of 109 mph. It was an extremely flexible rescue aircraft that could fully perform missions with a minimum crew. The helicopter was well suited for night and all-weather flight. The HH-52 had a hydraulic hoist and carried a rescue basket. The cabin could accommodate up to ten passengers or six litters. It was fully amphibious and was equipped with a removable foldout rescue platform that looked like a large extended step. It was a rectangular grid that sloped slightly downward beneath the water's surface when the helicopter was afloat. Incapacitated survivors could be scooped or dragged onto it greatly facilitating their rescue.

On January 9, 1963 the U.S. Coast Guard received the first of 99 Sikorsky S-62's which were given the designation HH-52A and the name "Seaguard", a name which never caught on amongst those who flew it. The HH-52 was the Coast Guard's first amphibious, turbine-powered helicopter.

LCDR Shelley returned to his permanent duty station and during 1962 was given periodic TAD assignments at Sikorsky during which he monitored progress and made inputs as to cockpit configuration and Search and rescue equipment. Again, all of Shelley's requests were incorporated. During one of these assignments Shelley and Opie Blanchard of Sikorsky put together a 10 flight transition syllabus that would be used to transition Coast Guard aviators into the HH-52.

In January of 1963 Shelley flew the first four acceptance tests 1352 to 1355 and on 16 January Shelley, Opie Blanchard from Sikorsky and Bill Kime, also from Sikorsky, proceeded to the Salem air station and transitioned all of the Helicopter pilots using the 10 flight syllabus that Shelly and Blanchard had developed. Salem went operational in the HH-52 on the 29th. On 12 February, Shelley and Blanchard proceeded to New Orleans and transitioned all pilots using the 10 flight transition syllabus. New Orleans went operational in the HH-52 on 22 February. On the first of April Shelley and Blanchard and Win Corley transitioned the St. Petersburg air station into the HH-**52.** I have included this sequence of events because, with the benefit of time and research, it is clear that the syllabus developed and executed by Shelley and Blanchard was the beginning of a new training/transition policy in the Coast Guard. The training/transition was both standard and efficient, provided by a highly qualified team, and yes – transition and training was no longer held hostage by whim.

On the basis of the early results a formal transition program was set up. This was placed under the direction of Win Corley, an excellent choice with many helicopter hours coupled with both instructor and management skills. The success of this program led to the establishment of the Basic Operational Training Unit (BOTU) at Savannah followed by ATC Mobile.

The Headquarters assignment:

Basically the Coast Guard Aviation Plan determined the requirements to perform the projected operational missions of Coast Guard aviation and the proposed funding to provide almost concurrently for

LCDR Shelley was transferred to Coast Guard Headquarters, Office Aviation Units, and was directly involved in the implementation program and charged with preparing the budget requests. Prior to the 1964 budget preparation LCDR Shelley was joined by LCDR Penn and they were directed to determine all future facility locations required to completely implement the Aviation Master Plan. The actual establishment of the proposed facilities would take place all the way through the budget years to completion. This was designed to facilitate planning and provide continuity to the budget procedure. The required funding for a five year period was spread out into roughly equal annual expenses for budget purposes. The plan was reviewed and updated yearly. This would be a continuing process. The only additional instruction given was to use data to support projected SAR loads and locations.

It became apparent that that SAR cases are heaviest where SAR facilities are located and the closer to the facility, the more cases there were. It was evident that the data was not going to be of help. It was decided that the primary criteria for location would be the operational capabilities of the rescue aircraft, and that this aircraft was going to be the HH-52. Shelley was well versed in HH-52 capabilities. Arcs based on the HH-52 capabilities were drawn ringing the United States. The anchor points were the existing air stations. In the area where the arcs intersected existing facilities were looked for and chosen.

The next step was harder. This was the justification for the choice. Existing facilities where the Coast Guard could be a tenant where looked for. This made life simpler and greatly reduced required expenditures. The next step was to gather all available information on marine activity shipping and commercial fishing. The population and location was taken into account for present and potential recreational boating. The SAR data for existing locations was quantified for the location generating it and used to estimate the possible SAR load that would be generated by the chosen location. Shelley said he would then try to place himself in the position of a local leader trying to get this unit for the protection of the people that lived there. The justification was submitted as a written report.

Once chosen itemized construction cost estimates were made for budget purposes: (1) Those air stations requiring construction at Civilian Air Fields (2) Those air stations utilizing leased space at civilian fields (3) Those air stations requiring construction at existing Coast Guard units (4) Those air stations utilizing leased space at existing military aviation facilities.

It is a fitting tribute that in the first 40 plus year period since this assignment was completed only one of the proposed air stations has been closed (Chicago) and two were combined (Brooklyn and Cape May) and their operations were moved to Atlantic City New Jersey.

Summation:

LCDR Shelley exercised extraordinary leadership, management, and technical skills in development of operational flight and training procedures to test, acquire, and deploy the Sikorsky HH-52A helicopter. This aircraft established the primacy of the helicopter as a rescue vehicle, changing the face of Search and Rescue. As a graduate of Navy Test Pilot School, he used keen technical and interpersonal skills to complete the evaluation in only four months. All modifications were accepted by the manufacturer. Twelve months later the HH-52A was fully operational. During the evaluation, LCDR Shelley applied turbine engine and translational lift characteristics of the helicopter to develop a pilot-controlled procedure to transition the

helicopter from forward flight to a hover without visual reference to the sea surface. This "beep to a hover" maneuver subsequently saved countless lives. He was instrumental in the development of a new Coast Guard standardized training/transition policy leading to establishment of a Basic Operational Training Unit at Savannah and eventually Aviation Training Center Mobile. LCDR Shelley co-authored a plan for future operating locations to complete implementation of the Aviation Master Plan. In nearly 50 years thereafter, the only modifications were the decommissioning of one air station and consolidation of two others.

The HH-52, with over 15,000 lives saved in its twenty-five years of service, has the honor of having rescued more persons than any other helicopter in the world at the time of its retirement. This little helicopter, a unique assemblage of proven parts, comfortably behind the cutting edge, performed astounding feats in thousands upon thousands occasions. It became the international icon for rescue and proved the worth of the helicopter many times over. It had an enormous positive impact on Coast Guard aviation. LCDR Shelley referred to it as "Old Trusty."

Beep to Hover

The following is an abbreviated version of LCDR Frank Shelly's commentary on the development of the Beep to hover maneuver.

A helicopter approach to landing is contrary to everything taught for a fixed wing *Stabilized Approach* wherein the same speed over the final approach point is maintained to a half mile out and continued until the round out over the runway. The helicopter, on the other hand, wants to go from cruising speed at altitude to zero speed four feet above the landing spot. This means that the helicopter is decelerating and descending at the same time on approach. During daylight VFR operations the pilot is able to observe visual reference indications that make the maneuver easier than it sounds. Close in adjustments are within the capability of the helicopter. Instrument flight or night over water operations (essentially instrument flight) is something else. That was why the artificial stability systems with an auto hover feature in the HUS generation of helicopters were so welcome. The pilot, however still had to monitor rotor/engine RPM.

Constant RPM in flight is of extreme importance. There are two reasons for this, one is structural and the other is power related. We cannot make the rotor constant speed like an aircraft propeller because rotor pitch angle is related to the angle of attack resulting in a constant messing with the lift. Instead a change in torque must be provided by a governor working directly on the engine. The governors available at the time were not sensitive enough to keep a piston engine at constant RPM with varying torque demands. Enter the free turbine jet engine such as the one in the HH-52A. With the engine power turbine spinning up at 27,000 to 30,000 RPM a one percent change could be easily sensed by the

governors available at the time. They could then be used to adjust the fuel control to increase/decrease the fuel input which increased/ decreased the temperature which either spun up or down the compressor giving an increase/decrease of flow through the power turbine. Thus the pilot could set the desired RPM and not have to monitor it.

There is an additional aerodynamic feature that enters into the equation. When a helicopter rotor system is in a hover, the lift is generated solely by the airflow from rotation. However the plane of rotation equates to a disc and if this disc translates in any direction so as to generate airflow of more than six knots across the disc, an additional lift is generated. The faster the disc is moved in any direction, the more "translational lift" is produced. At cruising speed, it is a significant portion of the lift holding the helicopter up. If the rotor disc is tilted slightly back during cruise you lose some of the forward thrust vector and the helicopter slows and as a result you lose some of the translational lift. The turbine governor keeps the rotor turning at the same speed and the rotational part of the lift remains constant. You do however have a decrease in overall lift and the helicopter starts to descend.

During the evaluation and test of the HH-52 numerous transitions to hover were made during which altitude/airspeed check points were recorded as the maneuver progressed. Armed with this information Shelly and Roll reasoned that just putting a little "beep" of back trim on the electric trim button in level flight would start the deceleration/descent. (It could be accompanied by a small initial power reduction) Then as each check point "window" was reached, feeding in another "beep" kept the maneuver going. It was a pretty much hands off, feet on the floor with maybe an extra withheld "beep" or a power tweak to hit each window.

To use this maneuver to investigate something on the water at night, the pilot would fly over the object on a downwind heading proceeding outbound for a couple of minutes while descending to the initial radar altimeter altitude. A procedure turn, similar to a no vector, non-precision instrument approach, was used to bring the helicopter back into the wind where a final approach was started. With any reasonable weather conditions, whatever it was that you wanted to look at was in front of you when you got to a 20 foot radar altitude and zero airspeed. The same procedure was utilized in areas of reduced visibility. The ATC Mobile training center later taught a teardrop pattern to save time but the principle remained the same.

With a modern electronics suite and automatic flight control systems this procedure is both primitive and not necessary. At the time, however, it greatly expanded the operational capabilities of the aircraft and resulted in the rescue and saving of many lives that otherwise would not have been possible.

HH-52A –Shipboard Operations

John “Bear” Moseley

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