H.M.C.S. HAIDA

INTERPRETATION MANUAL

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Introduction

The purpose of this manual is to enhance and standardise staff, crew, and volunteers' knowledge of the ship, its history, and operation so that the visiting public may be better informed, and hence, better served. The manual can be seen as a staff supplement to the self-guiding brochure. While there will be a considerable amount of information conveyed, it is not required that you memorize it. Rather, it is to be used as a resource, to be used as required. Some of you may have a particular interest in a certain area or apparatus which you would prefer to "specialise" in. This manual will provide you with the necessary information.

Historical Background

(This summary of *Haida*'s history and significance is based upon a paper presented by Mr. Michael Whitby, Head, Naval History Team, Directorate of History and Heritage, Department of National Defence)

HMCS Haida is Canada's most famous warship.

While *HMCS Sackville* in Halifax serves as a memorial to Canada's naval contribution in World War II, and in particular to one battle, the Battle of the Atlantic, *HMCS Haida* exemplifies Canada's naval experience for much of this century: from the years preceding the war when the tiny Royal Canadian Navy struggled for existence, through the war years when Canada made a global contribution to the war at sea, to the Cold War, when Canada, as a member of NATO, deterred aggression on the seas. In terms of operational experience, national and naval policy, technological development, historic personalities, and the cultural experience of Canadians at sea, *Haida* reflects important elements of our maritime experience.

Since its founding in 1910 the Canadian Navy has been primarily a destroyer navy. This type of warship has been best suited to our naval requirements: flexible, sufficiently small to work inshore for coastal defense yet sturdy enough and with enough endurance to survive the harsh conditions of the North Atlantic and Pacific oceans, and strong enough in terms of armament to defend against the type of threat we are most likely to encounter. They are capable of being built in Canadian shipyards and, always an important consideration, they are relatively inexpensive. (See the accompanying table and diagram for the relative sizes of World War II era naval vessels.)

Until Canada began to design her own destroyers in the 1950's, Canada either acquired ships from the Royal Navy or built British designs in Canada, though with modifications to suit Canadian conditions. In 1938, when the RCN was looking to expand, the Tribal Class destroyers then under construction for the Royal Navy were state-of-the-art in terms of British destroyer design. Larger and more heavily gunned than traditional designs, their purpose was to counter the powerful destroyers coming into service in the German, Japanese and Italian navies. The RCN saw the Tribals as the key to its survival: after World War I the Navy's fleet of obsolescent major warships and minor vessels was struck from strength in a cost-cutting move. Learning from that experience, the RCN wanted more substantial, modern vessels that would be too valuable to scrap.

Moreover, the Tribals seemed ideally suited to Canada's requirements. When defense spending began to increase in the late 1930s, the Mackenzie King government placed a priority on home defense. With the power and flexibility needed for the Navy's coastal defense role, the Tribal Class destroyers had the gun and torpedo strength to challenge surface raiders - which had posed the greatest threat in Canadian waters during the first war - while also possessing significant anti-aircraft and anti-submarine capability.

Table 1:

RELATIVE SIZE OF BRITISH WARSHIPS, WW II

		Displacement	Length	Crew
Typical Battleship:	H.M.S. *Hood*	42,200 tons	810 feet	1341
	H.M.S. *Repulse*	32,000 tons	794 feet	1181
Typical Cruiser:	H.M.S. *Swiftsure*	8,000 tons	555 feet	960
Destroyer:	Tribal Class as laid down	1870 tons	355 feet	190
Corvette:	Flower Class	925 tons	190 feet	85
Minesweeper:	Algerine Class	925 - 1040 tons	225 feet	104 - 138

(There are variations within each Class depending on exact date of construction.)

Nonetheless it took plenty of persuasion - and the onset of war - to obtain government approval. But in March 1940, after complex negotiations with the British, who were reluctant to devote scarce shipyard resources to building for other countries, it was agreed that Britain would build four Tribals for Canada in exchange for ten corvettes to be built in Canadian yards for the Royal Navy. *Haida* was the final of the four British-built ships, although eventually another four Canadian Tribals were built in Halifax.

The Canadian Tribals were to be named after indigenous native tribes. They were, HMCS IROQUOIS, HMCS ATHABASKAN, HMCS HURON, and HMCS HAIDA (in order of construction). The four built in Halifax completed after the war, were HMCS MICMAC, HMCS NOOTKA, HMCS CAYUGA, and HMCS ATHABASKAN (2). HAIDA was named after the Haida Nation of the Queen Charlotte Islands. The Haida people were skilful hunters, fishermen and fearsome warriors, marauding up and down the west coast as far south as the Columbia River. They made up the most sophisticated hunter-gatherer society the world has ever known. Their folklore attests to a mythical "thunderbird", the flapping of whose wings brought thunder, and the flashing of its eyes, the lightning. HAIDA's badge is a two-headed thunderbird (symbolising an all around view) with outstretched wings to symbolise HAIDA's guns thundering across the seas. The ship's colours are blue and gold. The ship does not have a motto. The thunderbird symbol is prominent in two places: the ship's badge on the quarterdeck, and atop the main (after) mast. This can be pointed out easily to visitors.

Although in all 27 Tribals were built - 16 for the British, 3 by the Australians and 8 for Canada - the Canadian ships were known from the outset as Improved Tribal Class Destroyers. Those responsible for the design and construction of the Canadian Tribals took advantage of the early lessons of the war, which the Australians failed to do, and built them stronger to withstand Arctic conditions. HAIDA was built by Vickers-Armstrong Ltd. at Newcastle-on-Tyne, England. The keel was laid down on September 29, 1941. The ship was launched (sponsored by Lady Laurie, Mayoress of London) on August 25, 1942. The ship commissioned (that is it entered naval service) on August 30, 1943.

It is not by accident that *Haida* is known as "Canada's Fightingest Ship", as she earned an impressive war record. Once commissioned, she initially took part in air operations off the Norwegian coast, and in escort duty on the famous Russian convoys. Her experiences here were far from unique, for several other Canadian ships, as well as hundreds of Canadians serving in British ships plus Canadian naval airmen, participated in this campaign. This was tough duty: convoys were run in the darkness of the harsh Arctic winter, base facilities were poor, and the Germans put up tough resistance in the form of U-boats and major surface ships.

One such convoy should be mentioned. In December 1943, the Germans sent the battle cruiser *Scharnhorst* to attack convoy JW55B, whose escort included the Canadian Tribals *Haida, Huron* and *Iroquois*. *Haida*'s captain, Harry DeWolf, was in command of the destroyers and merchant ships at the rear of the convoy and had the difficult task of making sure that the merchant ships kept station in the worst conditions, of chasing down U-boat contacts and on the two occasions when *Scharnhorst* approached, marshalling the escorts to drive her off. The enemy never got that close to the convoy and the outcome was the sinking of the *Scharnhorst*.

It was in the English Channel in 1944 that *Haida* and DeWolf achieved almost legendary status. Attempting to wear down German destroyer strength prior to the invasion of Europe, the 10th Destroyer Flotilla, which at one time or another included all four Canadian Tribals then in commission, fought a series of battles against German destroyers. In these *Haida* was the major player, participating in the destruction of three German destroyers as well as several coastal vessels. In the three battles culminating in the loss of German destroyers, and in the April 1944 battle which resulted in the loss of *HMCS Athabaskan*, DeWolf in *Haida* was either in command of the entire force involved or had command thrust upon him during the battle. In each case, the combination of his leadership and tenacity, and the skill and determination of *Haida*'s sailors, were key to victory. These successes won the admiration of fellow professionals and the Canadian people.

Arguably, no other warship made a greater contribution to Canada's naval traditions than did *Haida.*

The success of the Tribals during the War has overshadowed their post-war record, but until their final decommissioning in the mid-1960s the Tribals continued to make important contributions. Six of the Tribals saw duty in Korea, including two tours by *Haida*. Destroyers played an important role in this first United Nations peacemaking operation: blockading the enemy coast, defending friendly islands against amphibious assault; protecting the coastal flanks of UN armies; bombarding enemy positions; preventing the movement of enemy supplies by rail; and screening UN aircraft carriers flying off missions inland. Usually the Canadian destroyers operated in joint task forces with ships of other UN navies, experience which paid great dividends in the later Cold War years when such became normal practice.

During the Cold War, the Royal Canadian Navy's priority became anti-submarine warfare, and the Navy earned a reputation as one of the finest anti-submarine forces - if not the finest - in NATO. As part of the move to specialization, the Tribals, including *Haida,* were converted to destroyer-escorts. This involved a major transformation through the fitting of the Squid anti-submarine weapon, new gun armament, sophisticated surveillance systems and greatly improved living conditions. During the conversion of HAIDA between 1949 and 1951, the forward 4.7-inch guns were replaced with the twin 4-inch gun mountings, while the 4 inch mounting aft was replaced with the three-inch fifty-calibre gun. The after 4.7 inch mounting and the depth charge racks were removed and the squid anti-submarine mortars installed. The 20MM Oerlikons were replaced with the single 40MM Bofors guns. The two pounder pom pom was removed and replaced with the Mark 29 gun sight used with a Mark 34 radar to control the 3"50 gun. This is the armament the ship had when it went to Korea in 1952, and 1954. There have been additions and changes to the radar and sonar equipment since this major conversion. This is the version of *Haida* that today's visitor sees. In many ways she was the precursor to the sophisticated vessels that have followed her in the Navy, and as such she serves as a tribute to the technological prowess of the RCN during the Cold War.

Finally decommissioned in 1963, *Haida* was acquired from the Department of National Defense by a group of Toronto businessmen and former naval officers, supported by then-Premier John Robarts, himself a former naval officer. This group wished to see Canada's most famous warship preserved. She was brought to Toronto and opened as a museum ship in 1965, and was moved to her present berth at Ontario Place in 1971. In 1984, on the recommendation of the Historic Sites and Monuments Board of Canada, *HMCS Haida* was declared to be of national historic and architectural significance.

While *Haida*'s outstanding war record is unique among Canadian ships, she is also symbolic of Canada's naval experience for much of this century. Designed in the mid-1930s, *Haida*'s post-war modifications influenced ships that still serve in the Canadian Navy. So too the people who served in her shared the same experiences of thousands of other Canadians who have served in the Navy. They may not have served in Tribals, but they fought in World War II or Korea, they stood watch in NATO exercises and on UN missions, and they represented Canada to the world. It is this combination of the unique and the typical which is *Haida*'s historic legacy.

HMCS HAIDA BASIC DIMENSIONS

<u>Length</u>: 377 feet

<u>Beam</u>: (width) 37.5 feet

<u>Displacement</u>: (weight) 1,920 tons, 3,000 fully loaded with fuel, ammunition, provisions and crew.

<u>Fuel</u>: 525 tons of Bunker C oil, with a range of 5,700 nautical miles at a speed of 15 knots (17.3 mph or 28 km), or 3,000 nautical miles at 20 knots (23 mph or 37 km), and considerably less range as speed increased.

<u>Complement</u>: 14 officers, 230 other ranks.

Parks Canada Messages Summary

Every national historic site has been designated as such for important reasons and these reasons guide the way in which these sites are interpreted to the visiting public. *HMCS Haida* is of national historic and architectural significance because of

- **her role in naval combat, and**
- **because she is the last of the Tribal Class Destroyers.**

The *Haida* is valued because:

- she symbolizes Canada's naval experience in World War II, Korea and the Cold War;
- she is emblematic of Canada's role on the world stage;
- for her association with the Russian convoys, her support to the Normandy invasions, and operations in the English Channel and Bay of Biscay; and
- for her role in the Korean conflict.

TOURING THE SHIP

The following portion of this manual is laid out as if you are walking the tour. As more parts of the ship become available, a description of the area will be added. There are several appendixes at the back describing systems that involve more than a single compartment.

TORPEDO TUBES

This quadruple mounting houses four "Mark Nine" 21-inch diameter torpedoes. These were one of the ship's main offensive weapons against other vessels. The ship only carried four torpedoes in the tubes and could not reload at sea. This was done in harbour by crane due to the weight. The torpedo had to be perfectly aligned inside the tube so that the various setting devices could function. The davit held the torpedo while it was eased into the tube. There was an area, the Torpedo Pistol Shop, and Torpedo Stores where minor maintenance to gyros and to warheads was done. The torpedo could not be "dry fired" in the tube because it had to be immersed in seawater to cool the engine.

The mounting operated electrically by means of the motor above the mounting, but could also be cranked around manually if necessary. Normally, the torpedoes were aimed and fired from the Torpedo firing sights on the bridge, but could be fired "locally" from the mounting using its firing sight. The entire mounting trained ninety degrees over either side. The torpedoes were fired by means of an impulse charge, loaded into the breech. The expansion chamber then compressed the gas through the chamber and threw the torpedo clear of the ship by about ten feet. The trigger mechanism inside the torpedo then fired its engine as it left the tube. The torpedoes were fired from aft to forward to take into account the forward movement of the ship, and to prevent them from colliding with one another as they left the tube.

The tactics of the time dictated that the ship moved at right angles to the target and then turned to fire a "spread" of torpedoes on the apex of the turn. The torpedo could also be fired at a tangent to the target by means of setting the gyro from 0 to 30 degrees.

The torpedo itself weighs 3,000 pounds and had a range of 11,000 yards, or five and a half nautical miles at a speed of 45 nautical miles per hour (52 mph or 84 km). It had a warhead filled with 250 pounds of "torpex" which had the equivalent force of 800 pounds of TNT. Two different types of warhead exploders were used: magnetic - set to explode after a change in the magnetic field caused by the vessel's hull as the torpedo passed under it, or by a contact exploder - activated as the torpedo hits the target. Magnetic exploders were extremely unreliable and most Navies in WW2 discontinued their use.

AIR INTAKES FOR BOILER ROOMS 2 & 3

These screened areas are the combustion air intakes for the boiler. The air is drawn down into the room by turbine driven fans. The volume is variable depending on how many fires are burning in the boiler.

BEEF SCREEN

This screened locker was used to place large pieces of frozen meat. The cage was locked to prevent some or all of it disappearing before the cooks got it.

VEGETABLE LOCKER

This screened locker was used to store vegetables that did not require refrigeration.

FUNNEL UPTAKE DOORS

These were used during the cleaning of the boilers. NOTE:: there are two in the forward funnel and only one in the aft. One for each boiler.

POTATO LOCKER

The lockers were filled from the top. The covers were locked to keep the potatoes from disappearing. There is a locker on both sides of the galley

THE MAIN GALLEY

Within this space three to four cooks prepared three meals a day for over 200 men. The equipment contained is not as it was when the ship was operational. The propane stove was installed for the Sea Cadet courses in 1975 and replaced the original oil fired cast iron stove, and two large steam cauldrons. The forward section-the counter and cupboards are original. The food was served to the various mess men through the doors on either side of the galley and through the sliding panel that was fitted in the mid 1950's.

Inside the passageway on the starboard side is the bakery. It is currently empty. Originally, it had a large mix master, and two ovens. Bread and a few goodies like cake and pie's were made daily and usually baked at night, and then stowed in the Bread Locker out on deck under canvas for consumption that day. Just behind the galley both to port and to starboard are the two bins known as the Potato Lockers. A large quantity was obviously required. Potatoes were accessed by means of the hinged door in the tray. The purpose of the hasp was to prevent pilferage by the crew. Stokers were notorious for stealing potatoes and taking them below for "instant baked potato".

Out on deck on the port side across from the sea boat is a cage known as the beef screen. Here sides of beef were stowed and then were butchered out on deck in the area forward of the sea boat.

The galley is an important interpretative tool for the visitors. Most people are stunned by the cramped space. It is also important, as it is a key link to the mess deck later in the tour.

PANTRY

A storage area where the cooks would store there supplies.

BAKERY

The area where the night cooks would make the bread and other baked goods for the ships company. (The oven is missing).

PETTY OFFICER, CHIEF PETTY OFFICER, OFFICERS HEADS (four doors)

CHIEF PETTY OFFICERS WASH PLACE

This wash place contained five wash basins and one small shower.

PETTY OFFICERS WASH PLACE

This wash place contained five wash basins and one small shower.

THE TRANSMITTING STATION

The transmitting station has nothing to do with outside communications; rather, it is here that data necessary to aim and fire the main armament, the two twin four-inch mountings, was processed. Naval Gunnery is a very complex problem. Primarily, the moving ship was trying to hit a moving target. It was not simply a matter of leading the target. The calculations necessary for this simultaneous relative velocity solution were done by the ADMIRALTY FIRE CONTROL CLOCK, a primitive analogue mechanical computer. However, in its day, this would be the equivalent of today's Surface-to-Surface missile systems.

Information about the target, its range (distance from you), the compass bearing, its estimated speed, estimated course, were "fed" to the transmitting station from a variety of sources: the forward Mark 34 radar and gun director above the Bridge, the radar's in the Operations Room, and the gun mounting itself. The information was entered into the Fire Control Clock manually by a person setting the appropriate dials. Information about this ship was also entered. This vessel's course, and speed were necessary to complete the calculation of the "firing solution". The solution was a gun bearing and elevation which were then "transmitted" to gun mountings themselves. The gun's crews then trained and elevated to the specified angle.

When the guns were loaded, and the breech closed, the "gun ready lamps" would light up in:

(a) the Control Officer's position in the Director
(b) the transmitting station above the Clock
(c) The "layer's" position in the gun.

As the guns were loaded you would see "left gun A", "right gun A" "left gun B", "right gun B". When all four were lit, the Control Officer in the Director pushed a button (or directed the fire control party to do it from the Clock) and all four guns were fired electrically.

In order to hit the moving target a technique known as "straddling" was used. The first salvo, or shot was aimed to be past, or "over" the target, the second was to be under, or "short". This was observed from the Director and they reported the splashes or "the fall of shot" to the Fire Control Party. Halving the difference between these two ranges should result in hits on the third and subsequent salvoes.

Another variable necessary in the calculation of the firing solution was that of the wind direction and speed. The relative wind speed and direction were determined by the anemometer and wind vane located on the foremast yardarm, and was read from the indicators above the clock. The object to the right of the door is known as the Dumaresque. This calculates the wind triangle to give the true wind direction. The intensity of the wind has a significant effect on the round's trajectory. Other factors in the fire control solution are the ballistics, i.e. the type of propellant used, the number of rounds fired by the gun etc.

CANTEEN

This is where the ships crew could purchase there personal supplies, tobacco products, beer, soft drinks and other such items.

THE MESS DECKS

The mess decks are one of the most difficult areas to interpret adequately. First and foremost, mess deck is the term given to the area where the sailors lived. The crew inhabiting the forward end of the ship, or "in the foc'sle" was a method of accommodation used since the beginning of seafaring. It is only in the latter half of the twentieth century that the practice has ceased. One analogy that can be made is that the ship is really not that different from the VICTORY or CONSTITUTION in that the sailors lived over and around the guns they manned. HAIDA is similar in that they are around the gun support, and over the ammunition hoist which serviced them.

The most important message to convey is that of numbers. Within the four doors after upper mess 50 men slept, ate and dressed. Another 50 were below in the After Lower mess deck. Forward in the forward upper would have been another 45 men, while there were 20 in the Forward Lower mess deck. The forward end of the ship could accommodate 230 men, while the after end accommodated 20. It was crowded.

The men slept in hammocks (each had his own) which were put up when they went to bed. The black bars above your head were used for this. Everywhere you see a dent in the bar, represents the end of a hammock. The Admiralty allocation of "airspace" was eighteen inches per man. You got in or out of the hammock by pulling yourself up chin-up style from the bar, and then settling feet first. Each morning at 0600 "Wakey Wakey, Lash Up and Stow" would be piped. The hammocks were then lashed (tied) something like a sausage, and were put in the Hammock Racks located behind the gun support, and in the after corners of the space. This allowed for more manageable movement, both of crew and supplies (such as ammunition from the hoist). It also made it a little more comfortable for sitting at the tables.

Each of the tables represents a "Mess". That is eight or nine men were grouped into that particular area. A Leading Seaman, known as the Killick, was in charge of those men. Meals were prepared in the Main Galley, and at each meal, someone from each mess was designated as "the duty mess man" and it was their function to go to the galley with a large tray. There he reported which mess he was from and the cooks in the galley would "dish out" the entire meal to him who then took it back to his mess. From there, it was dished out to the individual members. This system was known as "Broadside Messing", a stark contrast to the cafeteria messing of today. The large grey lockers on the bulkheads were known as the "Mess Deck Fannies" and they housed the crockery, and utensils used by the members of that mess.

It was also the "the duty mess man's" job to wash the dishes after the meal. The duty mess man role rotated amongst the individual mess members on a daily basis.

The wooden lockers you see in the mess, which also double as mess seating (known as benches), were the only space that a sailor had for his clothing or "Kit". The "kit bag" or duffel bag would be placed in the bottom of the locker to serve as a liner. The individual items of clothing were folded, rolled and tied up in order to fit into the locker. By being rolled up they could then be layered in the locker. There was no such thing as "civilian clothes". The practice of sailors in the Canadian Navy wearing civilian clothes ashore did not begin until after HAIDA was decommissioned.

If you notice, there are three hatches going down from the after upper mess deck. This dates back to 1943. At that time all access to magazines had to have hatches in line so that ammunition could be hoisted up by hand if the electric hoist broke down. The forward starboard hatch went to the 4.7" guns shell room. The port hatch went to the casing room and the aft hatch went down to the "POM - POM" magazine which is now the forward KVA compartment.

PAINT LOCKER AND LAMP STORAGE

This area ahead of the mess decks is where the paint, signal lamp oil and some new deck equipment, such as small rope and blocks, were stored.

PROVISION ROME or STORES OFFICE

All material, parts and food stuff would be controlled and issued from this room.

SEAMANS WASHPLACE

This is the washplace for leading seaman and below. In this ship there numbers would be approximately 150 men.

SEAMANS HEADS

This is the heads for the leading seaman and below.

RADIO OFFICE (Radio 1)

The RADIO OFFICE contains three sections. The Radio Room itself is the area you actually see. The area inside the door on the left is the MESSAGE CENTRE. The room at the after end is the CODING ROOM, and this is the place where outgoing traffic was encoded (or encrypted) and decoded (See diagram 5). Some of the equipment in the RADIO ROOM was used by the Royal Canadian Navy during World War Two and on into the 1960's. Above the four CSR 5 receivers on top of the desks on the starboard side is the ANTENNA EXCHANGE BOARD. This enabled an operator to connect his receiver (by patch cord) to any of the ship's receiving antennas. On the shelf above the Antenna Exchange Board is an amplifying filter unit, which allows all four receivers to operate simultaneously, even on different frequencies. To the right of the desk are two power panels. On the left is the 24/220-volt DC Panel. On the right, under a glass sliding cover is the 120 volt 3 phase AC Panel.

On the port side are a number of sets fitted into the ship in the 1950's. Starting from aft to forward are two TED 200-400 MHz Ultra High Frequency (UHF) Transmitter Receivers which were remotely controlled from the Here, Bridge, Operations Room, and Radio Four. They allowed voice communication with other ships or aircraft. Next to that is the Canadian Marconi 11 transmitter, (CM-11) which was used with the CSR-5. These were designed in the mid 1930's, and were built by Canadian Marconi Company in Montreal. This equipment still works and gives excellent results. These sets were used for transmission and reception of MORSE CODE and for voice messages. They can also send and receive Radio Teletype in the AM mode, and receive Radio Facsimile in that mode. Next to that is the TDQ, which operates in the VHF range 120-160 MHz and in the final rack, is the TDQ receiver and one more TED. This was the basic communication system on the ship - both voice and continuous wave.

There are four Radio Rooms aboard. Radio One is the Main Radio Office in the port passageway. Radio Two is located off of the ships office flats in port side aft. Radio three, is on the port side signal deck, below the Bridge. Radio Four is above the Main Galley on the starboard side, aft of the signal deck. It was the "ELINT" compartment where radio transmissions of foreign ships (usually Soviet) would be monitored and recorded. The Transmitters located in the three areas are as follows:

There were four "Whip Antennas" fitted on the ship. The two forward ones on the bridge are receiving antenna’s going to radio 1. The two aft ones are for transmitting: one is for the PV500 and the other one is connected to a CM 11.

On the foremast there are two sets of yardarms. The “H” arm is for the UHF/VHF equipment in radio 1 and the “X” arm is for the four UHF sets in radio 3.

ELECTRONICS MAINTENANCE ROOM

Located on the main deck, port side, just forward of the break in the foc'sle, this space was installed in the 1950’s.

Here, technicians performed assorted repairs on some of the ship's electronic equipment. The only maintenance done in the EMR was on pieces of self -contained equipment that could be flashed up in this location that were light enough to carry there. The compartment also housed the ship's IFF (Identification Friend or Foe) equipment.

The RT's (Electronic Technicians) were only responsible for surveillance/navigation radars and communications equipment but this was sufficient to keep a small group very busy. ET's (Electrical Technicians) whose specialty was Sonar were designated ED's. Those whose expertise lay in Gunnery radar were designated EG's. The ET's did not use the EMR, so this would limit the amount and type of test equipment found in the EMR. In a later change, the RT trade was renamed to LT.

Under the 'L' shaped workbench, there are small toolbox pallets. On HAIDA, there are five positions but only a maximum of four techs have been confirmed. Technicians were issued toolboxes from naval stores along with a complement of tools. Many techs complained about the type of tools they were issued. Items like 20 oz. ball peen hammers, 100W soldering irons and lineman's pliers were more suitable for a sheet metal worker rather than an electronics tech.

Before this was the EMR, the ship's 293 radar occupied the entire compartment.

During installation of the EMR, the very right-most scuttle on the upper row, port side was removed and a plate welded over the hole. This, no doubt, simplified the fabrication process on the interior. This compartment was one of the last to be installed in the ship as evidenced by the three relatively "modern" light fixtures. These fixtures were commonly found on classes of ships which followed HAIDA and do not resemble any other fixtures on the ship. The workbench itself is fitted with 120 VAC, 220 VDC and 440 VAC outlets for powering up various pieces of equipment under test.

THE CARLEY FLOATS

These life rafts made out of tin and filled with cork were the primary life saving apparatus if the ship were to go down. Many people refer to the ships boats as lifeboats. They could be used for that, but given the way destroyers were sunk, very few ships had time to turn out the davits and lower boats. In the 1950's the Carley floats were replaced with twenty-man inflatable life rafts.

Wounded or injured survivors were allocated to the inside netting, so they would be sitting or lying on the raft. The survivors in the water held onto the rafts by clinging to the rope hand holds on the side (25-30 at a time). If they weren't rescued quickly or at all, the occupants perished from hypothermia and dehydration. Most of the casualties in the Battle of the Atlantic suffered this way. The average "life expectancy" in the North Atlantic was twenty minutes; even less in the Arctic.

Each member of the crew was assigned a specific raft, known as his RAFT STATION. When the ship left port, "Raft Stations" was piped and everyone not on watch went to their raft. This was the method of accounting for everyone aboard. This was also done if someone went overboard, to determine who was missing.

. TWIN FOUR INCH HA/LA MK 16 GUN MOUNTING

Loosely translated, it means two four-inch diameter guns, type sixteen, in a high angle (85 degrees), low angle (-10 degrees) mounting. There are two four-inch mountings: "**A**" gun on the foc'sle, and "**B**" gun above. The three inch fifty would be referred to as "**X**" gun. The initials S.I.L on the breech ring stand for the manufacturer, Sorel Industries Limited.

These guns constituted the ship's "main" armament as described in the section on the Transmitting Station. The gun is said to be in a mounting, as opposed to a turret. In a turret, such as on cruisers and battleships, the ammunition was supplied directly into the gun up through the centre. With the mounting, the ammunition came from outside it. If the gun mounting were to be removed the only evidence of it on deck would be a twelve-inch hole in the deck for the wiring. The gun support below housed the wiring and was a structural support. The gun mounting weighs sixteen tons. The equivalent force of the recoil with the guns at 45 degrees elevation was sixty tons. The gun was trained, elevated and was fired electrically, but was loaded manually. There was manual back up if the power failed. In reality, one person could conceivably train, elevate, load, aim and fire the gun - but only in extremes. The number of men in the gun crew varied, depending upon what the ship was doing. However, for basic interpretative purposes, the gun's crew can be said to have been fifteen, with another twelve supplying ammunition along the route from the magazine. The fire control personnel and the director are not included in this number. The composition of the gun's crew is as follows:

LEFT GUN	RIGHT GUN
1. Gun Layer (elevates)	2. Gun Trainer
3. Communication/Range setter	4. Breech worker
5. Breech worker, Capt. of Mount	6. Fuse mach. operator
7. Fuse machine operator	8. Fuse setter
9. Fuse setter	10. Loader
11. Loader	12. Ammunition supply
13. Ammunition supply	14. Safety/Rake number
15. Officer of the Quarters	

This list is applicable to “B “ gun only. “A” gun does not have the fuse machine operator or fuse setter.

The FUSE SETTING MACHINE has a brass and wood drill round sitting on it. Setting the fuse meant setting the range at which the projectile would explode. These guns also used a "proximity fuse" which had a radio transmitter and antenna-receiver inside the projectile. When it was fired, the transmitter sent out pulses. If these were reflected back to the receiver indicating proximity to the aircraft, the receiver then detonated the round. There were two different occasions when setting fuses was necessary. The first was for anti-aircraft, and the second was for surface illumination with STAR SHELL.

In the anti-aircraft mode, the fuse was set to the estimated altitude of the aircraft, and the explosion of the shell was intended to pierce the aircraft's skin with shrapnel. This was also known as "flak" - the puff of smoke you see around the aircraft in the war movies. Star Shells are completely different. They used a time mechanical fuse (the same as a clock). Inside the projectile was a flare attached to a small parachute. When the round exploded, the flare lit up and drifted down on the far side of the target thereby "illuminating it". This was the best way to illuminate a target, as you did not expose yourself when firing it. The use of searchlights in night fighting tactics was discouraged as the light exposed your position and the light then became a target.

Other types of ammunition used in the guns were S.A.P or SEMI ARMOUR PIERCING and H.E., or HIGH EXPLOSIVE. Semi Armour piercing means that the projectile was designed to penetrate the target and then explode inside it. High Explosive explodes immediately upon contact with anything. For HAIDA's actions, S.A.P. was the type of ammunition used, except in shore bombardments.

BASIC DATA MRK 16 4-INCH H.A.\L.A. GUNS

Weight of shell	35lbs
Weight of round	66lbs
Muzzle Velocity	2,619 feet per second for a new barrel
Rate of Fire	15 rounds per minute

FORECASTLE DECK

This is the bow of the ship(front end), The machine in the middle of the deck is called "Capstan Engine". It is a steam powered. On each side is a combined capstan, cable holder and brake wheels. The big chain is called a anchor cable. If the ship was going to be towed, they would disconnect the anchor, add a swivel and connect the towing wire to the swivel. It would be feed out through the Bull Ring. A section of cable would be lowered. This was done to help keep the towing wire below the surface. The anchor cable come up through the deck in a Navel Pipe and goes down to the anchor in the Hawse pipe. The small cable attached to the main cable is called a "Scotchman'

Near the front end, just to port you will find a brass circle. This was the forward fuel oil filling connection. On the starboard side you will find a small circle that says "Sperm Oil Filling". There is nothing connected to the under side of this fitting, but it was believed that it was for lamp oil. During the war all war ships carried a set of oil navigation lights incase of power failure. In those days they would have called the oil "paraffin".

THE SHIPWRIGHT SHOP

The shipwright shop was a workplace for sailors whose trade was a combination of plumber, carpenter and sheet metal worker. They were the forerunners of today's hull technicians.

THE PETTY OFFICERS SECOND CLASS MESS

The Petty Officers Second Class mess was the area where the various departmental, mid level supervisors lived. The Petty Officers were the main link with the crew and were the day-to-day, departmental supervisors.

LAUNDRY ROOM

This was the ship’s laundry. It contained a large drum type washer, extractor, electric ironing machine, and a steam heated dryer. The equipment is all missing. It was normally a two-man crew working study days. Each mess would have a specific day in which they would get their clothes washed. A little bribery helped get extra care of your laundry. This area was installed prior to going to Korea. Prior to this, each man was responsible for his own laundry

THE HEADS OF DEPARTMENTS AND ENGINE ROOM ARTIFICERS MESSES CHIEF PETTY OFFICER 1st CLASS & CHIEF PETTY OFFICER 2nd CLASS MESSES

This was the home of the Chief Petty Officers (C.P.O’s) of the ship. They were the senior non-commissioned officers of the ship, and were also the heads of their departments or trades. The coxswain was the senior non-commissioned member of the crew aboard. The coxswain was the only non-commissioned member of the crew who could go to speak directly to the Captain, everyone else had to go through the proper chain of command. The coxswain was the person in charge of scheduling watches, responsible for the operation of the canteen, and acted as a mediator and advisor for members of the crew in dealing with work or personal problems. There was also the chief boatswain mate (known as the "Buffer") who was the person in charge of the upper deck maintenance and supervised things like paint and cleaning crews, chief weapons technician**,** chief electrician, and chief store's man and a chief electronics tech.

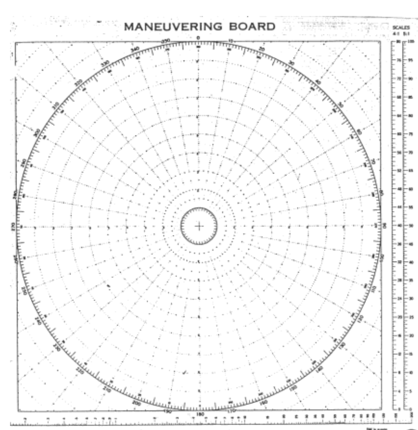
The other mess was for the engine room artificers (or E.R.A's). These were the senior members of the engineering department responsible for the operation and maintenance of the Engine Room, Boiler Rooms, Gearing Room, etc. The term "artificer" is from the British Navy which means tradesman, or highly skilled journeyman.

There is a small pantry in the laundry room flats for them to make small snack or even dinner. This area has a hot plate, sink and dishes. The fridge is in the mess.

THE OPERATIONS ROOM

There are actually four different spaces in this area, all of which serve a specific purpose. They are The OPERATIONS ROOM, the CHARTHOUSE, the SONAR CONTROL ROOM, and the WHEELHOUSE.

The operations room is the area seen from the door. During World War II it was known as the "plot ". There was one plot table under the opening in the deck head. There was a magnifying lens mounted in the opening. At night, the officers on the bridge could easily watch the plot from the Bridge above. With the 1949/50 refit came the introduction of radar, with a display on the bridge. At that time, an additional plot table was installed. There are two plot tables. The large one is correct but the smaller one is similar to the original one.. One plot table was used to diagram, or "plot" the movement of HAIDA and all other ships and subs, while the second table was used to track aircraft in the area. The way it works is that a projector at the bottom throws an image known as a GRATICULE to the tabletop. Simply defined, a graticule is something similar to a spider's web. The radial lines represent degrees of a circle (the compass), while the concentric circles represent distance in yards. Tracing paper was put on the glass top of the table and the projected graticule moved across the bottom of the table, throwing the image to the tracing paper. The motor was connected electrically to the gyrocompass and a chernikeeff log moved the graticule at a scale down speed and direction of the ship. You diagram the three dimensional phenomena (what you see visually) into a one dimension in order to discern the targets movements. Once that was established, the tactical information necessary to manoeuvre your ship was available. This information was then relayed from the "Plot" to the Bridge.



When the ship was built in 1943, this area's was much smaller. On the port and starboard sides in the OP's room and Sonar Control room you can notice the dropped deck head. All of the deck under the drop was outside. There was a walkway from "B" gun that went aft to the signal deck.

The specialized equipment in this small space is as follows:

Sperry Marine Radar – Mk2

This is a 0 to 30-mile range; surface search radar designated as High Definition Warning Surface (HDWS). From the early 1950's, until well into the 1970's, almost every ship in the RCN was fitted with the Sperry Mk 2. Although its primary use was to locate other ships, helicopters, navigation aids and shorelines, it was very effective in detecting submarine periscopes. The Mk 2 set was first produced by Sperry Gyroscope of Great Neck, N.Y. in 1953.

The Sperry radar operates in the 9375 MHz (former "X" band) at a power level of 30 kilowatts and has a maximum range of 30 miles. Today, Haida has a complete, working system and the parabolic slice antenna is mounted on the foremast just below the large air search antenna.

The other unit forward of the plotting table is a VK5 radar display manufactured by Westinghouse in Hamilton. The VK5 could display either the 6C (air search) or Sperry signals. Both radar displays are referred to as PPI (plan position indicators).

VK5 Repeater Unit

This is a radar PPI display that could be driven by either the 6C radar or Sperry radar signal. The VK5 can display bearing and range information in a standard configuration with range rings or electronic cursor but with the addition of off centre sweep it could display signals from another ship or aircraft and show you bearings and ranges from your own position. The VK5 can display bearing and range information in a standard configuration with range rings or an electronic cursor. By using the *off-centre* sweep function, it could display signals from another ship or aircraft or show bearings and ranges from one's own position. The power supply for the VK5 is in the sonar control room. The VK5 contains 101 electron tubes and has operated, but is in need of repair. Above the VK 5 is a bracket that mounted a SQS 501 repeater.

IFF (Identification Friend or Foe)

When Haida was first commissioned, she was fitted with the Mark III IFF system. By the time she was paid off, HAIDA had the Mark 10 IFF system which was comprised of the AN/UPA24, AN/UPX-1, and AN/UPX-5 devices. The control box for the UPX-24 video decoder can be seen on the forward bulkhead in the Ops Room near the VK5 display. One IFF antenna (white cylindrical object) can still be seen at the tip of the lower yardarm, foremast, on the port side. HAIDA's IFF equipment was fitted in the Electronics Maintenance Room (EMR) and unfortunately there are no longer any examples of it aboard the ship.

Decca Navigator

The Decca system was a coastal electronic navigation system that was more accurate than the loran system. There were special charts made up using standard charts with Decca lattices printed over it. They were fitted on the Canadian ships in the early 1960's. It consisted of a large receiver box and display unit. The antenna connection box is all that remains of the original unit, on the starboard side of the operations room. A Decca display unit is mounted nearby.

SQS 501 Sonar Display

This sonar was a bottoming unit with the beam going straight down. But it also a early version of side scan, in that there was transducers mounted on an angle in the side of the hull. You can see the remains of them down in the sword compartment.

CHART HOUSE

This is where the Navigating Officer did the majority of his work. In the 1960's this room contained a Loran-A receiver, gyro repeat and three chronometers. In the early 1960's, a Decca receiver was fitted. The drawers contain folios of charts of the regions of the world in which the ship was operating as well as other areas to which the ship might be diverted on short notice. The Navigator was responsible for the "passage plans" that is, determining the best course to get from point A to point B. In addition, the Navigator supervised the Navigator's Yeoman who was trained to "correct" or update the charts carried aboard. Prior to 1958 this area was the target designation room. In the 40's it contained a radio receiver to listen to the enemy transmissions. Prior to 1958 the chart house was on the starboard side of the OP's room while the area was known as the target designation room. Some of our older drawings show it that way.

SONAR CONTROL ROOM

This room contains the control equipment and indicators for the various sonar's sets carried in the ship. SONAR is an acronym for Sound Navigation and Ranging. Originally this was an American term which was adopted internationally with the formation of NATO, as the name for the devices which used sound waves transmitted underwater to locate submerged objects such as submarines, mines, torpedoes, or even wrecks.

Prior to the adoption of the term Sonar, the Canadian, British and other Commonwealth Navies used the term ASDIC, in reference to the Anti-Submarine Detection Investigation Committee of 1917, which designed the equipment.

HAIDA carried various submarine detection equipment over the years. By the end of her service life she was fitted with the following:

<u>Sonar type AN/SQS10</u> - An American built search sonar first produced in 1950 with a search range of 6000 yards under ideal conditions. This was vastly superior to the 2000-yard range of WWII vintage ASDIC sets.

<u>ASDIC SET 147F</u> - A British depth finding set which complimented the main ASDIC. It first entered service in 1943.

<u>ASDIC SET 164B</u> - An ASDIC used in conjunction with the Squid ahead-throwing weapons systems. It was a range and bearing finding device which was supplemented with data from the 147F set.

None of aforementioned equipment is aboard today. The following equipment is set up on the table on the outboard bulkhead, from forward to aft:

1. DEPTH FINDER CONTROLLER and indicator. Depth was determined by tilting the TRANSDUCER (Transmitter/Receiver) located in the Sonar dome attached to the bottom of the ship. By measuring the angle (o), and the range (r) the depth (d) was automatically calculated.

2. RANGE RECORDER- When an echo was received the metal stylus moving across the iodine treated paper "burned" a mark on the paper. This was measured on a mechanical scale to show the range. The Range Recorder also controlled the firing of the SQUID MORTARS. When the metal bar, on the top part of the recorder contacted the firing pin, the firing sequence for the mortars was initiated. Various factors in the firing equation were entered mechanically: own ship speed, target depth (estimated or calculated), target bearing, target range, range rate (the rate of change in the bearing or the target's movements). To obtain the complete solution it was necessary to reduce the bearing rate to "zero" in order to close the submarine on a collision course. The Squids fired automatically when the range equalled three hundred yards.

3. FIRST OPERATOR, or CONTROL CONSOLE. This indicator was used to set up the sonar pattern that was transmitted. Each time the operator heard an "echo" he pushed the button in the centre of the indicator. This sent an electrical pulse to the Range Recorder, Bearing Recorder and Depth Recorder, making a "burn" mark on the paper on each of them.

4. BEARING RECORDER. The bearing of the submarine Relative to the ship was recorded on the paper. The angle at which the line of these bearing marks developed, as successive echoes were recorded, indicated which way the target was moving- left or right Relative to the ship, and how fast.

Various other equipment was found in the Sonar Control Room, such as telephones, the Mark IV Fuse Setting Panel, and other devices for transmitting sonar information to the Bridge and OP's Room.

The equipment for transmitting and receiving in sonar pulse was located in the SONAR INSTRUMENT SPACE in the Forward Lower Mess deck. The TRANSDUCERS for each Sonar set were located in the SONAR DOME, directly below the Forward Lower Mess deck. This area was expanded width in wise in 1950 to accommodate more equipment.

WHEEL HOUSE

Two important operational functions took place here: (a) the ship was steered by the helmsman; (b) Engine orders were relayed from the Bridge, through the wheelhouse for execution and acknowledgement by the Engine Room.

The ship was directed or conned by means of a gyrocompass repeat. The gyrocompass was located off the electrical workshop flats. It generated an artificial axis pointing to TRUE North. The ship's course or heading was indicated by the number of degrees clockwise from North, being either 000 or 360, East 090, South 180 and West 270, etc. The helmsman was told what course to steer by the Officer of the Watch (OOW), and he did this by turning the ship to port or to starboard until the correct numeric course was showing on either the Starboard Gyro Repeater. The helmsman could not see where the ship was going. This is the concept the visitors find hard to imagine. The Helmsman was literally concerned with watching three numbers move either left or right in a lit screen of the gyro repeat. It was the Officer of the Watch, who was controlling the direction and speed. There is also a MAGNETIC COMPASS in the Wheelhouse. It was used to steer the ship if the Gyro Compass failed due to power failure or damage.

The engine room telegraphs were used to tell the Engine Room what to do. Notice that there is the Port Telegraph, and the Starboard Telegraph, which command the port and starboard engines. The settings on the telegraph are in three modes: STOP, AHEAD, and ASTERN. Within the Ahead and Astern settings there are three speeds, slow, half and full. The order would be given by the OOW via the voice pipe, and repeated by the Helmsman such as "Port engine slow ahead, Starboard engine slow astern". The men on the telegraphs would then set the telegraphs to the ordered speed. When this was done, the TELEGRAPH REPEATER in the Engine Room moved to the same setting and a loud bell rang in the Engine Room. Someone from Engine Room replied by pushing a button on the post that rang a reply gong. This then rang a bell in the Wheelhouse telegraphs which served as the acknowledgement. The Helmsman would then reply, "Engine Orders passed and repeated Sir" which told the OOW that the engine room had complied.

Once the ship was underway, the telegraphs were normally set at half ahead, or cruising speed. The ship's speed would be adjusted up or down by means of increasing or decreasing the number of Revolutions of the propeller shaft. This was ordered via the Starboard telegraph. You will notice that it has two handles, while the Port one. This is the Revolutions telegraph and applies to BOTH engines. The OOW would order "Revolutions Two Zero Zero". The Helmsman would repeat the order and the operator would set the starboard telegraph to 200 revolutions. Again, the bell would ring signifying the engine room's compliance, and the Helmsman would report "Two Zero Zero Revolutions passed and repeated, Sir."

There are a few more devices in the wheelhouse. 1) Four hydraulic pressure gages on the forward bulkhead to show weather the pumps in the wheel are working. 2) A rudder angle indicator to show whether the rudder was responding to the wheel. 3) An indicator to steer by sonar. This was used when the sonar system had a contact and allowed the helmsman to keep the ship heading towards the target. 4) Gyros fail alarm and light. This would come on if any problem developed with the gyrocompass.

From this you can surmise that something like coming alongside a jetty could involve numerous and simultaneous engine and wheel orders, all of which were relayed by the helmsman. This is why senior Petty Officers took the helm while doing such manoeuvres as they had years of experience. When this ship was in operation, and during the war, the coxswain took the wheel at action stations, or when entering or leaving harbour or any other intricate steering.

CAPTAINS SEA CABIN

This is a small room with a bunk and washbasin where the captain could come during a break in the action. He could get his steward to bring him refreshments there. There are communication devices so that he can stay in contact with the bridge.

THE BRIDGE

Command, Control, Communications are the three words which best describe the basic functions of the Bridge. Everything, and everybody aboard came under the "command" of the Bridge. Anything the ship was doing when underway, was controlled, authorised, or ordered from the Bridge. It was the "Brain" of the ship.

COMMAND

The CAPTAIN exercised command, either personally, or through the officer of the watch, or in some cases, the navigating officer known as the "Pilot". Command in this case included conning the ship, authorising the use of weapons, or of anything else that needed doing.

CONTROL

“Control” referred to the movement of the ship, and the operation of all weapons systems. The ship was “conned”, or directed by the Officer of the Watch (OOW). The ship was moved from one compass course to another. The OOW was usually standing at the pelorus, or the Gyrocompass repeater where he could be in the centre. There was a magnetic compass there as well in case the gyrocompass failed. He was the one who was watching where the ship was going. All departmental reports were made to him and then from him to the Captain through reports such as "Number One Boiler Room on Line", "A" Gun Closed up", "Damage Control Party Closed Up", etc. In addition to this, the Officer of the Watch was directly responsible for the duties of the watch on deck. The OOW was responsible to the Captain for the safety and navigation of the ship. Only the Captain could override the OOW.

All the ship's weapons systems were controlled from the Bridge. In surface action or a shore bombardment, the guns were controlled by the surface gun director, (see the section on the Transmitting Station). In anti-aircraft action, the Mk 29 gun sight and the MK 34 gunnery control radar, controlled the guns. The torpedoes were aimed and fired from the Bridge, from the Torpedo Firing Sights located on the port and starboard sides, aft of the gate to the Bridge.

COMMUNICATIONS

Communication was both external and internal. The 20” and the 10” signalling lamps were used to communicate with other ships in Morse code. The flag signals hoisted on the Signal Deck were controlled by the chief signalman, or yeoman of signals, from the bridge. In addition to these, Morse code could also be flashed from the fighting lights on the foremast yardarms. There was also a pair of infrared lamps for nighttime. Messages and signals sent from the Radio Room also originated from the Bridge. Internal communication was done by the ship's broadcast system, sound powered telephones, by voice pipe or by messenger. The sound powered telephones are a point-to-point communication system. The crank on the phone would be turned, a light and buzzer would activate on the called phone to draw attention. When going into action, each section of each department, Gunnery, Engineering, Communications, Damage Control, Operations, Torpedo and Anti Submarine reported to their department head, who in turn reported to the OOW. The same was true in normal peacetime cruising and at each change of Watch. Of course, this communication was not uni-directional.

The OOW could call almost anywhere in the ship as required. If he couldn't access the space directly, it would be done through the department. For example, if there was a problem with the steering gear, the OOW would communicate to the Steering Gear Compartment through Engine Room. The "circular" things on both sides of the Bridge are the target BEARING indicators. These have a variety of uses. First, it must be realized that when a ship was underway a system was necessary whereby the location of objects (other ships, navigational buoys etc.) could be recognized in relation to our ship's position. This was done by an identification system which used PORT and STARBOARD. Therefore the Bull Ring is Zero and the Ensign Staff is 180 degrees.

The SURFACE GUN DIRECTOR, is a MARK 3W RANGE FINDER/DIRECTOR. It had a crew of four: Control Officer, Rate Officer, Layer and Trainer. The range finding portion was removed when the Mk 34 radar was installed. The Control Officer viewed the target through optical range sights. The Trainer then moved the Director onto the bearing of the target. The Layer could then elevate to the angle of sight, but up to a maximum of eighty degrees. As this was happening, the Range taker was recording the range as viewed from the range finder. This data was sent to the Transmitting Station for processing. The Rate Officer was responsible for detecting changes of course and speed of the target. He sent this information to the T.S. by sound powered telephone.

When the Director moved, it drove the bearing and elevating indicators in "A" and "B" guns, and the Layer and Trainer in the mount moved to the same Relative Bearing and angle of elevation by following the "pointer". As stated previously, the Gun Ready Lamps are to the left of the Control Officer's seat. The Control Officer was also the one who observed the Fall of Shot, and this information, over, under, straddle was sent to the T/S by means of a buzzer, and sound powered phone.

THE CATWALKS

These walkways were installed in the ship during the refit of October 1944. Due to the split deck configuration (the forecastle higher than the "Main Deck"), specifically designated as the Upper Deck these ships were "wet". In periods of rough seas or heavy weather, the Main Deck was awash with water. Therefore, movement around the weather decks was very dangerous in certain situations. A "Lifeline" was rigged which started at the break in the forecastle, was lashed to the funnel "Guy Wires" and secured to the After Canopy, which the sailors could hold onto as they moved fore and aft. If it were really treacherous, safety belts would be hooked onto it. The inclusion of the catwalks connecting one deck (the foc'sle) with the After Canopy made fore and aft movement much easier and safer in heavy weather.

THE EMERGENCY STEERING POSITION

The Emergency Steering Position consists of the "Binnacle" which housed a Magnetic Compass, a Gyro Repeater (which is not there, but would have been on the upright bracket near the Port Telegraph), the steering wheel, and the two engine telegraphs. Note that there is no Revolutions Telegraph as in the Wheelhouse. Revolutions were passed to the Engine Room by sound powered phone. The actual location of the Wheelhouse, while being practical and efficient in terms of operating the ship, is very vulnerable in combat. When so engaged, standard tactics called for the Bridge to be the Primary target. If the Bridge was damaged or destroyed, so was the Command and control of the vessel and thus, its ability to continue to fight was dramatically reduced. If the Bridge were hit, the Wheelhouse would sustain damage.

The Emergency Steering Position is the back up position if the Wheelhouse was knocked out, or if steering from there failed. It was strictly used for steering, and engine controls, not command and control, as was the Bridge. Steering would resume from here. If there was a steering failure the ship could also steer from the tiller flats or by "Main Engines". This was very elementary manoeuvring, but if that was all you were capable of, then it was still effective.

When the ship was in action, the EXECUTIVE OFFICER, or the "second in command" was stationed at the E.C.P. so that he could also direct the DAMAGE CONTROL PARTIES. For example, if the Bridge were hit, the X.O. was the person who sent people there to (a) tend to the wounded, (b) put out the fires. Once appraised and advised of the situation, the X.O remained there, or assumed command of the ship if the Captain was killed or incapacitated.

THE 40MM BOFFINS

These 40MM BOFORS anti aircraft guns were installed at different times. The two at the emergency conning position were installed in late 1944 and the other two were installed in 1949-50, and are on the original twin 20MM OERLIKON power mountings. This was a Canadian Navy innovation. The mounting operated hydraulically, with the fluid being supplied by the pumps forward of the after funnel on the Bofor deck, and aft of the helm on the Emergency Steering position. The mounting moved in response to the movement of the fire control "joystick". These guns used to have a Mark 11 Gyro Gunfight.

The design of the gun is such that it had a very high rate of fire due to the fact that the vertical block in the breech, opened upon recoil of the gun, so that the casing was ejected almost immediately after firing. This resulted in a rate of fire of 120 rounds per minute. The rounds were loaded into the breech in "clips" of four as you see displayed on the mount. There was a crew of two on the mount: Aimer and Loader. The ammunition used was high explosive, and was not fused. The gun could elevate to 70 degrees, and could depress to 0 degrees which allowed it to be used against close in surface contacts which were below the arc of fire of the twin four inch. The Boffins proved to be extremely useful to the RCN ships in Korea for blowing up floating mines.

THE ORDNANCE WORKSHOP

The Armourer’s Mates who were responsible for maintenance to all of the ships weapons used this space. As much as possible, maintenance was done at the particular gun mount, but occasionally, parts were removed and serviced here, or in the Engineering Workshop. Thus, this space is primarily used now for the storage of tools and accessories. It was also used as the crew shelter for the Boffins.

THE AFTER MARK 34 RADAR COMPARTMENT

This space housed the Mark 34 radar that was the range part of the 63 fire control system (34 radar + 29 gunfight = 63 system) for the 3"50 gun. The deck above had a Mark 29 Gunfight which was linked directly to the Mark 34 Radar in the compartment and the 3”50 gun. The transmitter / receiver for the 34 radar was in the rag office flats directly under the gun.
The Mark 63 system is designed to give continuous solutions for the fire control problem and to direct the fire of the guns against targets at ranges of 800 to 7000 yards, and at speeds of 300 to 800 knots.

When the operator of the Mark 29 Gunfight pedestal could see the target, he tracked it by keeping it continuously in his sight. As he tracked the target visually the lead angle (or aim-off) was calculated electro-mechanically, and the gun was continuously trained onto the line of fire. As long as the gunfight operator kept his sight on the target the lead angle was maintained.

At the same time the radar antenna on the gun was pointed directly at the target. When the radar signal from the target was detected it is said that the target has been acquired. The Mark 34 radar system was held on to the target manually for range and range rate. There was a small 2” scope that had a dot in the centre to show the position of the target in the antenna. Other data such as ship's course and speed, along with wind direction and speed was fed into the Mark 34 system and the gun fire control solution was calculated. The gun was trained continuously to the correct line of fire and firing could commence when the target was in range.

In good visibility the target could be seen through the gunsight and the operator continued to track it. He could also see the radar signal in his sight. This was the same signal shown on the little screen in the radar room. By keeping the radar blip centred of the tube, the operator could continue to track the target even in darkness or poor visibility. As long as the operator was tracking the target a solution to the fire control problem was generated and the gun continued to be pointed on the correct line of fire.

“A” and “B” guns had a similar system with the Mark 29 sight just behind the bridge, the Mark 34 radar room under the aft end of the bridge and the transmitter / receiver in the transmitting station.

Both systems had a parallax system built in to account for the distance between the sight and the gun mount. Firing the guns ahead or astern made no difference with respect to the position of the sight versus the position of the gun. When you fired on either beam, it made a big difference especially at short range.

THE 3"50 R/U MAGAZINE

This room contained some of the ammunition for the 3"50 guns. There is also a magazine below the Wardroom Lobby. It contained both 3"50 rounds and 40mm rounds. The Ready Use Magazine was required to be close to the gun mount due to the large numbers of rounds expended by the guns. There was 205 rounds stored here. This space was restored to its present appearance in 1991. Items of note within this display are the four ammunition trays for supply to the ammunition numbers for the gun. In addition you can see the special canisters that the rounds were stored in. These actually interlock, to prevent their moving around at sea. This space was also used as the crew shelter for the 3”50 guns crew.

THE 3"50 CALIBRE GUNS

These guns fired a round that was three inches in diameter. The length of the gun barrel is 50 times the diameter=150 inches. Hence the name 3"50 calibre. This was designed by the U.S. Navy, primarily as an anti-aircraft gun. It could be used as a general-purpose weapon as well. This gun was installed during the conversion refit of 1950-1952 and occupies the space where the Twin Four Inch mount, or "X" Gun, was mounted during the World War II period.

Unlike the Twin Four Inch, these guns could only be operated electrically. There is no manual back up. This gun has two types of control; automatic control whereby the mount was operated from a remote director, and there was Local Control in which the mount operated in response to signals originating on the mount, from the fire control data. When in local control, there were two types: Local surface Control (the right hand position) and Local Anti aircraft Control (the position on the left).

The gun crew consisted of the following:

1. Mount Captain
2. Local Surface Operator
3. Local Antiaircraft Operator

4. Sight Setter
5. Left Shell man, Left Gun
6. Right Shell man, Left Gun
7. Left Shell man, Right Gun
8. Right Shell man, Right Gun
9. First Magazine Loader
10. Second Magazine Loader
11. Third Magazine Loader
12. Fourth Magazine Loader

One difference between this gun and the four inch is that here, the loaders were loading ammunition into a hopper system wherein the rounds cycle around. They were actually "catapulted" into the breech by means of the chain drive, hence the swiftness and number of rounds fired per gun. The expended casings were flung out via the chute and were thrown clear of the mount. The "baskets" located below the gun mount were for these expended rounds. As they ejected they would be sent down there so that they could not interfere with or cause a jam of the mounting.

BASIC DATA

Weight of Mounting:	31,700 pounds
Limits of Gun Movement:	Elevation 85 Deg
	Depression -15 Deg
	Left/Right Train 360 deg either side of zero

Gun Laying Speed, Elevating rate: 24 degrees/second
Training rate: 30 degrees/second
Rate of Fire, per gun, per minute, by design is 40 rounds per barrel

Maximum Range Surface Fire	14,200 yards
Ceiling at 85 degrees elevation	30,400 feet
Initial Velocity	2,750 ft/sec for a new barrel

THE SQUID ANTISUBMARINE MORTARS

The Squid Mortar represented a significant technological development during the Second World War, and was developed for the anti-submarine problem. In her original 1943 configuration, HAIDA carried depth charges in a rack on the stern as well as two Depth Charge Throwers. This was the standard anti-submarine weapon (held over from World War One) and which proved to be very ineffective for convoy "point defence" or in single ship attacks. The problem derived from the ASDIC detection gear. In order to attack the submarine, the surface ship had to pass over it to drop depth charges off the stern. However, as the ship got close to the target, the echo from the submarine was returned almost simultaneously with the ASDIC pulse being transmitted. Therefore, it was impossible to determine the precise range of the submarine. As you attacked, you were "guesstimating" the submarine's position. Also, once you did attack, you had to start a new ASDIC search to reacquire the target (that was the submarine's best chance for evasion). With the development of the "creeping attack" where one ship maintained a constant contact and then directed a second ship to the attack, the results improved. The escort groups using three to four ships and taking turns attacking later perfected this. This was not developed until late 1943.

The Squid combines the features of an ahead throwing weapon, with the fusing and explosive power of the depth charge. The first submarine sunk by Squid was in August 1944.

The firing range depended on the relative course and speed of the submarine. The range of the weapon is 300 yards. If the submarine were closing, the firing range would be greater than 300 yards, while if it were moving away, the firing range would be less. The firing range is different than the actual, because you have to allow time for the depth to be set and the bomb to be fired and get to the exploding depth. Just prior to firing, each bomb was given an electrical pulse that set the depth that it should explode at. When fired, the bombs flew over the ship's mast and landed 300 yard ahead. The six bombs were fired in a pre set sequence so that they actually formed opposite triangular patterns. If you look closely at the mount, you will see the three-barrel's are not parallel with each other in either plane. The first three were set the deepest, the second three, fifty feet shallower. The two patterns encircled the target and the simultaneous explosions at the two depths crushed the pressure hull of the submarine. Both mounts are gyro stabilised to counter ships roll. The gyro unit is located in the electrical workshop.

COOKS AND STEWARDS MESS

This was the mess deck for the twelve to fifteen ships' cooks and wardroom stewards. It is now a permanent display on Canada's Naval Uniforms, unveiled in June 1995. The first uniform is that of a Warrant Officer's Dress uniform, 1938. The jacket is known as a Frock coat. The "cocked hat" and its case reflect the Royal Navy's history and tradition of fighting sail and the "age of Nelson". The next three officer's uniforms show the distinctive lace between the Royal Canadian Naval Reserve (RCNR), the Royal Canadian Navy Volunteer Reserve (RCNVR) and the Royal Canadian Navy (RCN). The Engineer Lieutenant Commander has the "diamond" lace of the RCNR, while the Lieutenant is the "wavy" stripe of the RCNVR (the majority of those who served during World War II.) Captain DeWolf's white jacket shows the "straight" lace of the RCN, or regular navy. Commander Willson's Canadian Armed Forces "Green" uniform represents the period of 1970 to 1987 the so-called "unification uniform". It would not be a misrepresentation to say that naval personnel detested the "green" uniform. The last uniform is the current naval uniform, or "Distinctive Environmental Uniform" which came into service in 1987. The jacket is that of an Ordinary Seaman Cook.

TILLER FLATS

In this area is the equipment that operated the rudder of the ship. The three cylinders on the upper, port side of the steering motor assembly are called telemotors. They are moved back and forth by pumps located it the wheel assembly. The motion is transferred to the two steering motors through the big spring on the front of the assembly. The steering motors are hydraulic pumps that operate the two large hydraulic cylinders refereed to as rams. The rams push the tiller arm that is attached to the rudderpost. For a much more detailed description refer to the engineering section of the manual.

THE SQUID HANDLING ROOM

The Squid bombs came up the Squid Hoist using the electric winch on the port side. They were then stowed on the racks and shifted out to the trolleys by means of the hand cranks. The Local Control Fire Console is on the after bulkhead, on the starboard side just beside the door. On the forward bulkhead is the C.A.T. Gear or COUNTER ACOUSTIC TORPEDO device. The Germans developed an "escort killer" torpedo which "homed in" on the cavitation noise the ship's propellers made in the water.

CAVITATION is the formation of "cavities" or bubbles in the water, around the propeller blades. The explanation is quite complex, but basically, when the propeller blades turn at a certain speed, there is a pressure differential between the two sides of the blade which causes the water to vaporize, making a sort of bubble. The water rushing in to fill the cavity makes a loud noise. As the escort could not out run the torpedo, this became a very effective weapon. It was developed so that the U-boats could cripple the escorts of the convoy, enabling them to sink the merchant ships without fear of counterattack.

The CAT was towed astern or "streamed". The spindle allowed the towline to twist without flipping the CAT, while the two forty-five degree angle arms drove the CAT underwater. The fin kept it on a flat course. The sound of the water running between the two bars was similar to that of the propellers, and louder, so the torpedo would be attracted to it, instead of the ship.

The Squid Handling Room occupies the space originally held by "Y GUN", the after 4.7 mounting. It was here on the morning of August 6, 1944 that Leading Seaman Roy Betts, and Able Seaman Gordon Rowe were killed, and eight others wounded when a 4.7 casing exploded during loading. Although wounded himself, ABLE SEAMAN MICHAEL KERWIN pulled two members of the gun's crew out of the fiery mount. He was awarded a CONSPICUOUS GALLANTRY MEDAL (one of only two awarded to the RCN). There is a memorial plaque located on the bulkhead on the starboard side.

The only evidence of the mount still remaining in this area, are the two round plates welded on the deck either side of the forward door. That is the position of the ammunition hoists for the 4.7 gun

THE WARDROOM

The Wardroom is a very important interpretive area, as it shows the visitors the difference in lifestyles between the ratings and the officers. The Wardroom was the "home" of the ship's officers. They took their meals there and also used the area as a social and recreational one. The activities of the Wardroom Mess were supervised by the Executive Officer who was the President of the Mess. The Captain was not a member of the Mess, nor did he have access to the Wardroom. He was invited in for movies, socials and mess dinners, etc. This is a tradition dating back to the days of sail when the Captain had his own food, steward and coxswain. The system was actually very effective, as the Captain remained detached from the officers so that they could relax without being under constant scrutiny. The Command aspect was thus solidified, and reduced the likelihood of "personality clashes".

The WARDROOM was also used as the area for treating injured and wounded when the ship was in action. The Medical Officer and the Sick Berth Attendant assessed and treated wounded crewmembers or survivors as they were brought down. In fact, this room was used for that very purpose the night the ATHABASKAN was sunk. The combination of oil and water dripping from the survivors was such that it actually sloshed over the bottom sill of the Wardroom door. Seriously wounded or injured were placed in SICK BAY, or in the various Officers' Cabins. Hammocks could also be slung in the AFTER CANOPY to accommodate large numbers of wounded.

The Squid Hoist is the structure that dissects the room. It allows for the movement of squid mortars from the squid magazine below up to the squid handling room above. The curved settee behind it is actually the remains of half of the original 4.7” gun support for "Y Gun". Before 1950, the Squid Hoist would not have been there, and the other half of the gun support would have come to approximately where the after end of the elevator is now. The buffet is original. When viewing it, the cupboard on the left is the ship's pistol lock up (it contains wooden replicas). The cupboard on the right contains beer steins that were formally owned by the Wardrooms of HMCS NOOTKA, and HMCS CAYUGA, and have the names of some very famous Canadian Naval Officers on them. The space between them has the officers outgoing mailbox, and the chits in the slots are the individual officer's bar chits. The brass label on the mail box states "Presented by Marine Industries Ltd, to the Wardroom HMCS HAIDA on the occasion of her refit in Sorel P. Que. July 1961". The portrait displayed is that of Vice Admiral Horatio Nelson, Viscount of Levis, and victor of the battles of Cape St. Vincent (1797), the Nile (1798), Copenhagen (1801) and Trafalgar (1805). It could be argued that his presence has no validity or link with HAIDA; however Nelson is universally revered within the naval community. Many of the traditions of the Service are direct results of his influence and success.

The blue flag to the left of the buffet is the flag of the Lieutenant Governor of Ontario, and was given to the ship by John Black Aird. The portrait on the Squid Hoist is that of Queen Elizabeth the Second. All officers hold a Commission which is a call by the Monarch for that person to serve in the military on his/her behalf. When the ship Commissioned in 1943 King George VI was the monarch so the ship was His Majesty's Canadian Ship. When HAIDA recommissioned in 1952, she was the first Commonwealth warship to commission under Queen Elizabeth II.

There are two large photographs, and one painting displayed above the settee. The picture with the white matt and silver frame is the Commissioning picture taken on August 30, 1943. It is a useful tool as it shows the original armament, and the Home Fleet Camouflage pattern. The photograph in the black frame showing HAIDA taking a bow wave was taken in 1948. HAIDA is actually going through the wake of the aircraft carrier HMCS MAGNIFICENT just prior to refuelling. This is an excellent picture showing the way the ship moved, and provides good detail of the original 4.7" mountings. The noted American marine artist, Carl Evers, did the painting entitled “Action at Dawn”. The picture depicts HAIDA engaging the German Destroyer T-27 on April 29, 1944. This painting also provides good detail of the ship's original configuration.

OFFICERS' CABINS

Within the WARDROOM Lobby are five cabins for some of the ship's officers. The three on the Starboard side are (from forward to aft) Cabin One, Cabin Three and Cabin Five. The two on the Port side are the EXECUTIVE OFFICER'S CABIN, and Cabin Six. With the exception of the X.O.'s cabin, the rest are double cabins, with two officers in each. Between 1950 and 1958 there was another cabin across from the COOKS AND STEWARD'S MESS, aft of the Wardroom known as Cabin Seven. It housed four junior officers. After 1958 it became number three naval stores. We currently store flags there.

The upper bunks in the double cabins fold down to make a settee.The desks, wardrobes, and sinks are all original. Another point to make is that CDR Bob Willson (who is on the board of Friends of HMCS HAIDA and was a former CO of HAIDA while at Ontario Place) lived in Cabin One for two years from 1956-1958, when he was a Sub-Lieutenant and junior Lieutenant, as the ship's Navigating Officer. There were four officers who had single cabins as in each case, the cabin doubled as their Department's office. They were: the Captain, the Executive Officer, the Supply Officer, and the Engineering Officer.

The Executive Officer was not a watch keeper; rather his position could best be described as the ship's General Manager. He co-ordinated the ship's routine with the Captain and the various Heads of Departments. He was responsible for the ship's Watch and Quarter

Bill for each member of the crew. This shows (a) his mess (b) his action station (c) his station for entering and leaving harbour (d) his Special Sea Duty Station (e) his Raft Station and (f) whether he was G (able to draw grog) T (temperance i.e. no grog) or U.A. or Under Age and not entitled to draw grog. The X.O. also drafted a document known as daily orders which precisely detailed the ship's activities for the next day. These would be prepared in the coxswain's office and distributed throughout the ship during the early evening so that everyone was in the know. During the Last Dog Watch the X.O. conducted rounds. That was inspection of the living spaces for general cleanliness, and seaworthiness. The X.O. would also co-ordinate the defect lists and compile the requests for repair or servicing back in port. As stated previously, the X.O. was also the President of the Wardroom Mess and supervised the activities associated with this.

The SUPPLY OFFICER'S cabin is located in the SHIP'S OFFICE FLAT below the CAPTAIN'S DAY CABIN. It is the one aft of the Ship's office on the starboard side. The Supply Officer was responsible for the ships victualling (getting food), and he was the person responsible for the crew's pay or the "Paybob". He also controlled the stores accounts held by the various departments, and performed the duties of the Captain's Secretary.

The ship's office was used by the Pay writer for documentation of the crew's pay records, and by the Captain's Writer who was responsible for personnel (divisional records). He also typed the Monthly Reports of Proceedings, the written record of all the ship's activities and was responsible for typing the plethora of reports and letters associated with Service life.

Below the ships office flats are fuel oil tanks number 7 and 8.

OFFICERS WASH PLACE

All of the ships officers except for the captain used this area..

The officers wash place is a reconstruction as this area was stripped of all the original fittings during the conversion to a sea cadet camp. Only the wash basin is believed to be original to the space in that the drain pipe connected perfectively to the drain. The chipped marble deck is original. The steam rad, cabinet and sink were all located on the ship. The bath tub and taps were purchased.

OFFICERS' GALLEY

As with the Main Galley, the counter and cupboards in this space are original. Originally, there was an oil fired stove here. The oil stove here is a slightly longer than the original. It was acquired from an old retired navy tug in 2007. The exhaust stack is a recreation. The chimney is located just forward of the 3"50 gun and was distinctive due to its "H" shape. It was called the "Charley Noble". This stack is also a recreation in that the original rusted away. Meals for the officers would be prepared here and sent down to the Wardroom pantry for serving. The Captain's Steward also used this space to prepare meals for the Captain which he then served via the Captain's Pantry.

HAIDA BATTLE HONOURS

HAIDA’s Battle Honours board is located outside the Captain’s cabin. Haida has been awarded six battle honours depicting her service in WW2 and Korea. Arctic 1943 and 1945 are for her service on the Russian convoys and in liberating Norway. The English Channel represents her service in the 10th Destroyer Flotilla as do the other honours of Normandy (Operation Overlord the invasion of Europe 6 June 1944) and Biscay. The award for Korea is actually one honour as those were the dates in which the ship served in her first tour. HAIDA served a second tour in 1954 as a peacekeeper after the cessation of hostilities. The other item of note is that HAIDA does not have a motto (such as ATHABASKAN'S - "We fight as one"). Some visitors assume that with the RCN motto "Fear God and Honour the Queen" is HAIDA'S.

HAIDA INCORPORATED PLAQUE

This plaque beside the door to the Captain's cabin honours the members of HAIDA Incorporated formed by Neil Bruce who acquired and preserved the ship in 1964. The ship was operated by these people from 1964 until 1971 when the ship was turned over to the Government of Ontario. She owes her existence to these people.

CAPTAIN'S DAY CABIN

It was here that the Captain managed the affairs of the ship. The space consists of the office or Day Cabin, a bedroom or Sleeping Cabin and bathroom. The Captain used this cabin in harbour, and sometimes during the day at sea. When the ship was at sea he slept in the Captain's Sea Cabin in order to be close to the Bridge and the Operations Room. The built-in furniture, such as the settee, sideboard, fireplace bunk and cupboards are original. As fitted in 1943, the desk was actually against the starboard bulkhead. It was changed to its present place in the refit of 1961. The chairs and table are more recent additions.

As stated in the section on the Wardroom, the Captain lived independently of the ship's officers. He had his meals prepared by the Captain's Steward and these were served from the Captain's Pantry through the sliding hatch. The table in the centre serves as a dining table as the Captain would also entertain fellow squadron Captains or senior officers in this space. He would also invite some of his junior officers to dine with him.

The Captain's Day Cabin also served as an emergency operating room. The operating table on display in SICK BAY was bolted to the deck in the centre of the suite. You can see the circular bracket which held the surgical light. This space was ideal for this purpose as it is close to Sick Bay, and the space had no function when the ship was in action. There are two known cases where this cabin was used for surgery. The first was an appendectomy successfully performed on November 28, 1943, and a wounded sailor was operated on (successfully) to remove a 20MM round in February 1945. Surgery was seldom done at sea as it was better to transfer the patient to a larger ship such as a cruiser, or an aircraft carrier which had proper facilities.

The Captain's Day Cabin and the Sick Bay are the only areas where damage to the ship sustained in action can be seen. On the starboard bulkhead, just forward and below the present 3"50 casing cage there is a 2"x 2" metal patch. This covers a bullet hole from an Oerlikon round fired by the German destroyer T-29 on April 26, 1944. Two other rounds went into Sick Bay but there were no casualties. Rumour has it that the round that entered the Captain's Cabin took the heads off Cdr. DeWolf's golf clubs but this has been neither confirmed nor denied.

The deck covering in the office portion is a replacement except for the six part tiles on the starboard side, which are original to decommissioning. The sleeping are is replacement but the wash place is original.

CAPTAINS PANTRY

This is a small are on the starboard side, where the captains stewart could prepare a meal for the captain. It contained a warming oven, hot plate, toaster and a coffee maker. All of the dishes and glass ware were stored here.

PISTOL SHOP

The assembly and instillation of the torpedo explosive control devices (pistols) was performed here.
The ship carried two torpedo blowing heads (practice heads). They were stored here.

SICK BAY

The SICK BAY is the ship's hospital or infirmary. The ship carried a Medical Officer in wartime who was assisted by a Sick Berth Attendant who was really the equivalent of a Registered Nurse. Seriously ill or wounded would be attended to here, or in the officer's cabins as seen in the section on the Wardroom. During peace time the ship just had the Sick Berth Attendant who was called the "TIFFY" or "DOC". These people were very highly skilled. Members of the ship's company who were ill or required attention would muster for "SICK PARADE" usually each morning at 0800. Depending on the severity of the problem, the "Tiffy" would see to it, or send the patient ashore for treatment.

REG (REGULATING) OFFICE FLATS

Located below sickbay are the reg office flats. Off of this area, on the starboard side, is the coxswains officer (regulating) office where the seaman branch (watch keeping, etc) was controlled. It was also where mail was sorted and sent from. Next to the ship office is the Engineering Officer's cabin. There, he had all of the engineering and electrical drawings for the whole ship. On the port side is Radio Room #2. This room contains two CM11 transmitter/receiver units and one PV 500 transmitter. For a full description of HAIDA's electronics and electrical fit can be found in a separate manual of this manual. The fourth room in this area is the after KVA compartment. The after 50 KVA motor alternator is located in this space. Below this area are the main fuel tanks numbers 5 and 6 plus number 2 diesel fuel tank.

Engineers Work Shop

This is the work shop of the engineering department. It contained a metal lathe, a drill press, and a bench grinder. All of the tools and small parts for routine maintenance would have been stored here. In the little room in the forward starboard corner is a hatch leading down to the aft end of the Engine room. The hatch just inside the door goes down to the forward end or the gear room.

Damage Control Office

This area was manned all the time the ship was at sea. There was a drawing on the forward bulkhead showing all the hatches and doors on the whole ship. Depending on the damage control state, you would have to get permission from the duty watch keeper in the office before you open a hatch going down. The watch keeper would put a small tag on his board and give you a large tag that you would leave visible on the hatch while you were below. On completion of the job, you would secure the hatch and return the tag to the office.

If the ship received any damage from an outside source (collision, storm or enemy action) or a fire onboard, the resolution would be controlled from this office. All the red phones on the ship, connect here.

Areas Below the Open Part of the Ship

We will start at the bow and head aft.
In the paint locker there are two hatches. The forward one goes into the only part of the ship that is a void. It is called the forepeak. It goes rite to the bottom of the ship. The aft hatch goes down into the cable locker. This was the storage are for the anchor cables (chains). Below the cable locker is the number 1 fresh water tank.

Just outside the paint locker in the forward upper messdeck is a hatch going down to the Sword control room and below that is the sword compartment. On the starboard side about a third of the way aft is a round circle in the deck. This is an emergency escape hatch from the forward lower mess deck.

The aft hatch in the messdeck goes down to the forward lower messdeck. At the forward end of the mess is the number one naval stores room. The room on the port side of the mess is the sonar equipment room. Under the naval store is the sonar dome compartment have access to number two naval sores forward and the cool room on the starboard side aft. The hatch in the aft-port corner goes down to the frig flats containing the refrigeration equipment and access to the ships walk in freezer.

In the after upper the are four hatches going down. All four open into the after lower mess. The forward two just aft of the ammunition hoists are directly over the hatch in the lower mess going to A magazine. In the forties, the 4.7" guns used two piece ammunition with the shells stored in one room with the cartridge in the other. When the ship was converted to 4" guns, a door was added between the rooms. The hatches are in line so incase of a hoist failure, ammunition could be raised by block and tackle. The hatch on the port side aft is over a hatch going down to what used to be the Pom-Pom magazine. This was converted to the forward KVA compartment with shelves on the out board side for stores. In the aft starboard side of the lower mess deck is a hatch going to the provisions room. The is the dry and canned food stores room. The forth hatch in the upper mess deck is an emergency escape hatch.

The are hatches leading below in both the port and starboard passage ways. The one on the port side goes down the what we call the stokers mess while the one on the starboard side goes to the petty officer first class mess. This hatch is also in line with one below leading into B magazine. The port side hatch has been mover from the original spot is no longer line up to the mag. At the aft end of the stokers mess is two small hatches leading to the first of eight fuel tanks. Number one on the starboard side with number two on the port side.

At the aft end of the port passage way is another hatch going below. On the port side is the electrical work shop, the Gyro room in the middle and the low power room (forward switch board) on the starboard side. Below this are the numbers three (starboard) and four (port) fuel tanks. There is also access to the forward diesel fuel tank under the ladder. In the centre is a second hatch. This goes into the air lock of number 1 boiler room.

Outside the door on the port side is a hatch that is the emergency escape hatch from the boiler room. Just aft of the beef screen is a thwart ship upper deck passage. The area on the forward side of the passage was the SER (shipboard entertainment room). It originally held a radio receiver, a gimble mounted record player, and audio amplifier. The music was piped around the ship through its own sound system. On the aft bulkhead is the door to the number 2 boiler room air lock and the hatch going down is the emergency exit from the area.

In the next passage way, on the forward side is the door for the number 3 boiler room with the emergency escape hatch beside it.

The first door aft of the torpedo tubes on the pot side was the torpedo work shop. Just inside the next door is a large vertical fresh water pressurizing tank. Forward of the tank inboard is a small door. This was the sick bay heads. Beside the heads is a hatch going down to the aft end of the gear room.

The hatch just aft of the captains pantry is the torpedo warhead magazine. This space contained warheads for the four torpedoes. They were hoisted in and out using the eyebolt bracket directly above the hatch. I was also the storage are for the small arms ammunition and some hand grenades.

The next hatch just aft of the captains cabin is access to the ships office flats. The ships office is on the starboard side forward. All of the crews personel records were maintained here along with your pay records. On payday the crew would muster there and collect your pay usually issued by the supply officer.

Just aft of the office, was the supply officers (SO) cabin. On the port side, there are two officers cabins. All three cabins were single bunks. They were change to double in 1970 for sea cadet officers. We do have some of the original wooden parts of the bunks stored in the squid magazine. Below the flats are the number 7&8 bunker C fuel tanks and access to both the port and starboard plumber blocks. (shaft bearings)

In the wardroom flats the are four hatches in the deck. The forward one goes down to the 3"50 magazine. The two one the sides are access to the gland compartment. This is were the shaft goes through the hull. The hatch just outside the ward room door goes to the squid Magazine.

In the stewart mess flats the are two hatches. The forward one goes down to the ward room stores. This is where all the good dishes, flatware, glasses and wine for the wardroom was stored. the aft hatch was the spirit locker. The ships rum supply was kept here.

APPENDIX 1
H.M.C.S. HAIDA COMMANDING OFFICERS

Commander H.G. DeWolf, C.B.E., D.S.O., D.S.C., R.C.N.
30 August 1943 - 18 December 1944

Lieutenant-Commander R.P. Welland, D.S.C., R.C.N.
19 December 1944 - 2 September 1945

Lieutenant-Commander F.B. Caldwell, R.C.N.
3 March 1947 - 11 December 1947

Lieutenant-Commander A.F. Pickard
12 December 1947 - 15 May 1949

Lieutenant-Commander E.T.G. Madgwick, R.C.N.
16 May 1949 - 12 January 1950

Commander R.A. Webber, D.S.C., R.C.N.
13 January 1950 - 31 December 1951

Commander Dunn Lantier, R.C.N.
1 January 1952 - 28 October 1953

Captain J.A. Charles, C.D., R.C.N.
29 October 1953 - 15 December 1954

Commander Victor Browne, C.D., R.C.N.
16 December 1954 - 10 July 1956

Commander H.R. Beck, C.D., R.C.N.
11 July 1956 - 6 April 1958

Commander John Husher, C.D., R.C.N.
7 April 1958 - 2 September 1960

Commander G.S. Clark, C.D., R.C.N.
3 September 1960 - 2 August 1961

Commander D.C. Rutherford, C.D., R.C.N.
3 August 1961 - 19 July 1962

Commander W.H. Atkinson, D.S.C., C.D., R.C.N.
20 July 1962 - 22 September 1963

Lieutenant-Commander D.K. Gamblin, C.D., R.C.N.
23 September 1963 - 11 October 1963

APPENDIX II
ELECTRICAL SYSTEMS

The electrical system on the ship is a 225-volt direct current ungrounded system. Two 200-kilowatt steam turbine units in the engine room produced the primary supply and two 100-kilowatt diesel units, one in number one boiler room and the other in the gear room produced the secondary or emergency power. Prior to 1950 the diesel generators were only 60 kilowatt but were upgraded to 100 kilowatt with the introduction of the alternating current system. The 60-kilowatt generators were air start getting air from the Lister air compressor in number one boiler room, which is started with a hand crank. The 100-kilowatt diesels are electric start using a 60-volt battery bank that supplies power through a set of starting contacts, to the generator. A direct current motor and a generator are almost the same. If you supply power to a generator it will turn like a motor. If you turn the generator with the diesel or some other rotary source, it generates electricity. In harbor, the ship would be connected to a shore supply allowing the onboard units to be shut down.

There are two switchboards on the ship. One is located forward of the number one boiler in what is known as the low power room. The aft switchboard is in the gear room. One 200-kilowatt turbine, through a 900-amp breaker, and one 100-kilowatt diesel, through a 300-amp breaker, feed each board. The generators could be run in parallel or set up on different parts of the board by use of an isolating switch. The generators do not have automatic voltage regulators but the voltage can be varied by remote control from the switchboards. There are two power tie lines running between the boards, one on the port side and the other on the starboard side of the ship. The reason for two is if one became damaged you would still have a feed. The forward switchboard feeds thirty-one circuits through two pole, fused disconnects. The aft switchboard has twenty circuits, through two pole, fused disconnects. All of the weapons systems, steering system, motor generators, motor alternators and fire pumps are fed from both switchboards with change over switches located near the device. You can recognize the change over switches by the two lights on the front. One light is for the normal supply and the other is for the alternate. An example of this is the Hull and Fire pump in the Wardroom Flats. The change over switch is right beside the pump. The steering system actually has five hard-wired sources. The primary line runs from the aft switchboard but there are secondary lines coming off each generator through manual change over switches, bypassing the switchboards, to the steering motor starters in the engine room. There are lighting and fan circuits coming off each board. These circuits go to fuses sub panel and then to the circuit or device concerned.

The emergency power system consists of lengths of two conductor cables with two-hook terminals on each end. There is at least one cable set in every section of the ship. There will be multiple cables in the areas where the generators are located. They start in a junction box at each generator. The box contains bolt in type fuses that emergency cables can be connected to but there is no disconnect for them. The fuse boxes on the 200-kilowatt generators have two fuses for cables whereas the 100-kilowatt diesels only have one fuse. There is bulkhead feed through terminals so you can go from compartment to compartment without disturbing watertight integrity. In this way you can still get power to any piece of equipment if all the as fitted lines are damaged.

The secondary power known as low power (22 volts dc) is used to operate equipment like gyro repeats, plot tables, signal systems, some emergency lighting and in an emergency some of the radio equipment via a resistor. There are two different types of circuit here, one ungrounded and the other has the negative side grounded. Two motor generators located in the low power room produced the 24 volts DC. Only one is required to operate the system, but if both generators failed there is a battery backup also in the low power room.

As the volume of electronic equipment increased, there became a need for an alternating current (AC) supply system. During the 1949/50 refit, two 50-kilowatt motor alternators were installed, one forward in the KVA compartment below the after lower mess deck and the other one off the ships office flats next to Radio 2. The switchboard for the forward unit is in the electrical workshop while the after switchboard is in the same compartment with the alternator. These produce 440 volt 3 phase 60-cycle (hertz) ungrounded power at 50 kilowatts each. Both sets have automatic voltage regulators and frequency controls. Both sets feed automatic change over switches so that one unit can supply all the requirements. This 440-volt power was used to operate the three inch 50 gun mount, the Six Charlie radar, Mk 34 radar antenna on “B” gun and some parts of the sonar systems. The 440 volts is also transformed down to 120 volts 3 phase delta, ungrounded for most of the electronic systems such as radios, radar and sonar equipment. Additional 120 ac circuits were available in mess deck areas, officer cabins and wardroom. The Haida had a non-official modification installed by the crew in the late fifties. It was the installation of florescent lights in the forward mess decks running of the ac system. The ship was also fitted with two 120 volt 400 cycle motor alternators in the forward KVA compartment, that supplied power to parts of the weapon systems and to parts of the plotting system. There are two 200 volt 1100 cycle motor alternators in the low power room, to feed the control amplifiers for the 4” guns that located in the transmitting station.

There are two permanently installed circuits on the ship that you seldom hear about. The first one is the degaussing system. It consists of two cables running around the inside of the ship, on the ship's side from stem to stern. There is a third cable in the forward part of the ship. These cables have twenty-one conductors in each. They are wired up as giant coils. From end to end there is over 6 miles (10.5 km) of wire. All ships when they are built develop a magnetic field during assembly. This is the field that triggers magnetic mines and attracts magnet homing torpedoes. The coil can be energized with direct current and will neutralize the built in field. When the built-in field is energized the three magnet compasses alter because of it, so coils had to be installed on the binnacles to compensate for the change. The control box for the system is in number one boiler room. It consists of a manual current regulator, an amp meter and an on / off reversing switch.

The second circuit is the cathodic protection system. There is one electrode mounted on each of the two bilge keels. They are mounted on wooden blocks to insulate them from the ship. A small current is set up in each to counter any stray currents set up by dissimilar metals on the exterior of the ship. These stray currents can cause the hull to deteriorate. The power supplies for both are in the after switchboard. This system was turned off when the ship came into fresh water because the external currents generated in fresh water are too small to control.

When the ship came to Toronto in 1964, a 600 volt 3 phase 200-amp power supply system was fitted on the ship in what use to be the SRE compartment. It is transformed down to

208 volt 3 phase 4 wire to power all of added lighting systems where the public tours the ship. In the process of doing this, a lot of the original system was destroyed.

At present, there is a small 195-volt DC power supply in the engineer's workshop that supplies the after switch board through the original shore supply box. We have started a long-term project of converting as much as possible back to the original 220-volt system. The reason for this conversion is to cut down on the overloading of the original system. A lot of the lighting systems are run in 16-gauge wire good for about 10 amps. By running on 120 volts we double the amps which causing wires and control units such as switches and dimmers to burn out. Radio 1 and the EMR (electronic maintenance room) have already been completed.

The ships original 440-volt system has been re-energize with an autotransformer located in the low power room. It is fed by a feed from the 600-volt system.

The ship has the as fitted electrical drawings for the direct current and some of the alternating current systems. There are 51 drawings on the DC system, for general power and another 26 drawings just for lighting. These drawings maybe viewed, request but not removed from the ship.

APPENDIX III
HAIDA's RADAR SYSTEMS

HAIDA'S RADAR and RDF FITS
1944 - Foremast top: 291 combined.
After boathouse: 271 combined with 241 IFF pitchfork antenna.
Mainmast: HF/DF birdcage antenna.
1948 - Foremast top: HF/DF birdcage.
Foremast midpoint: 293 'cheesecake'. May have been installed as early as 1944 during HAIDA's Canadian refit
Mainmast: 291 combined.
1953 - Korea, first tour of duty.
Foremast top: 293 WC type. (Warning Combined.
Descending order: IFF dipole; Sperry HDWS radar (Mark II)
Mainmast stump: 291 combined.
1954 - Korea, second tour of duty.
Foremast top: 293 WC type. (Warning Combined.
Descending order: IFF dipole; AN/SPS6C; Sperry HDWS
Mainmast: 291 combined (rarely used).
1956 - SHF/DF antenna added to foremast top for AN/UPD501 radar DF set. (Described in Radio 4 section)
When HAIDA paid off she was fitted with the Sperry Mark II navigation radar, the AN/SPS6-C air search radar and the AN/UPD501 radar D/F set.

EQUIPMENT TYPES

271 TYPE

While the SW1C prototype was being tested in HMCS Chambly, a new air/surface warning set, namely the 271, was being tested aboard HMS Orchis in England in 1941. The 271 set, using the cavity magnetron, operated on ten centimetre wavelengths at a power level of 70 kilowatts and was keyed by 1.5 microsecond wide pulses. This was quite a breakthrough in technology for the time. Its finer and narrower beam (5 degrees H by 20 degrees V) would permit escorts to detect trimmed-down U-boats at long distances, consistently and accurately. Sea trials indicated that the 271 could detect a trimmed-down submarine at 3,500 yards and a periscope at 900 yards. A battle ship was detectable at 13 nm. This was a sharp contrast to the unrealistic test results of the SW1C. By the spring of 1943, the large majority of mid-ocean escorts were fitted with the 271; however, many ships of the Western Local Escort Force were not. To complicate matters, the British introduced two improved models, namely, the 271P and 271Q. Both of these versions had output power increased from 5 kilowatts in the 271 to 90 kilowatts in the 271Q. This quantum jump in power output can be directly attributed to a major improvement in magnetron technology. While the RCN was struggling to fit new ships with first generation 271's, they were also under great pressure to upgrade existing radars. By September 1943, only fourteen 271Q sets and fifty-three 271P's were fitted into RCN vessels along with three original production models. The introduction of 10 cm radar into fleet destroyers was delayed until the needs of the escorts were satisfied.

Since the 271 set operated at the 10 cm wavelength, the antenna could be made small enough to be housed in its own Perspex bubble and mounted on top of the operator's cabin. The antenna consisted of a 'double cheesecake' with separate transmitting and receiving antennas stacked one on top of the other. This radar was sometimes called 'lighthouse' due to the shape of the dome. Some of the transmitting and receiving elements had to be affixed directly to the back of the antenna to overcome co-axial line losses. In the original 271, the power feed to the antenna was by coaxial cable so this limited rotation to 200 degrees. When the original magnetron was redesigned to produce higher power, wave-guide was introduced to the antenna system. Coaxial cable could not handle those power levels.

Initially, the crews of the ships in which they were installed viewed the new 271 set with suspicion. Noting that the ratings were reluctant to go aloft, especially to the crow's nest just above the 'lighthouse', the captain of a ship in which a new 271 radar had just been installed questioned a seaman as to the reason. After a bashful amount of toe stubbing, the sailor confessed that the 'buzz' was that rays from the set would make a man impotent. Nipping an incident in the bud, the quick-witted captain declared the rumour to be nonsense. "Radar rays", he maintained, "made a man temporarily sterile, not impotent". From this viewpoint, it was viewed as a bonus rather than a drawback especially on shore leave. The 271 then radar became the most popular piece of equipment in the ship.

A 271 set was installed on HMCS Haida during her January 1944 refit while she was in Plymouth. The radar hut was located astern between the searchlight and the pom-pom guns. An integral, perspex, "hat-box" antenna was mounted directly above the 271 office.

285/285P TYPE

This was a secondary battery gunnery radar, first built in 1940 and then fitted in 1941. It employed two types of aerials: one with 6 Yagi's and the other with 5 Yagi's. In the six Yagi version, three aerials were used to transmit and three to receive. This arrangement produced a narrower 18 by 43 degree beam. Bearing accuracy was 3 to 4 degrees typical, with an accuracy of 100 yards on the 15,000-yard scale. This 25-kilowatt set was keyed by 1.7 microsecond pulses and operated at a 50 cm wavelength. At maximum range, it could detect a cruiser at 7 nm. On Haida, the 285 set was fitted-on-build (1943). The gunnery office was located at the base of the fore mast while the aerial was mounted atop the director control tower on the bridge. The 'P' variant was an improvement on the original design with the introduction of a transmit/receive switch (T-R), which permitted the use of a common antenna. Beam width was reduced to 9.5 degrees along with a reduction in pulse width and higher transmitter power. The Auto Barrage Unit (ABU), which was associated with the Ranging Panel L22, was also installed. ABU was fed with range and rate of change information from the L22 panel and using a mechanical calculator, provided the 'instant of fire' for range settings on the fuses in use.

Unfortunately, the 285 was fundamentally flawed due to its inability to follow aerial targets in elevation and was replaced with the model 275. As the director was manually controlled, it was difficult to follow fast moving aircraft.

291 TYPE

This was the final British 214 Mcs (P-Band) small ship, air search radar that was introduced in 1942. Early versions of this set required separate transmitting and receiving antennas, but a TR box was soon developed. The antenna was similar in concept to that of a 281 type, but the dipoles were supported by an X-shaped structure. This antenna had a beam width of 40 degrees and was of the lazy 'H' construction. Power output was 100 kilowatts at a pulse length of 1.1 microseconds. It had the capability of detecting a bomber at 15 nm. By 1944, type 291 was fitted to nearly all British destroyers and lesser escorts. Its installation time was seven days. The M, P and Q versions had power rotation for the antenna and PPI displays in addition to the 'A' scopes. Type 291U, developed for coastal forces and trawlers, had a special lightweight aerial consisting of a pair of superimposed Yagis. It could detect a submarine at 1.5 nm. Another variant, the 291W, was designed for submarines with a rotating aerial that had to be watertight and withstand hydrostatic pressure.

Eventually, the 291U and W sets were replaced with the model 267W. As for the 291, it remained in service in destroyers until about 1952 after which destroyer air search was restricted to coverage provided by the 293 set, the target indication radar.

Both the 291 and 293 sets were fitted on HMCS Haida simultaneously. Les Taylor of Walsall, England, a former radar mechanic on Haida, recalls the details of the fitting. "The 291 office was located on the flag deck below the bridge. The antenna, which was located at the top of the foremast, was fed by pyrotenax cable. This coaxial type cable consisted of a centre conductor surrounded by a powdered, ceramic-like compressed insulating material. The copper conductor and the insulation were enclosed within a hollow copper tube. If, for any reason, moisture entered the cable, its insulation properties fell below acceptable limits and required the occasional treatment with a blowtorch to drive out the moisture.

Apart from these and other radar sets, I was also responsible for a new navigation aid called the QH3. It was developed by the RAF and later, its two military designers formed the DECCA Navigator Company. The QH3 was fitted while Haida was in Plymouth in 1944 and was housed in the chartroom, directly below the bridge. This set used a triangular transmission system that was reputed to fix our position to within a cable length. The QH3 became known as the QM set in the Royal Navy after 1945.

During my service on HAIDA, I was solely responsible for maintenance, range calibration, and repair of the radar equipment. There was no one that I could turn to for help, advice or to discuss technical problems. Slightly short of my eighteenth birthday, and being the youngest person aboard, I was supposed to be the expert. The technical radar school at HMS Valkyrie on the Isle of Man had many rooms containing radar equipment for either large or small ships. We were given a training choice on particular radar types that were fitted on large or small ships. Afterwards, we were drafted to those particular ships upon the completion of our training. I chose small ships. How lucky".

Transmitter; 291 receiver; 291 indicator; Aerial control under indicator.
Power supply board for outfit DUF (under aerial control); PPI; 242 IFF modulator...mixer, transmitter, IFF responder below PPI. The 291 radar was co-located in the Second W/T office which is now called Radio 2. On starboard bulkhead, PPI control board and 242 IFF control board.

293 TYPE

This type was an S-band target indicator (sometimes referred to as 'Warning Combined' type) using the same transmitter as the 277 type and was equipped with the new, azimuth stabilized, 'cheese' antenna. It acquired that name because it looked like a block of cheese cut in half. Stabilization was necessary otherwise, the roll of the ship would tilt the 'fanned' beam and air targets might be displayed at wildly wrong bearings. The beam was wide in the vertical plane so that the ship's roll would have little effect. Typical detection range was 15 nm for an aircraft at 10,000 feet. Type 293M, which incorporated an 8-foot antenna, was introduced into service in 1945. 293P was similar to the previous model but it was modified for easier maintenance. A post-war radar program introduced the 293Q set with a redesigned 12-foot antenna. HAIDA was fitted with the 293 type until the late 1950's. In Korea, 293 radars were operated in accordance with an Electronic Emission Control (EMC) policy. This meant that the radar could be turned on for a 3-minute duration for every 15-minute interval since the 293 was detectable by warning devices. It was assumed that the Koreans had such devices so the 293 sets were used for short periods of time only. High Definition Warning Sets (HDWS) radar was not detectable and required no such precautions.

The 293 radar system first saw service in 1944 and HAIDA was fitted with the system soon thereafter. This system was a 10-centimeter, S-band target indicator radar sometimes referred to as 'Warning Combined' (WC) type. It employed a circular, sweeping display known as Plan Position Indicator (PPI). Operating at power levels of 500 kilowatts, the radar set had a typical detection range of 15 nautical miles for an aircraft flying at 10,000 feet. (*Photo by Jerry Proc)* HAIDA’s 293 radar saw service up to the late 1950’s. Then it fell into disuse, eventually being removed by the early 1960’s. The antenna displayed here was built in 1945 and would have been fitted to HAIDA’s foremast. Since 1966, the antenna was on display on top of the ship's lattice foremast but it was removed in July of 2001 in order to make room for the air search radar antenna.

4356M BOTTLE TRANSMITTER

A brief description of the bottle transmitter (B.T.) is included here since it was fitted on HAIDA. It did not emit any radio frequencies. This device was used to provide transmission to a group of repeater motors, such as those in a radar installation, or to step up the number of repeaters that can be controlled from a gyro-compass where it is inconvenient to use a multiple transmitter or transmitter panel. They were also used extensively where it was desired to use Admiralty type equipment controlled by some other type of gyrocompass. B.T.'s fell into two groups -- pattern #5356 that transmitted to M-type repeater motors and pattern #5355 that transmitted to Sperry-type repeater motors. The B.T. could operate a load equivalent to fifteen Mark 10 M-type repeater motors at its maximum. On HAIDA, the bottle transmitter was used to transmit azimuth information from the Admiralty Mk 5 Gyrocompass to remote indicators.

AN/SPA-4

The Range-Azimuth Indicator AN/SPA-4 was a self-contained unit that was designed for operation with any naval search radar system having a pulse repetition frequency between 140 and 3,000 pps. This indicator was capable of receiving radar information from one of eight different radar systems as selected by a front panel control. The Royal Canadian Navy did not use this feature. Instead, there was an externally mounted selector switch that used for that purpose. The SPA4 employed a remote PPI type indicator using a 10-inch, flat CRT.

Azimuth was determined by means of a mechanical cursor coupled to an electronic cursor jointly they were accurate to within one degree. Azimuth information was also indicated by a mechanical counter when the cursor was moved. Range information was obtained from range rings that could be displayed at intervals of 0.5, 1, 2, 5, 10, 20 and 50 miles. A mechanical counter could also measure range. An electronic range strobe was accurate to within 1 percent of the maximum range being viewed.

The SPA-4 was also capable of transmitting electrically, the bearing and range information to other systems such as fire control or directly to a projector on the plot table. This information was the output of the electronic strobe. That would cut down on verbal communication.

SPECIFICATIONS

Range selection	1.5 to 300 miles continuous using a centered PPI and limited by the pulse rate of radar set that it was connected to.
Weight	378 pounds
Dimensions	38" H x 19" W x 21" D
Power requirements	120 VAC, 60 Hz at 10 amps
Contractor	RCA Victor Company, Montreal P.Q.
Contract number	FE 113375, A/T 2-P-1-1877
Vintage	September 1954

When HAIDA was paid off, she was equipped with two AN/SPA4A units. One was located in the radar hut and the other unit was on the bridge.

AN/SPG34

An X-band fire control range radar for AA guns. The antenna was a 40-inch diameter dish that could produce a 2.4-degree beam. Power output was 25 to 30 Kw with a range of 25,000 yards. HAIDA was fitted with two the AN/SPG-34 fire control radar. The signal was displayed on an "A" scope that showed range only. As this was not an automatic system, the operator had to maintain the target in the centre of the screen to keep the range correct. There was a smaller scope that showed the position of the target in the beam. This signal was also displayed on a small scope on the Mark 29 gun sight that tracked the target. In fog this could be used to track the target even though you could not see it in the scope.

AN/SPS-6C

The radar set AN/SPS6-C was a ship borne, long range, air and surface search type designed to supply target bearing and range data to its five inch A-scope indicator. In addition, as many as four, external, PPI indicators of the Radar Indicating Equipment VE, or Radar Repeater Equipment VJ or VK types could be attached to the SPS-6C. The RCN called this system WA meaning Warning Air. In 1947, the SPS-6 was granted AN nomenclature and the US Navy procured the initial sets from Westinghouse. Following quickly in 1947 were the 6A and 6B variants. The 6C and 6D versions were introduced in 1951, and the final 6E model in 1964.

SPECIFICATIONS

Frequency range	1215 to 1350 Mcs band
Power output	500 to 750 kilowatts
Pulse repetition rate	150 or 600 pulses per second

Receiver type	Super heterodyne type; 30 Mcs IF. Equipped with automatic frequency control and anti-jamming features.
Range markers	The 'A' scope had range markers of 4, 20, 80, and 200 miles.
Indicator types	The system was designed to interface to VE, VF or VG type equipment.
Power requirements	115 or 440 VAC, 60 Hertz at 5.5 kilowatts

The antenna was a unidirectional, parabolic type reflector, equipped with a wind-balancing vane and had a characteristic 30-degree cosecant pattern in the vertical plane. Horizontally, the beam width was 3.5 degrees. Its rotational period was 5 to 15 RPM in automatic mode and up to 2.5 rpm in manual mode. A dual feed horn on the antenna transmitted and received both radar and IFF signals. Overall weight for the antenna and its mounting pedestal was 924 pounds. The antenna itself weighed 591 pounds. Contrast that with the weight of the system cabinet which tipped the scales at 1,063 pounds.

During the life of this system, there were four major American procurements. The first two were awarded to Westinghouse of Baltimore Md, the third went to AVCO Mfg/Crosley Division of Evandale Ohio and the final procurement was given to Stromberg- Carlson of Rochester, New York. Quantity and years of procurement by the RCN are not known at this time. HAIDA was fitted with AN/SPS-6C at the time she was paid off. If was originally fitted on her second tour of duty.

Deliveries of the SPS-10 to the USN began in October of 1953. It was considered so effective in ASW operations that 25% of all ASW vessels were fitted with this set by the end of 1956. As late as 1976, this type was described as the most reliable surface search radar with a Mean Time Between Failure (MTBF) of 150 hours and a 6-hour Mean Time to Repair (MTTR).

AN/UPM-99

This was the radar test set used aboard HAIDA.

RTU

HAIDA was fitted with RTU during the mid 1940's. The acronym means Range Transmission Unit (M type system). It was used to transmit radar information to remote indicators on the ship.

SPERRY MARINE RADAR - MK 2

This was a medium range, surface search radar designated as a High Definition Warning Surface (HDWS) set. From the early 1950's, until well into the 1970's, almost every ship in the RCN was fitted with the Sperry Mk 2. Although its primary use was to locate other ships, helicopters, navigation aids and shorelines, it was very effective in detecting submarine periscopes. This type was fitted aboard HAIDA. After life expiry, the Mk 2 was replaced by the Sperry Mk 127E solid-state radar.

SPECIFICATIONS

Peak power	30 kilowatts
Operating frequency	9375 Mcs +\- 45 Mcs
Pulse length	0.25 microseconds
Pulse repetition rate	1000 pulses per second

Scanner rotation	15 rpm
Beam Width	Horizontal - 2 degrees Vertical - 17 degrees
Range markers	Fixed 0.5, 2, and 5 mile intervals +/- 1% Variable - 0.3 to 20 miles +/- 2%
Range scales	1, 2, 6, 15 and 30 miles
Resolution	Range - 80 yards Bearing - 2 degrees
Indicator CRT size	12 inch diameter
Dimensions and Weights	Indicator - 27"D x 20"W x 51"H ; 350 lbs Scanner - 20"L x 50"W x 49.5"H ; 300 lbs Tx/Rx - 26.5"D x 22"W x 17"H ; 190 lbs M-G Set - 36"L x 15"W x 12"D ; 330 lbs
Power requirements	115 VAC 60 Hz, 1000 watts
Contractor	Sperry Gyroscope, Great Neck, N.Y
Vintage	May 1953

VK5

This is a radar display and one unit was installed in HAIDA's operations room. It is similar to the SPA 4 except you can display a radar signal from another ship or aircraft. The display can be off set is so that you can take bearings and ranges from your own position. Also like the SPA 4 you can send the bearing and range to another piece of equipment electronically. The VK5 contained 101 vacuum tubes.

APPENDIX IV
IFF SYSTEMS

EQUIPMENT TYPES
British IFF systems were coded into two series during World War 2; the 240 designation was used for interrogators and the 250 series for responders and beacons. Only IFF equipment types used aboard HMCS Haida are described. When HAIDA paid off, she used the AN-UPX12 IFF.

242 IFF Interrogator Set Series
Type 242 IFF series interrogation equipment was fitted on RCN ships in conjunction with Type 291 and Type 275 radar sets to provide 'A' band interrogation using the standard Mark III IFF system. Interrogators could function anywhere in the 165 to 185 Mcs band, but were normally used around 179 or 182 Mcs (1.8 to 1.6 metres) at a power output of 1 kilowatt. The pulse repetition frequency was 125 or 50 pulses per second and the pulse length was 6 microseconds. When used with radar types 291, the 242 was fitted with aerial outfit 'ASD'. This aerial had an omni-directional radiation pattern. Type 242 was first introduced into service in 1943. The pulse repetition frequency of the main radar was counted down in ratios of 4:1 or 10:1 in the modulator which then fired the interrogator transmitter. Simultaneously, a secondary trace, displaced from the main trace was displayed as an 'A' scope presentation. Interrogator signals received by the responsor unit were displayed on this secondary trace as inverted signals along with the normal radar echoes. Correspondence of the interrogator pulse and the radar echo identified the target. The associated ship borne transponder was the type 253 or the Mark III IFF when fitted on an aircraft. Haida was fitted with the 242WC and 242WS types in the mid 1940's.

242 Type Interrogator
The 242M was IFF interrogator equipment used in conjunction with radar types 277 and 293. It operated in the 159 to 189 Mcs band, had a selectable power output and transmitted 4 microsecond pulses at a rate of 500 pps. Types 242P/Q were used with radar sets 960/982/983.The operation of the type 242M is similar to that of type 242 except for some minor modifications. Transmitter power was now selectable between low and high power outputs (2 kw or 10 kw) and the output frequency could be varied across a 30 Mcs wide band. A pre-amplifier was incorporated in the transmitter unit that increased the responsor range and the transmit/receive (T/R) switching arrangements were improved. When the 242M operated in conjunction with the 276/277/293 radar types, it was fitted with aerial outfit 'ASS'. This aerial consisted of four broadband vertical dipoles with power rotation.

253P Transponder
Type 253P was a ship borne transponder, compatible with the Mark III IFF system and operated in response to triggering pulses from any interrogator or radar set in the same frequency band. When triggered, Types 253P/Q responded with various coded signals as required for the purposes of normal interrogation or ship-to-ship identification or homing. This set could operate in the 157 to 187 Mcs band but normally operated at 182 Mcs for ship-to-ship identification or when used as a beacon facility. In a normal fit, aerial outfit 'ASH' was used. For installation aboard coastal craft, aerial outfit 'ANT' was used. Normally the power output was 10 watts. A low power setting of 0.75 watts was available as an anti-direction finding measure. The

receipt of signals from interrogators of radar sets triggered the pulse repetition frequency. This was limited only by a 300-microsecond period of quiescence between each transmission. The pulse length of the output signal could be set for narrow (6-10 us), wide (17-25 us), or distress mode (80 us).

Types 253P and 253Q were similar except that type 253Q was mounted in a resilient steel cabinet. By operating the buttons marked 'I', 'A', and 'B' on the code selection unit, the following operating conditions were permitted:

> I: Normal Mark III IFF responses (sweeping 157-187 Mcs every 2.8 seconds). Six codes were available by selection and each code consisted of four transmissions using narrow and wide pulses. A complete code was transmitted once every 11.2 seconds. A special extra wide pulse was available for distress purposes.
>
> A: Alternate normal IFF codes consisting of four narrow pulses for 5.6 seconds followed by 5.6 seconds of Identity Code on a fixed frequency of 182 Mcs. This code consisted of two letters that could be of any combination of nine narrow, wide or blank pulses which were selected by means of the nine switches on the Code Selection Unit.
>
> C: Chopped response on the frequency of 182 Mcs. The response was mechanically interrupted for 40 milliseconds every one-fifth second to distinguish it from a normal code.

To limit mutual interference, the antenna for type 253P was situated at least 12 feet or more from the nearest interrogator antenna on a ship. Haida was fitted with the type 253P transponder during the mid 1940's.

AN/UPX-12
AN/UPA-24

This was the group video decoder for the AN/UPX12 IFF system fitted aboard HAIDA. It was mounted in the Ops Room and controlled the mode of transmission (i.e. mode 1, 2 or 3) and the 'squawk' code assigned to each particular ship.

APPENDIX V
HAIDA'S COMUNICATIONS EQUIPMENT - MID 1940's

In October of 1993, an equipment manifest belonging to HAIDA was discovered in the National Archives of Canada. The entries relating to radio equipment were collated in the chart shown below. At a later date, some of the equipment was superseded with functionally equivalent gear that was built by Canadian manufacturers.

RADIO EQUIPMENT MANIFEST
(Believed to be from 1944 or 1945)

QTY	FUNCT DESIG.	ORIGINAL EQUIP	DESCRIPTION
1	Loran	DAS2	Loran 'A' position finding receiver
1	MF/DF	FM12	MF/DF receiver; 42 to 1060 kc
1	HF/DF	FH4	HF/DF receiver; 1 to 24 Mc
1	HF/DF	B28	Receiver; 60 to 420 kc; .5 to 30 Mc
1	W/T Tx	TV5	Transmitter; CW / MCW / RT
1	W/T Tx	TBL12	Transmitter; 175 to 600 kc; 2 to 18 Mc
1	W/T Tx	4T	Transmitter; 100 to 17000 kc; freq multiplication unit
1	W/T Tx	60FR	Transmitter; 100 to 17000 kc ; CW / MCW / RT
1	W/T Tx	60EM	Transmitter; 100 to 17000 kc ; CW/MCW/RT
2	W/T Tx/Rx	53	Battery Rx/Tx; 3 to 6 Mc
1	W/T Tx/Rx	TBS	Transmitter/Receiver; 60 to 80 Mc; 50 watts
1	W/T Tx/Rx	86M	Transmitter/Receiver; 100 to 156 Mc; 9 watts
1	W/T Rx	B29	Receiver; 15 to 550 kc
7	W/T Rx	B28	Receiver; 60 to 420 kc; .5 to 30 Mc
2	W/T Rx	B19	Receiver; 40 to 13,500 kc

LEGEND
QTY INST = Quantity installed on board.
FUNCT DESIG = Functional designation as per manifest.
EQUIP = these are the model numbers as fitted.

DESCRIPTION OF WORLD WAR II EQUIPMENT

The equipment described in this section was fitted aboard HAIDA during WWII and the immediate post war era.

B19 Receiver (Tuner/Amplifier)

This was part of the 60 Series Transmitter.
A four tube, 40 to 13,500 kcs, regenerative receiver, originally designed in 1937 for the Admiralty Pattern Type 52T transportable set. In addition, it was also used in receiver outfit CBA and also as part of the W/T 60E set. In the documentation, the B19 is noted as a 'tuner-amplifier'. Batteries provided power. The filaments required 2 volts and the plate supply was a 99-volt battery tapped at 72 volts to provide the screen supply for the RF amplifier tube. Band

selection was accomplished through the use of seven, plug-in range coils. During World War 2 these receivers were used to receive shore based broadcasts.

B28 Receiver

This was a dual range, super heterodyne receiver which was developed from the Marconi CR100/4 series of receivers of 1940 and modified in 1941. The low frequency band coverage was 60 to 420 kc while medium/high frequency coverage was 500 kc to 30 Mc. One notable feature of this receiver allowed the IF passband to be varied from 6000 cycles to 100 cycles.
Power input - 200/250 VAC, 50 Hz @ 85 watts or batteries.
Weight - 82 pounds.
Dimensions - 16 x 16.5 x 12.5 inches

B29 Receiver

Originally developed from the Marconi CR200 receiver in 1941, this unit was a five tube TRF (tuned radio frequency) design and had a frequency range of 15 to 550 kc. The B29 incorporated two VR100 RF amplifiers, a VR99 detector/oscillator, two AF stages (6J5 and NR69) and a 5U4G rectifier tube. A narrow, 1 kc bandwidth filter was included in the audio stages for CW reception. It could operate on 120/220 VAC 50 Hz or 6VDC power sources.
Power input - 100/110 or 200/220 VAC, 50 Hz @ 33 watts.
Weight - 82 pounds.
Dimensions - 19 x 13.5 x 16 inches.

CW KEYS

This type of key or similar models would have been used aboard HAIDA during WWII. This particular example is an Admiralty Pattern No. 7681.

DAS Loran 'A' Receiver

This was a four band Loran A receiver of U.S. origin and was designed to receive signals in the 1.7 to 2.075 and 9.9 to 12.1 Mc bands. Power consumption was 240 watts from a 120 VAC 2.7 ampere source. The Loran radio system was used to establish the position of a ship or aircraft. It consisted of a master and one or more slave stations. The master station emitted a short pulse or signal, which was repeated by the slave station. These pulsed, synchronized transmissions were received aboard ship or aircraft and recorded on the screen of an oscilloscope built into the Loran receiver. By reading the time difference of the signals between one pair of stations and those of another pair, the position of the ship or aircraft was found at the intersection of hyperbolic curves printed on a special chart. Today, Loran A is obsolete having been replaced by Loran C, and a satellite navigation system such as GPS.

FH4 HF/DF Receiver

This was a 1 to 24 Mc HF/DF receiver which had a cathode ray scope for direct visual bearing indication and was superior to its predecessor due to the ability of being able to distinguish between the sky wave and the ground wave. Its scope was as big as a pie plate, and was surrounded by a compass rose. Accuracy was limited from 2 to 10 degrees and the unit was powered by a 230 VAC 50 Hz mains source. The FH4 was connected to a Bellini-Tosi aerial array consisting of fore/aft (F/A), port/starboard (P/S) loops and a sense aerial. The initial sets were designed with five RF and IF coils that had to be changed for different frequency ranges. In 1945, the set was improved by the addition of a band-changing switch.

As one WWII Sparker summed it up: " Changing frequency bands was a bitch with the early model particularly since the set had to be recalibrated every time you did it. Your chances of getting a bearing on a U-boat "B-bar" message of as little as seven letters were abysmal."

FM12 MF/DF Receiver
See description in Radio 4 section.

FR12 Transmitter/Receiver
During the war years, the FR12 was a mainstay on many vessels and was used on CW for inter-communication between escort ships on convoy runs. Voice was available but rarely used. Its popularity dropped when the TBS transmitter/receiver was introduced into service. For further details and a photo of the FR12, please refer to the description in the Radio 1 section.

HT11 Radiotelephone
This was a marine radiotelephone whose superheterodyne receiver tuned two bands: 550 kc to 1600 kc and 2100 kc to 2900 kc. Output power was 11 watts and the transmitter could be controlled with a foot switch. On transmit, one of four crystal-controlled frequencies between 1500 kc to 3000 kc could be selected. Power could be supplied from either a 6 or 12 VDC source depending on the model of the power supply. The HT11 was manufactured by the Hallicrafters Company of Chicago. Operators used it for communications between ships equipped with HF/DF installations. Ted Burke of Ottawa, Ontario was a Sparker during WWII and he recalls a few things about the HT11. "The HT-11, a battery operated MF R/T set, was usually found in the HF/DF office where it provided communication between a flotilla's "Huff-Duffers". It was fitted with a chest microphone and a foot operated on/off pedal so that the operator could be taking D/F bearings while talking. I knew this gear well because mine was hooked up backwards to the battery and its charging circuit so much so that we could never got to sea without it failing at once to the bewilderment of the Londonderry Port Wireless Officer to whom I complained after each trip. Finally, the HT-11 was yanked out and replaced with the TCS, a superior AC powered CW and RT set with enormous range. It should not be confused with the TBS VHF set which was used for communications between escorts and remote controlled by the bridge. We actually had two TCS sets fitted in HMS NESS K219, a River-class frigate. Inexplicably, one was installed in the starboard minesweeping flat where the salt air rusted it badly! Mine got me through the war nicely.
In a frigate, the HF/DF office was under the port bridge Oerlikon and just aft of the forward gun, which, if trained to port and fired, would cause all the spares to be blown out of their racks - but the sets were never, affected. Probably nobody remembers this now, but the messages passed on the HT-11 and the TCS were coded in the "ZR" code to be found in the Fleet Signal Book. For example, "ZR5" meant "I have obtained the following bearing on a U-boat transmitting a B-bar message." I never got to use it".

Loud Hail
All ships were equipped with Loud Hails. The most popular types were the models TE-129 and the TE-311B. The latter's output could be switched from a hailing position to a radio entertainment position. HAIDA was fitted with the RCA Model 431 Loud Hail.

S27 Receiver
The Hallicrafters S27 was designed in 1940 and covers 27 Mcs through 143 Mcs for the reception of AM, CW and FM signals using three bands. Its original cost was $US 175. Key

features of the design were the use of mil-spec components and wiring, no electrolytic capacitors, and heavy-duty chassis with strong internal bracing. The tuner is a separate, removable chassis, and uses acorn tubes. Specifically, the set incorporates the following: an IF of 5250 Kc; a Foster-Seely FM discriminator; a switchable 'narrow' and 'broad' IF bandpass; and a push-pull 6V6 audio amplifier stage. Another variant of the receiver, the S27B, was made between 1940 and 1941. Its frequency range covered 36 to 165 Mcs. Production of the S27 continued from 1940 to 1943 when it was replaced by the by S-36. S-36/36A began production in 1942 and covered 27.8 to 143 Mcs. From an electrical viewpoint, the replacement model was virtually identical except for some tube changes in the audio section. Many S27's were used during World War II as countermeasures receivers. The S27 used aboard HMCS HAIDA was known as the 'Headache Receiver'.

SCR 522 VHF Transmitter/Receiver
The SCR-552 is the American equivalent of the 86M set which is listed on HAIDA's manifest. It has been included here because it was retrofitted in lieu of the 86M sets after WWII.
The SCR 522 was a voice only, transmitter/receiver operating in the 100 to 156 Mc bands with a power input of 8 to 9 watts. It was re-design of the British TR 1133 VHF set in order that it could be manufactured with American tooling. Operation was provided on any one of four crystal-controlled channels. Integrally mounted in a common case, was the BC624A VHF receiver and the BC 625A VHF transmitter. The rest of the system consisted of 28 VDC input dynamotor (PE-94-A) and various jack and junction boxes. Input power consumption was 311 watts. Transmitter channel 'D' was sometimes used in 'pipsqueak' mode. Pipsqueak was a homing or DF tone sent from the aircraft to a ground station so the ground station could take bearings on the aircraft. It was useful either for normal DF work or when the aircraft was in trouble and the pilot did not want to stay around to transmit. There was a "contactor" unit BC-608-A located on the aircraft instrument panel, which looked like a clock, and had a spring wound with a knob. When activated, the contactor keyed the '522 for about 15 seconds in each one-minute period. Normally, the SCR 522 was fitted into aircraft, however, in this instance, it was a case of the navy adopting a piece of equipment from another service for it's own use. The British Air Ministry and the U.S. Army Signal Corps also used it. In the RCN, the SCR522 (in the form of the Model 86M) was used for inter- ship voice communication. If the SCR522 was operated with the PE-98 dynamotor unit (14VDC), the SCR 522 was designated as SCR 542. Both sets were identical in all other respects.
After the war, the SCR 522 became available in large quantities in the surplus marketplace thus providing many amateur radio operators with an inexpensive means of getting started in 2 meter VHF. The Colonial Radio Corporation to the Allied forces supplied many of these sets in 1943.

SIGNALLING LAMPS
HAIDA was fitted with the following signaling lamps according to an equipment manifest of the mid 1940's:

Quantity	Size	Description
2	10 inch	Type 3860A
2	20 inch	Type 170A Mk IV

In addition to these, the ship was equipped with a variety of hand held or portable signal lamps such as the Aldis lamp and the Intermediate Signal Lamp (ISE).

Sound Reproducing Equipment
It was the job of the radio operator to man the ship's SRE and play records for the entertainment of the crew. All mess decks, including the wardroom and Captain's quarter were equipped with speakers. Besides playing the popular music of the day, the operator would usually slip in records that reflected his personal music style. Profits from ship's canteens were used to purchase new records thus increasing the variety of music in the library. In contrast, corvettes in the Royal Canadian Navy were not even fitted with loudspeakers. In order to communicate important orders, a Boson's Mate with a boson's call was used or a system of ringing bells. To overcome the motions of pitch and roll, record turntables were mounted in a rather heavy gimbals mount which kept them level. Most of the faults that occurred in the SRE were in the speaker connections or speaker cones and were induced by the firing of the ship's guns and vibrations from the ship itself. HAIDA was equipped with the AP 4660 sound reproducing system. When reception was possible, the Canadian Broadcasting Corporation was very popular among crews. Sailors usually preferred to listen to any American stations rather than the BBC.

TBL Transmitter
This LF/HF transmitter was manufactured by Westinghouse Electric in the United States and was generally available after 1944. Contracts were also awarded to General Electric and RCA. It was fitted in the main radio office where it used exclusively to provide ship to shore communication and was operated from a position in the same office. Many Telegraphers still remember that 'big black box' in the radio office. The cabinet measured 72" high by 32 inches wide and weighed 804 pounds. In the TBL, only two tube types were used. The type 860 tetrode was used for the master oscillator, doublers and driver amplifiers while the RF stage employed a pair of 803 tetrodes.
Frequency Bands: (LF) - 175 to 600 Kc. (HF) 2 to 18.1 Mc
Modes of Operation: CW/MCW/AM
Power output: CW - 200 watts, MCW - 100 watts, AM - 50 watts

TBS Transmitter/Receiver
The TBS series of VHF MCW/RT transmitter/receiver were manufactured between 1938 and 1944 by RCA Victor, Camden N.J. Specifically, the model TBS-6 was released on Aug 25, 1943. This set covered the 60 to 80 Mc range with a power input of 50 watts. Frequency control of both the transmitter and receiver was accomplished by crystal control. The operators who used these sets adopted the unofficial name 'Talk Between Ships'. Since the TBS operated in a line-of-sight range, a belief prevailed that it was impervious to enemy interception, however, its use in the RCN was restricted to that of convoy duty during the war. Using the TBS in harbour was prohibited. Power to operate the TBS was derived from motor-generator sets. Primary power for these M-G sets was obtained from a variety of D.C. or A.C. sources, depending on what was fitted on a particular ship. The chief differences in the various TBS models were determined by the particular M-G set that powered the unit. Of special interest, is the TBS transmission line. It was a concentric, 3/8-inch diameter, soft copper transmission line having an impedance of 70 ohms. To purge the transmission line of entrapped air or moisture-laden gas, the operator would open the valve on a 2000-psi nitrogen bottle and pressurize the

transmission line to a maximum of 20 psi. The antenna fitted on destroyers was a quarter wave vertical with four horizontal rods to form a ground plane.
From a documentation viewpoint, RCA published an instruction manual for the TBS series that was second to none. Some of the schematics are printed with multiple colours and the manual is filled with cartoon-style illustrations. There was likely a reason for this - the TBS was being supplied to a huge base of users whose technical skills were unknown. It was great foresight on RCA's part to produce a manual that could be understood by people with little or no experience with installing or operating radios.

On September 17/43, HAIDA was assigned to the Royal Navy's home fleet base at Scapa Flow for work up exercises. Here, the Royal Navy conducted a 24-hour radio exercise in maneuvering the fleet by W/T (Morse key) and HAIDA's operators were required to participate until the procedures were perfected. When the TBS and 86M units entered service, the need for fleet maneuvering by Morse key was eliminated as all further operations were conducted by voice.

As TV became popular in the late 1940's and early 1950's, emissions from TBS type radios interfered with television broadcast reception. In an effort to reduce complaints from the civilian population, the RCN did not permit operation of these sets unless the ship was more than 100 nm from land. The typical communications range for these sets was 10 miles.

TV5 Transmitter/Receiver
The TV5 was an emergency transmitter/receiver made by Marconi was located in a ship's main radio office. It was remotely operated by Morse key or voice. This set provided communications with other ships or aircraft depending on operational requirements but its availability for Fleet destroyers was very unlikely in the years of 1943 and 1944. In some ships, the TV5 might have been fitted into the second wireless office. Freq Range:
(TX) - 1200 to 3000 kc; plus 500 kc
(RX) - 400 to 1200 kc; 1200 to 3300 kc
Average power input: 15 watts
Modes: CW/MCW/AM
Power input: 24 VDC
Tube Lineup: Osc - KT66; Modulator - two KT66's. RF Amplifier - KT8 and KT66.
Internal power: 600 VDC at 150 ma from a motor generator attached to a 24-volt battery.

53 TYPE
A small, portable, 32 pound, transmitter/receiver that was used in the 3000 to 6000 kc band. The accessories bag, which consisted of four, three-foot lengths of aerial rod, ground sheet, headphones and control cable contributed another 26 pounds of weight. Spare batteries would impose an additional weight burden. The designers intended that the unit be transported by two men. For power, the type 53 used a 99-volt dry battery for the plate supply and a 2-volt battery for the filaments. Fresh batteries provided twenty hours of service. Internally, the transmitter consisted of a master oscillator and a power amplifier, while the receiver was a four tube, regenerative type. The 53 set provided communications when a party was sent ashore or when there was a need to board another vessel. Model 53's were a standard fit for Fleet destroyers in 1943. This was surprising, considering that the unit was first designed in 1933.
60 Series Transmitters

This was a three tube, low power transmitting system, first designed in 1938 and based on the type 4TA frequency multiplier unit/transmitter. Type 60 specifications are listed as follows:
CW - 100 kcs to 17.2 Mcs; 40 watts
MCW - 100 kcs to 17.2 Mcs; 20 watts
R/T - 400 kcs to 17.2 Mcs; 10 watts
Tube lineup: Master oscillator - NT68
Modulator - NR16A
Power amplifier - NT65
Microphone: Carbon
Keying: Grid

Frequency control was maintained by crystal or VFO. Between 1930 and 7000 kcs, the crystal was operated on the fundamental frequency; from 7,000 to 17,200 kc it operated on harmonics. Owing to the reduction in power produced by suppressor grid modulation, radiotelephone transmission below 400 kcs was not satisfactory. HAIDA was fitted with the 60EM and 60FR variants. Noted below are the highlights regarding each model:

60EM - No R/T capability. Second major variant (M). Crystal control was available; similar to type 60D. The prime power source was a 20-volt battery connected to a motor-generator (E). A 4-volt battery always provided filament power. The power supply for the control and keying circuits was always connected to the ship's 110/220 mains supply.

60FR - R/T capability (R). Fitted with a 230 VAC 50 c/s power supply; a rectifier was also installed to provide power for Fighter Direction lights.
Other type 60 variants included:

60D - 230V 50 c/s generator feeding a rectifier unit. Provided HT, LT, grid bias and keying voltages. No R/T capability.
60E - Original design; battery supply (E); no crystal control.
60EQR - Battery supplies (E); third major modification variant (Q); crystal control available; R/T Capability (R)

In the RCN, the type 60 was used primarily on 2410 kcs in low power, voice mode during convoy duty and local harbour operations.

86M Type (SCR 522 Equivalent)
A voice only, crystal controlled transmitter operating in the 100 to 156 Mc band with a power input of 8 to 9 watts. This was the British version of the SCR 522 set. It could operate from a 230 VAC 50 Hz power main or 24 VDC supplied by a battery. In January of 1944, when HAIDA was transferred to Plymouth Command, an 86M was installed on the bridge and was used for voice communications. When communicating with aircraft, a range of 120 miles could be realized if the aircraft was flying at 10,000 feet. According to Geoff Mason of Bristol England, "the original 86M fitting in Royal Navy ships used 24 VDC to feed a standard aircraft dynamotor. In late 1945, a 230 VAC power unit (SE8) was developed and became the standard fit for the 86M in all ships and submarines. In the first fittings, the configuration of the 86 set was a straight copy from that of an aircraft. Later, the 86M set permitted the use of the standard RN microphone/headset socket. Initially, the set and the frequency controller were fitted on the

bridge but after the war, the controller was moved to the Operations Room.
The first aerials, fitted between 1942 and 1944, were mounted on the end of the yardarm in the vertical plane and fed by co-ax. This co-ax was cut back at the aerial end to expose the center conductor for a length suitable for the frequency band to be used, thus forming the active element. The copper braiding was then unwoven and formed into two counterpoises. This handiwork was then secured to a wooden 'cruciform' structure which provided supporting strength and was mounted vertically on the end of the yardarm. Two of these antennas were fitted per ship and one or the other would be selected depending from which side the approaching ship or aircraft was coming.

By 1943, a standard aerial outfit (APH) was introduced into service and was mounted on an extension bar fitted to the yardarm end so as to provide a better line of sight. Only one APH aerial was fitted for each 86M set. The 'sword' type of aircraft aerials were never observed on RN ships but may have been used on smaller craft such as rescue launches".

Harold Dixon of Minooka Illinois served as a Sparker aboard HMCS HAIDA. He recollects using the 86M set. "The only time it was used was during action stations when engaging the enemy. My operating position was on the port side of the bridge, just below the "step". In that position during action stations, my head just came up to the glass where I could see in all directions. There in the operating position, I had used both straight key CW and VHF voice. I used split earphones with CW in one and VHF in the other. CW was the main communications method and it was used by the CO of the destroyer flotilla to issue orders. Those orders were quick command signals like Blue Nine for 90 degrees (right turn etc..) In fact, another HAIDA Sparker, Jack Raine, was usually the operator in the radio office that kept me on frequency. As far as VHF goes, I could put that on the speaker for "Hard over Harry" to hear (Harry DeWolf, HAIDA's CO in 1944). The VHF radio was right there so he could use it at any time. Commander Dewolf was quite a guy. At sea, I had to stand at my action station for long periods of time. In the North waters it was darn cold, and everyone battled fatigue so it was very easy to fall asleep. I did it once but not for a long because I got a good kick from good old "Harry". He said "sailor keep awake" and boy it never happened again".
In the mid 1940's, the 86M was removed and HAIDA was fitted with the SCR 522.

HAIDA'S MAIN WIRELESS OFFICE - circa 1943

Jack Raine of Vancouver, B.C. fifty-one years later, made the following sketch of HAIDA’s main radio office from memory.

Notes: W.M. is the Admiralty pattern wave meter.
K means transmitting key.
C/D means the coding and decoding area.

Jack also provides some operational information from 1943. "In the C/D area there was a black box (not shown) located under the bookcase. It was used by the POTEL for filing of confidential documents and reference material. The POTEL reported to the signal officer and was briefed regarding the level of secrecy prior to each operation. Telegraphists were given information only on a 'need-to-know' basis - information such as names of ships, radio call signs and frequencies. Whenever the ship was in harbour for more than 48 hours, we were required to make test calls to shore stations using one or more of the ship to shore bands. These calls were made using the 4TA and the TBL12 transmitters".

HAIDA'S SECOND WIRELESS OFFICE - circa 1943

Frank Dobson of Wolfville, N.S in July of 1994, drew this 1943 equipment fitting from memory. Originally, this fifty square foot office was positioned on the port side, aft. According to Frank, this radio office was moved during the September/ December 1944 refit to inside the 'new' mast. The room was fitted with one chair, so it is assumed that there was only one operator per watch.

APPENDIX VI
RADIO ROOM 1 DESCRIPTION - 1962 FITTING

1.1 - MAIN AREA

LOCATION: After of the upper mess deck, port passageway.
YEAR OF INSTALLATION : 1943. Modified in 1950, 1957 and 1962. Restored in 1985. Enhancements to the basic restoration continue as of Oct 1992.
CREW COMPLEMENT: 5 radio operators plus a clerk.

> Staffing could consist of the following ranks:
> P1RM - Petty Officer 1st Class Radioman
> Dayman P2 - (did not stand watches. He would be a Petty Officer 2nd class)
> LSRM - Leading Seaman Radioman
> ABRM - Able Seaman Radioman
> Watch keepers 3 OS - Ordinary Seamen

PURPOSE OF THIS ROOM : Main receiving and transmitting office for the ship. LF receive, HF, VHF, UHF receive and transmit capabilities.
TELEPHONE CONNECTIONS: Telephone D23 connects with Radio 4, the OPS room and the bridge. There is a dedicated line to the Ward room flats and another one to Radio 3.

DESCRIPTION OF EQUIPMENT

1.1.1 - Aerial Exchange Board

This was a matrix board composed of a grouping of SO-239 RF connectors which permitted the interconnection of different receiving antennas to the various receivers located in Radio 1. There are four antennas connected to the coax connectors in the Y-axis on the very left of the board. Each of these connectors has additional parallel connections in the X-axis. At the bottom of the board, there are six connectors which attach to the various receivers. Antennas were attached to receivers using one-foot long patch cords. The antennas connected to the Aerial Exchange Board were only used for receiving.

Why were there two receiving whip antennas installed? The first reason would be redundancy - in case of damage. Secondarily, the radio operators discovered that by having two whip antennas to choose from, it gave them the ability to select the antenna which provided the best quality of reception.

Sometimes, it was case where one whip would simply receive a little better than the other so the better of the two would be selected. The overall antenna architecture aboard ship was to have all of the high frequency receiving antennas mounted forward and all transmitting antennas mounted aft in order to provide maximum separation. HAIDA's four whip antennas were painted white up to the first knuckle joint and black for the remainder. The original reasoning for this may be obscure but logic dictates that the lower part was white to conform to an overall colour scheme, which dictated that masts, derricks, etc., would be white. The upper part was black because the antennas were exposed to funnel smoke and got very dirty. On a black surface, the dirt wasn't as conspicuous.

As the requirement for additional radio channels grew during the 1950's, it was important that each ship had separate receivers operating on many different frequencies. Space had to found for all of the their respective antennas so as to avoid mutual interference or interference from the ships radar. One solution to this problem was the installation of an antenna multicoupler.

***1.1.2* - AMC-6-2 Antenna Multicouple**r
Manufactured by TMC Limited (Ottawa) in 1953, this device is a broadband RF amplifier which allowed a common antenna to drive up to six different receivers in the range between 2 and 30 Mc. A switchable filter would provide 35-db attenuation against interference from signals below 1.5 Mc and each output port provides 10-db gain when the filter is switched in. The unit currently installed on HAIDA is not the original T164D type but it's authentic enough for display purposes.

***1.1.3* - AN/URR35A Receiver**
This was a double conversion, UHF, superheterodyne receiver designed to receive AM or Modulated CW (MCW) signals in the 225 to 400 Mc band. The first intermediate frequency (IF) stages operate at 18.6 Mc while the second IF functions at 1.775 Mc. URR35's were always slaved to the same TED3 transmitter, as the transmitter contains the antenna changeover relay.

Receiver tuning was normally crystal controlled, however, a capacitor could be used in lieu of a crystal under emergency conditions. To tune the receiver under crystal control, the main tuning control was coarsely set to match the frequency of the crystal. The tuning control would be swept back and forth and left and locked in the position where the loudest background noise was heard.

There were four variations in the URR35 receiver family:
URR35 and URR35A - Same except for minor changes in the value of two resistors.
URR35B - This variant was fitted with a new blower and a plug-and- jack connector in order to facilitate replacement. The value of the IF Gain control was increased to provide better control.
URR35C - In this version, the scanning circuit and the SCAN connector on the low pass filter were eliminated along with test cables included with previous equipment. A few resistor values were also changed. All parts were interchangeable with previous versions except for the low pass filter assembly at the rear of the unit. There is no evidence at this time to suggest that the RCN used the B or C variants.

These receivers were of robust design both mechanically and electrically. They had a tube count of twenty-two and weighed 57 pounds.

***1.1.4* - Channel Amplifier Unit - CAU**
A bi-directional amplifier and control unit which amplified a remote audio source and fed this to the audio input of a transmitter. In addition, it would amplify audio output from a receiver and then feed it to a remote location on the ship. CAU's were always used in conjunction with Channel Switching Units and Remote Control Units. The model number of the CAU installed on HAIDA is AM-5143/URA-501V(A). These are solid state (integrated circuit) units which incorporate voice compression and were directly interchangeable with the vacuum tube versions that were originally fitted on HAIDA.
As originally designed, the CAU connects to a 32 post terminal board located behind the unit and HAIDA is fitted with this terminal board system. In later installations, the terminal board was replaced with a bulkhead mounted, Amphenol Series 26 connector. As the CAU was slid into

it's operating position, the male connector on the CAU chassis would mate with the female connector mounted on the bulkhead plate. When the CAU was withdrawn on its runners for maintenance, a patching cord would be used to provide a connection between the CAU and the rest of the system.

There was one internal CAU setting which needed to be changed and was dependent upon the type of radio connecting to that CAU. Plug P511 is inserted into socket S511 when the CAU is used with a LF/HF gear. This action causes the audio input to be attenuated to the same level as that from a VHF/UHF receiver. This same plug is inserted into S512 when the CAU is used with VHF/UHF equipment. The audio to the transmitter was boosted by 10 db, while the audio from the receiver was amplified by 30 db. When CAU's were attached to CW or RATT transmitters, keying speeds were limited to 100 cps due to cable length.

1.1.5 **- Channel Switching Unit - CSU**

Informally, the CSU was known as the "Bread Slicer" and was the heart of the Shipborne Radio Remote Control System. This device allows up to ten different Remote Control Units to be switched or shared between five different transmitter/receiver pairs. By moving a slide switch, any RCU could be connected to any available radio channel. Once a slide switch was set to a particular position, the RCU could only communicate the channel provided by that particular transmitter/receiver pair.

The number of RCU connections or radio channel connections to the CSU could be expanded through the use of an intermediate cable harness. If more than ten RCU connections are required, a vertical intermediate cable harness can be installed in order to daisy chain vertically adjacent CSU's. This would allow additional RCU's to be shared with five radio channels. Similarly, the installation of a horizontal intermediate harness could be used to increase the number of available radio channels.

Mounted across the top of the CSU's are green and red lamps. Each green/red pair provides channel status. RED means 'ready for transmission' while GREEN indicates that the channel is 'transmitting'.

Another component of the remote control system was the Receiver Switching Unit (RSU). This unit provided a means of switching any one of six receivers to any one of five radio channels. When fitted, there could only be one RSU for the whole system. RSU's were not used on HAIDA and are only mentioned here for the sake of completeness. The CSU/RCU/CAU remote control system was a Canadian development that worked very well and was admired by our contemporaries in the Royal Navy and the United States Navy. Beaconing Optical and Precision Materials Company (BOP) in Granby, Quebec, manufactured all of the radio remote control system.

1.1.6 **- CM11 Transmitter/Receiver**

First built in 1942, the CM11 was a transmitter/receiver that was capable of operation in the 375 kc to 13.5 Mc range. There were two distinct bands of operation: 375 to 515 kc on low frequency and 1.5 to 13.5 Mc on high frequency. In the high frequency band, the CM11 could be used with crystal or master oscillator frequency control. For low band operation, only the master oscillator could be used. The RCN labeled CM11 crystals with two additional frequencies besides the fundamental - the second harmonic and the third harmonic. The transmitter could be tuned to operate on any of the three frequencies. Modes and power levels were: CW - 100 watts; MCW - 70 watts; AM - 30 watts.

Inter-connection between the transmitter, receiver and antenna tuner was provided by snatch plugs. These connectors operate on the same principle as knife switches. Each of the three slide out units in the CM11 are equipped with female snatch plugs. When slid into place, the antenna tuner, transmitter and receiver interconnect through a wiring bus that is fitted with male snatch plugs. When withdrawn for maintenance, patch cords had to be installed between the transmitter or receiver and the bus. The CM11 antenna tuner was a very versatile device, since it could match antennas that were 5 to 750 ohms resistive and supported operation in the range of 375 kc to 13.8 Mc.

Keith Kennedy ex-C2NET(s) of Surrey BC notes that "the CM11 was notorious for generating harmonics and spurious emissions and HMC Ships would routinely receive harmful interference reports from the Department of Transport monitoring station located at Wetawaskin Alberta. We had little in the way of test equipment and certainly nothing as fancy as a spectrum analyzer so we just followed the CM11 tuning instructions and filed the reports away. The CM11 was also known for its chirpy CW signal when controlled by the master oscillator but it behaved properly under crystal control. CM11's also had a bad habit becoming detuned as the ship rolled. It was the result of changing capacitance between the antenna and the surface of the sea".

On HAIDA's bridge, an SM11 remote radio telephone control unit can still be seen. It was abandoned after the RCU/CSU/CAU radio remote control system was installed. All of the CM11's fitted on HAIDA were connected to the Shipborne Remote Control System and were keyed or controlled by the RCU's.

The power supply for the CM11 was very versatile, as it could operate on 120/220 VAC or 24/36/220 VDC power sources. A fifteen second time delay circuit prevented power from being applied to the transmitter in order to protect the mercury vapour rectifiers. There was an emergency mode which decreased the time delay to 4 seconds but at the expense of shorter mercury rectifier life. Weighing in around 478 pounds, the CM11 just wasn't portable! Eventually, the CM11 was superseded by the AN/URC32 transceiver.

1.1.7 **- CPRC-26 Transceiver**

The CPRC-26 was a self-contained, battery operated, transceiver (walkie talkie) which operated in the frequency range of 47.0 to 55.4 Mc. Its 300 milliwatt input is frequency modulated using a deviation of +/- 15 KHz. Six, crystal controlled channels were available for communication. Power was provided by a dry battery and a fresh unit would provide about 20 hours of service. Normally, the CPRC-26 would be used with a 47-inch collapsible whip antenna.

All RCN ships carried three CPRC-26 transceivers which were usually kept in the main radio office. A communicator would carry one in a lifeboat and with landing or boarding parties. Other uses included short-term communication between ships for such jobs as jackstay transfers, underway fuelling and shoots. It was an excellent means of communication between the bridge and the emergency conning position during times of crisis. In total, there were around 4,500 of these units built for NATO forces by Philips and Canadian Rogers. By 1969, the RCN declared this gear as obsolete, dangerous or unreliable depending on the source of information.

Ray Robinson VK2ILV, an avid radio collector residing in Australia, provides an insight into the methods used by the Australian Army to maintain and test the CPRC-26. " The CPRC-26 VHF radio was used by the Australian Army as a VHF backpack. AWA (Amalgamated Wireless Australia) at their Military Electronics Division in Sydney, had the repair contract from the Army, including sets that were returned from Vietnam. I recently spoke to a technician who worked on these sets in the approximate period from 1964 to 1967.

He was working on these sets by himself, and there were others working on other army sets. He would call in the boss or the others if a set proved troublesome. They came in batches, varying from 10 sets to 50 sets. Generally, they were complete with whips, handsets, bags and instruction plates. These were supplied if missing, and the sets left complete, and ready to use, with fresh batteries. He could average 5 repairs a day.

The test equipment used was not very specialized. Maintenance types used an AWA VHF signal generator and an AWA Noise and Distortion meter for testing the receiver. Close at hand were a power output meter and a dummy load for testing the transmitter. A set of meters, mounted on a panel, was used to plug into the radio test socket. A bench power supply was used in place of the battery pack. For most repairs, an ordinary soldering iron was used for heating the bases of the modules. No CTS-3/PRC test set was available for testing the modules, nor a spectrum analyzer for looking the output spectrum and harmonics.
During maintenance, the most common faults were in IF cans for the receiver and the modulator cans for the transmitter. Low transmitter output was usually the output tube (valve). Some resistors under the base plate would go high in value, and sometimes a diode in the discriminator would go out of specification. Failures and problems were usually due to microphonic valves, so the common repair method was to connect up the test equipment and a pair of headphones, and tap or flick the suspected module with your finger, and listen for ringing. The module would be replaced if found to be noisy. Sometimes the module would fail completely after a tap or flick.

Isolating a fault to a particular module was done by trying a suspected module in a working bench radio, and also by using a known good module in the faulty radio. When the radios came in for refurbishing or reconditioning, they were cleaned and checked, and given a new set of modules. Some sets had broken switches, and split cases. He recalls one set that a bullet had entered and was still inside. After repair, the sets were heated in a lamp box, then sealed with a new desiccant inside, and given a final test. A red seal was placed over the case/front panel join, so that any tampering could be detected".

1.1.8 **- CSR 5A Receiver**

First built by Canadian Marconi in 1942, this general coverage receiver was capable of receiving AM and CW signals between 80 kc and 30 Mc with the exception of the broadcast band. It had a tube count of thirteen and weighed in at sixty-eight pounds without power supply. CSR 5A's spent most of their working life receiving the Fleet Broadcast or guarding the International or marine distress frequencies. Each receiver was connected to its own wall-mounted speaker, but headphones were the order of the day. Loudspeakers were used when one Radioman had to guard more than one frequency. This was known as a loudspeaker watch.

A modification was made to this receiver by the RCN. The "F" band (80 to 200 kc) was adjusted 10 kc low to enable the reception of the broadcast frequency of 73.6 kc. This frequency is still assigned to Maritime Command as of 1994. The RCN also labeled CSR- 5A crystals with two additional frequencies besides the fundamental - the second harmonic and the third harmonic. The receiver could be tuned to operate on the fundamental or the other two frequencies. One of the noted quirks of the CSR 5A was the habit of going off frequency in rough weather when continuous tuning was used. If a large wave hit the ship, it would overcome the friction of the tuning gear assembly and knock the dial off frequency. There were no such things as frequency synthesizers or phase locked loops in those days. The vernier control would be used to retune the frequency.

In the CSR 5A, the band-switch assembly has been wired into a sub-chassis which can be detached from the main chassis. This operation should be never be attempted by the inexperienced. First, you extract the receiver from its case and detach the bottom cover plates - do not be concerned over the 30 screws that secure the plates. Next, desolder 29 connections as outlined in the manual. Following that, there are another 20 screws to remove in order to physically detach the RF turret. Do not go insane in the process, or you won't be able to get the pieces back together. This brief glimpse of 1942 radio maintenance has been presented for those readers who have complaints about 1990's manufacturing methodology.
In July of 1992, there was only one functioning CSR 5A receiver in Radio 1. During the winter of 1992/1993, four of the receivers were repaired, refinished in the original colour of 50 years ago and refitted with shock absorber assemblies. One receiver in particular, had ten faults which required correction.

The VP3 power supply for the CSR 5A was designed to operate from 120/220 volt 50/60 Hz AC power or 12 VDC. When operating on DC power, some changes had to be made. Marconi designed two power interlocks to ensure that no damage could be caused by inadvertent operation on the wrong power source. To switch from AC to DC operation, a five-pin interlock plug had to be moved from one socket to another. Subsequently, the AC line cord had to be disconnected from the wall socket and inserted into a special chassis mounted receptacle. VP3 power supplies also acquired a reputation for fusing the contacts on the vibrator and frying the primary winding on the power transformer. By 1969, the CSR 5A was considered obsolete and was taken out of service.

In July of 1992, there was only one VP3 supply among four CSR 5A receivers. Another VP3 was found in storage but was completely deteriorated and was rebuilt from bare metal. Since three other VP3 power supplies were missing, near replicas were constructed in order to restore operation to the receivers.

1.1.10 **- RCK Receiver - AN/URR21**

Weighing in at 117 lbs, the RCK was a 'low radiation' VHF receiver built by E.H. Scott Radio Laboratories during the 1940's. Copious use of RF shielding helped contribute to its hefty weight. The RCK had four crystal-controlled channels and operated in conjunction with the TDQ transmitter in the 110 to 160 Mc radio band. Also, there were nine sockets for storing additional crystals.

One unusual feature of the design was the tuning system. Normally, when a receiver is under crystal control, the main tuning dial must be set to the same frequency as the crystal. This is accomplished by sweeping the dial back and forth across the operating frequency until the loudest background noise is produced. In the RCK, there was a mechanical tuning mechanism that could be preset so the main tuning dial hits a 'detent' position at the exact frequency of operation. When this happened, a red channel indicator light came on to show the channel number being received. If any of the crystals were changed, and you wanted the use of the 'lamp on frequency' feature, then a mechanical tuning assembly would have to be re-adjusted with an internally mounted Allen key.

1.1.9 **- FR12-TH Transceiver**

Made by Canadian Marconi in the early 1940's the FR12 was a three mode transceiver - CW, MCW and radio telephone. Power input was 15 watts on CW, less on MCW and even less on phone. It was capable of transmitting on low wave (375 to 580 kc) or short wave (1700 to 4200 kc) depending on the model type. On low wave, the set had a range of about 20 miles. On receive, it was capable of continuous tuning from 300 to 4200 kc. The letter H in the model number indicates that the remote control option was installed, however, it was not compatible with HAIDA's Radio Remote Control System and was not used.

Under normal use, the FR12 would be used to communicate with merchant ships or the Naval Administrative Net. Pictures taken in the 1950's show the handset installed, so it was definitely used on voice. This unit could provide emergency communications if all else failed since it only operated from a 12 volt DC power source. The receiver section consisted of a five tube superheterodyne design with the ability to continuously tune the range of 300 to 4200 kc in three bands. To simplify the overall design, there was no direct frequency readout for the receiver. Instead, a circular logging scale dial was provided. It was necessary to calibrate the dial, and record the readings in advance.

In the transmitter section, there was an oscillator, a modulator and a dual power output stage. One of four, selectable, internally mounted crystals determined the operating frequency. In order to activate the modulator, one simply inserted the handset plug into the front panel socket. The microphone in the handset provided the interlock for the modulator. If this was done while the Dynamotor was running, a noticeable slow down of the Dynamotor could be heard.

Power for the FR12 could be provided by one of two modes. In standby mode, the filament circuit for the transmitting tubes gets disabled. Filament power for the receiver would be provided from the main battery. The 180-volt B+ line for the receiver would be furnished from four, external, 45 volt dry batteries wired in series. Standby mode would dramatically increase the life of the main battery. In normal mode, the main battery provided all power for the receiver and transmitter. An internal Dynamotor produced high tension for the transmitter but it had to be inspected after every 500 hours of operation. Input power to the FR12 was 12 volts DC at 6 amps on receive and 13 amps on transmit when used in normal mode. On HAIDA, the antenna for the FR12 was a sloping, twenty-seven foot vertical wire designated as the PORT OUTER VERTICAL.

Al Goodwin of Dartmouth N.S. did some range experiments with the FR12. "It was sent away in a sea boat on a couple of occasions. In those days, we didn't have commercial mobile antennas available to us, so we rigged up a 35-foot whip antenna. The exercise was not deemed a success as we lost communications around five miles. On HAIDA, we used this set for both AM and CW communications. For CW operation, we would have to attach a key with a very long lead. In an unusual case, the late Keith Lake (VE1PX) used the FR12 to modulate the Marconi PV500 thus giving it AM capability for use on the amateur bands. He put out quite a strong signal compared to the 30 watts of the Marconi CM11".

1.1.11 - Remote Control Unit (RCU)

This was a device that allowed a radio channel to be controlled from a remote location on the ship. RCU's come in single channel and four channel versions, with and without weatherproof covers. A single channel unit only had the capability of controlling one radio channel, while the four-channel unit could switch between, and control, up to four radio channels. An RCU supported both voice and CW operation and provided the functions of an intercom.

Every system has limitations, so the Radiomen had to observe some operating precautions. In normal operation, the manufacturer suggested that a maximum for four RCU's be connected to any given radio channel. Intercom functions were limited to those RCU's connected to the same radio channel. It was also possible to connect more than one RCU to a radio channel. Despite these minor restrictions, the system worked very well.

1.1.12 - TDQ Transmitter

First built for the U.S. Navy in May of 1943, this unit was capable of voice or MCW transmissions in the 115 to 156 Mc band running 45 watts continuous power. Any one of four selectable crystals determined the frequency of operation.

Before the days of UHF equipment, destroyers were fitted with a pair of TDQ/RCK sets. These were used for operations circuits such as "Plot Primary". When the RCN followed the United States Navy to UHF voice, the TDQ/RCK was left behind as the only VHF set capable of monitoring and communicating with aircraft, other ships, yachts and harbour facilities. The basic role for this set became that of 'guard' for the VHF distress frequency of 121.5 MHz. The TDQ could be remotely operated through the shipborne radio remote control system. Weighing in at 285 pounds, it was extremely heavy by today's standards.

1.1.13 - TED3 (AN/URT502) Transmitter

The TED3 was a low power UHF transmitter capable of AM or MCW operation in the 225 to 400 Mc band. TED transmitters were designated as AN/URT502A by the RCN and were built by Westinghouse in Hamilton Ontario and the RCA Victor Company. Nevada Air Products and RCA Victor produced URT502B's. Each TED3 in Radio 1 was connected to a separate, weatherproof, UHF dipole antenna located on the lower yardarm of the foremast. The designated model number for the antenna is AT-150/SRC.

A TED3 was always used in conjunction with a Channel Amplifier Unit and a URR35 receiver. This combination of equipment provided a "UHF communications channel". Radio 1 provided three out of the seven UHF communication channels aboard HAIDA, while Radio 3 provided the other four. Surprisingly, TED's were routinely used in MCW mode on the intership Task Group Common circuit.

TED's had small, axial crystals which fit into a four-position crystal holder located behind a hinged door. Radiomen had to carry out frequency shifting drills which consisted of quickly changing the whole set and it could become very frustrating if a crystal was dropped. It would invariably disappear under an equipment rack and would never roll back out!

***1.1.14* - Frequency Measuring Equipment**
The BC221-M Frequency Meter was designed to provide a means of accurately calibrating transmitting and receiving equipment within the frequency range of 125 kc to 20 Mc where no crystal was available for a radio channel. This meter is a portable heterodyne type with a built in crystal calibrator. A unique calibration book was prepared for each unit and it could not be interchanged with other BC221 meters. Power was provided by a dual voltage dry battery. Eventually the AN/URM 32 Frequency Meter superseded the BC221-M. This unit was used to calibrate transmitters in the frequency range of 125 kHz to 1000 MHz when crystals were not available. Unlike the older BC221, the URM 32 could be powered from 120 VAC or batteries. In addition to its use as a frequency meter, this unit also had the capabilities of a signal generator.

On HAIDA, radios were tuned with the BC221 frequency meter.

OTHER EQUIPMENT

AID Speaker
Radio 1 is fitted with one AID speaker and fitted to it's right is a boom mounted, AID microphone. The 1962 drawing does not show a microphone fitted, so this one remains a mystery.

Amateur Radio
Currently, VE3CGJ is an amateur radio station that is operated from the clerks' desk during the tourist season. Today's equipment consists of a modern transceiver connected to an inverted vee 80/40/10 meter trap dipole. This dipole is attached to the end of the port yardarm on the fore mast. For 15 metres, a regular dipole has been attached between the fore and main masts. At the end of HAIDA's service life, she had an active amateur license under the call sign of VE0NV, so it's fitting to have an amateur station operating from this room today.
Al Goodwin of Dartmouth N.S., served aboard HAIDA as the POTEL (senior radio operator) from May of 1960 until she was de- commissioned in October of 1963. Al recollects memories from this period. "I operated the amateur radio station from early 1962 when I first received my ticket until we paid her off. At one time, we had five operators working the bands and that was probably a record number for one ship. For a receiver, I removed the Hammarlund SP600 in Radio 4 and used it with either a Marconi CM11 or PV500 transmitter. A VE0 call was very rare in those days and one CQ brought back a 'pileup'. One thing still sticks out from this period. The CO thought that operating an amateur station was really neat. He used to bring his guests into Radio 1 and show them the QSL cards that were displayed on the aft side of the message centre bulkhead. One day, he noticed a QSL card from Russia and asked - 'What would you talk to him about?' I replied 'Crypto codes - of course', a remark that I passed during the height of the Cold War".

Clocks and Power
AC power to the radio room was notoriously unstable and the cyclic output of the alternators was even worse. This prevented the use of electric clocks whose synchronous motors

depended on precise regulation of the frequency of the input power. Although marginally better, Seth Thomas mechanical clocks were used, but they too were somewhat erratic. These clocks had to be set to time stations WWV or WWVH daily.

Mounted on the aft bulkhead of Radio 1, is the DC power distribution panel for the equipment in the room which was capable of operation from a DC power source in case of emergency. A large battery bank positioned in the starboard passageway aft of the bulkhead in Radio 1 provided emergency power. This battery could be re-charged by the ship's electrical system.

Adjacent to the DC panel, is the wood and glass encased AC distribution panel. AC power for the equipment in Radio 1 was supplied from here. HAIDA was originally fitted with a 225 VDC electrical system. Two 200-kilowatt generators that were steam driven and two diesel driven 60-kilowatt units supplied power. As more and more American equipment was fitted in the ship, it became necessary to produce 120 VAC 60 Hertz power. Lead case cable was used in Canadian ship construction post-war as evidenced in the four Canadian-built Tribals. Probably the first use of armoured cable was in the 3"50 gun system (including gun drives, Mk63 GFCS and AN/SPG34 radar) installed in Tribals around 1950.

Crystal Cabinet
The crystal cabinet was used to store all of the crystals that would be required to fulfill any Communications Plan. Keith Kennedy of Surrey B.C recollects details about the cabinet. "Physically, the cabinet was of wood or aluminum construction, and was as wide as the TDQ transmitter and two thirds of its height. When the ship was in harbour, the front doors were secured with a bar and combination lock. Internally, there were six to eight slide out plywood shelves or trays with numerous felt lined pockets approximately two inches square. Each pocket contained two crystals - one for service and one was a backup. The transmitter and receiver crystals were kept on separate shelves to prevent them from getting mixed up. For the most part, the cabinet was used to store crystals for TED/URR type equipment, but some CM11 crystals were also stored here when the cabinet was located adjacent to that equipment".

CW Keys
Two types of straight keys were used for CW transmission. One was the Speed-x square, chrome based type. The other was the tear- drop shaped, black wrinkle finish base variety. Keys were mounted on a clear plastic plate which straddled a rectangular hole located in a bay, at the right side of the operating desk. Electrical connections were made to the KEY input of the Remote Control Units next to the CSR 5A receivers. In HAIDA's case, it's suspected that the keys were hardwired into the RCU.

Headphones
Headphones that were in general use in the 1950's had bakelite earpieces cushioned by soft rubber coated pads. The two spring bands connecting the two earpieces was covered with stitched, tan coloured leather. Each headphone assembly bore two markings: MX- 41/AR and ANB-H-1.

Metal Desks and Chairs
Eaton's of Canada supplied metal desks that were used for the operating consoles but it is not known whether the general public could purchase them. The original colour is a metallic flake

green finish as evidenced by looking underneath some of the sliding typewriter trays. Over the years, the desks have been repainted in the routine colour of navy grey. On HAIDA, all of the slide out drawers in the desks are missing the locking latches. These would be essential to have in a rough sea.

Gregory McLean of Abbotsford B.C. recalls, with great detail, the furnishings and the some of the routines in Radio 1. "The chairs used in some radio rooms of the 1950's were swiveling arm chairs. They were of robust construction, with padded backs and tubular sides. The bases of these chairs were bolted to the deck and a pivoting steel shaft was affixed to the underside of the seat. This shaft was fitted into the base, thus giving the chair firm support and allowing the operator to swivel 360 degrees. This type of seating arrangement persisted in some ships and is still in use today.

To a great extent, it was felt that the swivel chair was superior to the 'chair and chain' technique which was used on HAIDA at the time of her de-commissioning. The tubular sides and the anchored base gave firm support in rough seas and was easy to use. On the chained chairs, the chair did not move once the chain was secured making it difficult to get ones legs out from under the desk.

Decks on ships were scrubbed every day, but special house cleaning was done for Captain's rounds. Radio 1 "scrub out" was in the middle or morning watch when the radio traffic volume was least. At that time, the swivel chairs were pulled from their bases and set to one side. The 'broadcast' chair was left to last in case traffic resumed".

When seamen were not on radio watch, spare hours were filled with maintenance, book amendments, cleaning stations and working part ship (painting, scraping etc).

Typewriters

The typewriters used at the operating consoles were Royal or Remington Telegraphic typewriters which could only print capital letters and some special symbols. They were of the closed frame variety and painted in wrinkle finish grey. The typewriter itself, was bolted to a sliding tray which was located in the middle bay of the desk. Radiomen often referred to the typewriters as "mills". In those days, the Royal or Remington typewriters looked sleek and modern.

Often, an operator would spend long hours in continuous copy. In order to make life more comfortable, he would pull the pins that restrained the typewriter tray and move the tray out and slightly down. Everything worked fine until a large wave hit the ship and in turn, it would cause the typewriter to jump forward and unto the operators lap, often with undesirable results. The unfortunate operator might be talking with a slightly high-pitched voice for a while. The paper supply for the typewriters consisted of rolls which were mounted on a separate assembly within the centre bay of the desk. Each roll of paper had metal caps inserted into the cardboard core. Metal caps were saved as some of the paper rolls issued by the navy did not come supplied with these. A thin steel rod was passed through holes punched in the metal caps. The rod was then placed into slots on an angle iron bolted inside the middle bay. This assembly allowed the paper to unroll easily and kept the roll stable as the ship moved about in the sea. The paper holder assembly was not part of the original desk and was added as the need arose.

Generally speaking, one or two-ply paper rolls were used for CW copy but usually one. Teletype circuits, particularly broadcast, used two or three ply but usually two. When supplies of one ply paper ran short, a three-ply roll would be rewound into individual two and one ply rolls. These techniques were used because storage space on board was always at a premium. Having 'stores' carry multipurpose items was most desirable. Teletype ribbons were rewound onto typewriter spools because the ribbons supplied for teletypes lasted much longer than the typewriter ribbons that the navy purchased.

Three-copy paper was used when the ship was the designated guard ship in the group and copying the broadcast. The main problem with custom wound rolls was the tendency for the paper to loose alignment. During a busy watch, the operator had to align the sheets frequently. It was both the fault of the platen pressure and the type of paper being used. This problem became very critical when receiving a long message and the machine could not be stopped to fix the paper. Needless to say, using more than two-ply paper was not popular.

Fanfold paper with perforations was tried at one point, but the paper was difficult to set at the perforation line. One message might be three lines long while the following message might be three pages long. Some Radiomen were accustomed to tear-off rolls and would tear off the sheet at the point where the message ended. Trying to line up the perforations before the next message started proved somewhat difficult.

Currently, there are open frame black Underwood typewriters on display at the console positions. These are too old for the era and are being replaced as suitable units can be located.

Shielding and Woodwork

Under the paneling, Radio 1 is encased with sheet copper which becomes visible around the door moulding for the Coding Office door. The purpose of the copper shield is to minimize radio interference that is produced from different parts of the ship and to ensure that radio frequency interference generated within Radio 1 does not affect sensitive equipment in other parts of the ship.

There are two inconsistencies in the layout for Radio 1. First, on the AC power panel cabinet, the bottom right hand corner has been chiseled out. I am told that there was a filing cabinet in this position but the 1962 drawings do not show this. Secondly, a general layout drawing of 1962 indicates that a shelf is mounted on the starboard side of Radio 1 aft of the Message Centre bulkhead. This has been restored just like the drawing shows, but in reality, there was something much larger installed as evidenced by the silhouette of newer varnish.

Sound Powered Telephones

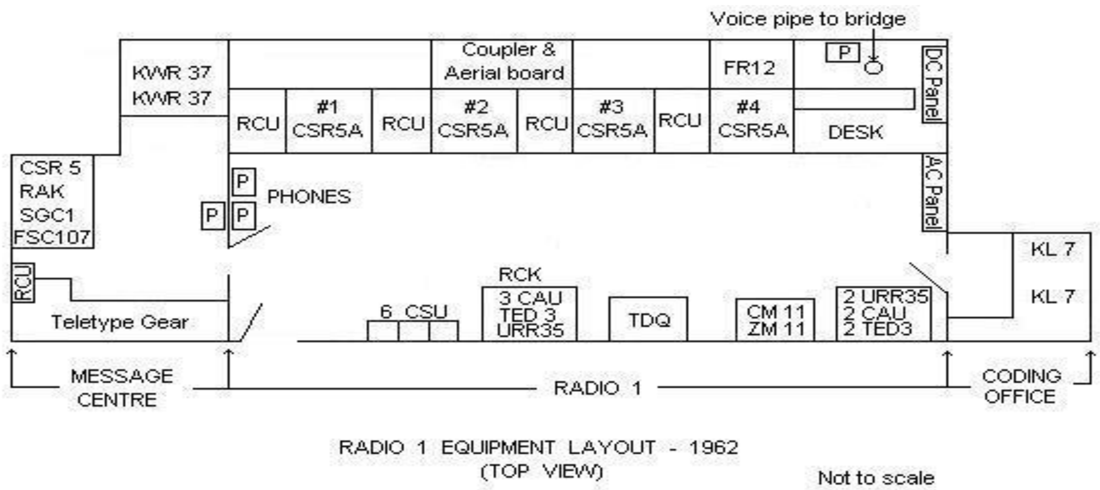
Installed throughout the ship are numerous sound powered telephones. Unlike a regular telephone which needs 48 VDC to operate, these telephones convert the energy of sound waves into electrical energy which power the sets. Unfortunately, they have much lower transmitting efficiencies than a regular telephone, therefore, they can only be used for very short distances.

The actual efficiency of a sound powered link is about 25 db lower than that of a regular carbon microphone system. This limits the sound powered equipment to point-to-point applications and limited party line applications where the line loss does not exceed 15 db. Because of the resonant characteristics of the microphone and receiver units, the frequency response of the telephone falls off sharply for frequencies above 2000 Hz.

There are two types of telephones installed on HAIDA. One type is the single line set and the other type is a selectable, six line unit. To originate a call on a single line set, the user turns the crank on the phone. This sends a ring voltage down the line which powers a buzzer and illuminates a neon lamp on the remote unit. The remote user than picks up the handset and communication can be established with the use of push-to-talk switches. Phones can be wired as party lines, so rotating the crank on one phone makes all of the other phones ring. By using ringing codes, only a certain phone will get answered. On a party line, the recipient of a call listens for the correct ringing code then selects the proper line with a rotary switch. The telephone system uses three wire, armoured cable for communication. White is common, black is voice, and red is ring.

HAIDA's original telephones were manufactured by the Telephone Mfg. Company in London England. In later years, the RCN retrofitted most of the telephones with a handset stowage compartment. The photo illustrates a sound powered telephone in a badly deteriorated state. After 6 to 8 hours labour, the phones can be restored back to their 1960's condition.

Voice Pipe
Besides being used for the transmission of voice traffic, the voice pipe in Radio 1 was also used to move paper messages between the bridge and radio room. Messages were placed in a small canister known as the 'bucket'. This was raised and lowered from the bridge using a string known as Coston Gunline. When there was a message destined for the bridge, the Radioman signaled the bridge by pressing a switch next to the voice pipe. The party on the bridge would then haul up the message. On occasion, the string would break and the bucket became a 'bullet' which would then provide the 'sender' with a great surprise. Very strange items were known to travel through those voice pipes. On some occasions, the bucket became a pencil sharpener. There was not a pencil sharpener on the bridge, so the duty signaller on the bridge would put his pencils in the bucket and lower it down to radio room where there was a pencil sharpener. Back up they came ready to go.


Voice pipe to bridge
KWR 37
KWR 37
Coupler &
Aerial board
FR12
P
DC Panel
RCU
#1
CSR5A
RCU
#2
CSR5A
RCU
#3
CSR5A
RCU
#4
CSR5A
DESK
CSR 5
RAK
SGC1
FSC107
P
PHONES
P
P
AC Panel
KL 7
KL 7
RCU
RCK
Teletype Gear
6 CSU
3 CAU
TED 3
URR35
TDQ
CM 11
ZM 11
2 URR35
2 CAU
2 TED3
MESSAGE
CENTRE
RADIO 1
CODING
OFFICE
RADIO 1 EQUIPMENT LAYOUT - 1962
(TOP VIEW)
Not to scale

APPENDIX VII
CODING OFFICE DESCRIPTION - 1962 FITTING

CODING OFFICE DESCRIPTION - 1962 FITTING

LOCATION : Part of Radio Room 1

YEAR OF INSTALLATION : 1950.

PURPOSE OF THIS ROOM : To encode messages using a KL7 encoding machine. There were two units in the coding office and one was probably a spare. These are standalone units as the schematics do not indicate any connections to other equipment. The crypto office was always locked unless someone was working in there .

DESCRIPTION OF EQUIPMENT

KL7 Coding Unit
This was an off-line cipher machine code name ADONIS, and was similar to, but more advanced than the famous German Enigma machine. It was used for the protection of exclusive (off-line) traffic. The unit had the approximate dimensions of a medium sized portable typewriter and was housed in an extruded aluminum carrying case which was painted in an olive drab, khaki colour. Navy versions, were of course, navy grey and the hinged case lid opened from front to rear.

On the front of the KL7, there was a character counter to help keep track of the number of characters in a message and a small lamp to illuminate the keyboard. Electro-mechanically, the KL7 was an eight-rotor machine. Rotor #4 was maintained in a 'neutral' position. Crypto-variables such as rotor and plug board settings were referenced from a hardbound paper codebook or 'flash' paper bound into a small booklet. The KL7's used aboard HAIDA were powered from a 120 volt 60 Hertz source. In the RCN, a complete second rotor assembly was stored in a separate box away from the machine. This assembly had the settings from the previous day and could easily be substituted in the KL7 to decode a late arriving message from the previous day.

To encrypt a plain text message, the operator would enter the message on the keyboard and the KL7 generated a gummed tape using 5 letter groups. The tape was pasted on a message pad and the resultant encoded message was submitted to the Message Centre where specific information such as Routing Indicators and Date-Time-Group was added. Finally, the complete message was passed to a radio operator or a Teletype operator for transmission. The system operated at a speed of 12 to 15 words per minute.

To decrypt, coded messages were received in 5 letter groups. These, in turn, would be entered on the KL7 keyboard, and the machine would generate a gummed tape with the plain language text on it. This was pasted on a message pad and given to the message Centre where it was typed up and duplicated for distribution within the ship and for filing. According to

Walt Hutchens, an ex-USN coder, "the noise produced by the KL7 rotors advancing was one of the two most distinctive sounds that I have ever heard. The other sound was the last round and the clip being ejected from an M-1 Garand".

Components for the KL7 and its variants were manufactured in the mid 50's to the mid 60's by several United States government contracted firms and the Singer Company was a major supplier. The parts were then assembled at either the Philadelphia Army Depot or at the Bluegrass, Kentucky plant. After final assembly, the units became the property of the National Security Agency and were distributed to the various military users. All crypto machines and materials were on loan to North Atlantic Treaty Organization member countries including Canada. In addition, there was also an airborne version of the KL7 which was modified at one of the US Air Force Security Service facilities in Mississippi for use in aircraft.

The KL7A was a battery-powered version which had a higher degree of soundproofing to counter the problems produced by the acoustics of the machine. Batteries were not intended for portability, but for technical security reasons. Since the machine had a high TEMPEST and acoustical signature, there were concerns that it might be 'exploitable'. TEMPEST is an unclassified term that describes the vulnerability of an electronic device to having the classified components of its design intercepted and exploited. A machine that does not process classified information does not have a TEMPEST problem, only a radio frequency interference problem. Acoustical signature describes those systems which make an audible sound (sonic or subsonic or ultrasonic) which is repetitive and identifiable to certain specific functions. If these sounds are recorded from a distance, it is potentially feasible to compromise the machine.

After the Walker family spy ring was exposed in the mid 1980's, it was found that they had supplied the Soviet Union with a complete working KL7 and all keying materials. Immediately, all KL7's were withdrawn from service and returned to the COMSEC depot at Ft. Mead Maryland. This included all codebooks, spare parts, manuals and any other paraphernalia associated with the unit.

Another crypto system known by the code name of Orestes employed a device called the KW 7. Although not fitted on HAIDA, the KW 7 was an on-line, send/receive crypto unit installed in shore stations and aboard ships. It was used for ship to shore and for inter-ship radio Teletype communications. To send messages over a secure UHF teletype circuit, a model 28 Teletype or reader (T-D) sent the prepared message to the KW 7 which in turn keyed the TED3 UHF transmitter in the AM mode. Note, that the KW 7 was not a synchronous unit, therefore, it required a phasing signal to be sent in order to attain a lock on the received signal.

All of the crypto gear fitted on Canadian ships in the 1950's and 1960's was owned by the National Security Agency of the United States and was loaned to North Atlantic Treaty Organization member countries including Canada. Also included, was keying material, key lists, certain rotors, and key cards. This material came in a variety of editions depending upon the application. Examples of these crypto packages would be named CANUSEYESONLY, CANUKUS, AUSCANUKUS, NATO, ALLIED, and so on. Some of it was ANEYESONLY and would have been generated in Canada by the Communications Security

Establishment.

It is interesting to note that by 1969 standards, the life cycle of a crypto system was generally set at 20 years even if the hardware didn't wear out. The KL7 and KW7 systems were still in use in 1969, long after their life expiry cycle. When crypto equipment was deemed surplus or obsolete, it was destroyed. Ships not equipped with on-line crypto equipment were considered to have a distinct time disadvantage in ship-shore-ship and inter-ship operations. The KL7 system was "life expired' as of 1969.

Disposal Of Classified Material

Bill Janes of Perkins Quebec and Gregory McLean of Abbotsford B.C., focus on the problems associated with the disposal of classified material. "During World War II, there was no provision made on many ships for the filing of unclassified and classified messages. Sometimes the Telegraphists used their personal lockers for the storage of this material. The First Lieutenant or the Captain usually kept highly classified traffic.

As radio teletype was introduced into the fleet, it created an unforeseen problem - the voluminous disposal of classified waste. When the fleet broadcast used CW, only those messages destined for a ship were copied and decoded. This system left little waste paper and it could be disposed of easily. With the introduction of RATT, two or three ply paper was used to copy the broadcast. All messages would also be re-broadcast twice during a 24-hour period. With CW, messages had to be brief and code groups or common abbreviations were the rule. Non- essential items like book corrections and NDHQ promotions were sent my mail or courier to a Message Centre at the next port of call. You guessed it - every message was eventually sent over RATT including news summaries. This resulted in voluminous amounts of paper and disposal of this classified material became an immense problem.

When a ship became a guard ship for a squadron, it meant four-ply paper was mounted in the Teletype machine and on certain occasions, six ply. With this many copies, the guard ship was now impacted with the paper disposal problem. The normal routine for the destruction of classified waste on Tribals was to burn it in the boiler.

This was accomplished by taking the paper through the boiler room air lock and down a vertical ladder. Actual disposal was accomplished by opening a small inspection hole on the boiler face and feeding the waste paper into the boiler, a small quantity at a time. This activity was usually done each morning at the convenience of the Stokers rather than the Radiomen. This procedure was initiated by securing permission from the Engineer and Stoker on duty or alternately from the bridge. The burning of paper sometimes produced an intolerable amount of smoke from the funnel. On occasion, the Radioman would have to assist with a boiler cleaning when the Chief Engineer thought that the classified waste helped to foul the boiler tubing.

The method most often used in the 1950's and 1960's to dispose of classified waste was to burn it in a modified forty-five gallon oil drum. Radiomen would lash the drum to a rail on the upper deck near the funnel and the burning would commence. It is not known if this method was in common use on Tribals. One must appreciate that all of this paper had to be treated with the same level of consideration as filed messages - highly confidential. It had to be kept under lock and key and under guard if exposed. Much of the paper was burned in the ship itself but the RCN shore bases installed secure incinerators to help with the disposal of vast amounts of classified waste. The radio stations and dockyards on the east and west coasts had busy furnaces as did the Communication School at Cornwallis. Occasionally, incompletely burnt messages were found in the incinerators.

When the modern communication facilities at HMCS Aldergrove British Columbia were constructed in the mid 1970's, the destruction facility was located indoors and fuelled by natural gas. It was so efficient, that the RCMP used it to destroy marijuana and other evidence which was no longer required. On ship, the waste material was usually stored in the Classified Books Officer (CBO) storage area. When this became full, Radio 2 or Radio 3 was used as a storage area. Eventually, a shredder was fitted into the Message Centre to help alleviate the disposal problem. It would shred all waste to pieces measuring 3/8 inch long and 1/16 inch wide. When these shreddings required quick disposal, they could be mixed from garbage from the galley and thrown over the lee-side when outside territorial limits. Within territorial limits, the waste was stored within the ship and burned ashore.

There were also procedures in place for emergency destruction of coding equipment and classified material. Ships were equipped with weighted bags for the disposal of books and paper. Sledgehammers were to be used on equipment. If the emergency disposal procedure was invoked, orders were to destroy as much as possible. Machines were to be smashed with the hammers. Pages were to be torn from books and paper was to be hand shredded. If time permitted, the paper was to be thrown over the side. If the ship was in deep water, then the paper waste could be allowed to go down with the ship.

APPENDIX VIII
MESSAGE CENTRE DESCRIPTION - 1962
FITTING

LOCATION : Part of Radio Room 1
YEAR OF INSTALLATION : Feb 1957. Physical restoration completed April 17, 1993.
Equipment acquisition is on going.
CREW COMPLEMENT : 1
PURPOSE OF THIS ROOM : This was the main focal point for the processing, distribution and filing of all messages that were sent to or from the ship by radio, flashing light, flags and (in harbour) messenger.
TELEPHONE CONNECTIONS: Telephone D10 connects with Radio 2 and Radio 3.

The bulk of the system is in the Message Center.

DESCRIPTION OF EQUIPMENT

1.2.1 - AN/SGC1A Radio Teletype Terminal Set

This device permitted the transmission and reception of radio teletype (RATT) messages between stations that were similarity equipped. The RCN used this mode of transmission in the 225 to 400 MHz UHF band. When a RATT message was to be transmitted, the teletype machine or paper tape reader (T-D) would interrupt a DC current loop based on the elements of the Baudot signaling code. The resulting pulses were applied to the input of an audio oscillator within the terminal set. These pulses then keyed the oscillator to produce either a 500 Hz or 700 Hz audio tone. When the loop was closed a 700 hz tone was produced. A 500 Hz tone was produced when the loop was open. The 700 Hz tone was considered to be the MARK state while the 500-Hertz tone was the SPACE state. Alternately opening and closing the loop caused the output of the terminal set to toggle between 700 and 500 Hz, thus representing the Baudot code as a warbling audio tone. In turn, the audio output was applied to the microphone input of an AM transmitter.

This method of keying the transmitter was called audio frequency shift keying (AFSK). When traffic was to be sent, a control signal from the SGC1A placed the radio transmitter on the air until the messages had been transmitted. This control signal was activated by striking the space bar on the Teletype machine prior to sending traffic. Alternately, if the T-D was used was the input source, the first character on the tape would have to be a space character.
When receiving messages, the process was reversed. The SGC1A accepted the incoming mark and space tones from an associated AM receiver such as the AN/URR35A. These toggling tones ultimately controlled the keying of the DC current loop. This terminal set was manufactured by the Remler Co. Ltd. of San Francisco. The first examples of the AN/SGC1A were produced in November of 1950.

1.2.2 - CSR5 Receiver

The sole purpose of this receiver was to receive high frequency RATT signals which provided input to the frequency shift converter. Normally, reception was crystal controlled, however, when crystals were not available, the CSR 5A tuning control had to constantly be readjusted to maintain proper RATT reception. When CSR 5A receivers were rack mounted, they were usually powered with a Marconi WE11 rack mounted power supply. This supply only operated from a 120 or 220 VAC power source. On HAIDA, a replica was constructed to replace the WE-11 unit that was missing. (See Radio 1 section for photo reference).

1.2.3 **- KWR-37 On-Line Crypto Receiver**

Code-named JASON, the sole purpose of this unit was to automatically decipher the encoded RATT fleet broadcasts. On the input side, it was connected to the current loop output of a frequency shift converter. The output side was connected to a Teletype.

GENERAL INFORMATION

The shore station started each day's broadcast at 0000 Zulu and transmitted without interruption for 23 hours and 55 minutes each day. On shore, the encryption device such as a KWT-37 was synchronized with a time signal station (CHU or WWV) and the originating device sent an automatic 'start' signal followed by a continuous stream of encrypted, non-repeating traffic throughout the day.

The decoding 'key' which was similar to an IBM style punch card had a pattern of randomly punched holes, and had to be changed daily, prior to the start of the next day's broadcast. Encryption keys were changed by unlocking a front door on the KWR-37, removing the existing card, and installing the card that was designated for the next day. These cards were inserted behind a small door in the front of the KWR-37 using the built-in alignment pins. The door closed against a block of small, spring-loaded steel pins. Where a pin touched the paper card, no signal passed; where a pin poked through a hole in the card and touched a silver-plated metallic track, a circuit was made. Each card held enough keys to cover 14 years of usage before the key repeated itself. For very confidential messages, the fleet broadcasts consisted of encapsulated five character cipher groups which had to be decoded manually on a KL7 crypto unit. An example of a message of this type is the notification to a crew member's next-of-kin of his death. Sometimes, there were periods were no messages were being sent on the Fleet broadcast and the Teletype would just sit there receiving null characters.
John Dill of Kingsville Texas, was a crypto machine mechanic in the USN in the 1960's and 70's, and kindly documented his experiences with the KWR-37. "The holes in the punched cards directed the key stream to a series of bistable multivibrators (flip-flops) which were wired on thirteen printed circuit boards located on the left side of the machine when one opened the equipment drawer. All the flip-flops plugged into a motherboard which was positioned horizontally. The active devices in these circuits were sub-miniature, type 6088, wire lead, sharp cutoff pentodes made by Raytheon or General Electric. These tubes were about 5/16 inch in diameter and 1 1/4 inches long and anchored by metal clips on each circuit board. The 6088 pentode was also known as type CK522AX. Depending on circuit design, the 6088 could be driven to produce as much as 10.5 mw of power at the high end or as little as 1.2 mw at the low end! One multivibrator stage consisted of two 6088 pentodes for the flip-flop and one 6814 sub-miniature triode amplifier, a vacuum tube originally designed for late generation tube computers. All stages had to be perfectly balanced, hence the use of resistors with 1% tolerance. Typically, the pentodes ran at 67.5 volts B+ and the triodes at 100 volts. There were four flip-flops per board and the entire unit contained approximately 500 tubes.

In addition to the operational key cards, there were also cards used strictly for testing. Each card in the test deck, checked a different KWR-37 function. Two of the cards, produced a distinctive pattern of beeps to indicate proper operation and the technician had to listen attentively. Used, operational cards were destroyed on periodic basis with two people witnessing their destruction, depending on the specific 'customer'. With care, the test cards could last for years.

The door for the key card was equipped with a lock in order to prevent anyone but authorized personnel from seeing the punch card. For security reasons, the card door was made from very thick steel. Details about the construction of this door are still classified since a similar arrangement was used on some newer machines. Affixed to the door, was a small placard with the letters NOF. This stood for 'Not for Observation by Foreign national'. It was permissible for a foreign national to view the front of the machine, but that same person would have to leave the premises if the front door of the '37 was opened for any reason.
When the '37 was first designed, an 'order wire' mode was incorporated. It was intended to pass plain text instructions to the distant station in order to bring up the system in crypto mode. These instructions were to be passed in the clear using code words. When the '37 went into service, the order wire was actually disabled.

OPERATION
Transmissions began at 0000Z and continued without pause or repetition for 23 hours, 55 minutes each day. Whether any messages were being sent or not, the 'customers' KWR-37's were on-line, in sync and receiving the transmitted key stream. In the event of a power loss or if the unit went out of sync, the operator would have to initiate a restart. When the sending station stopped transmitting, all receiving units worldwide would be prepared to receive transmissions for the next day. If radio conditions were normal, the transmitting station's Auto Start signal would automatically start the machine. If Auto Start was missed due to atmospherics, the operator had to late start the unit. This procedure is discussed further in the text.

On the front panel of the unit, there was a control composed of two concentric dials; the outer for hours and the inner one for minutes. Above that, were three miniature switches marked Start, Reset and Sync. Two small, orange lamps tagged Mark and Space flashed alternately in time with the incoming signal. Re- synchronization of the KWR-37 required that the machine be reset, then run it forward in time at high speed to catch up to, then slightly pass, the transmitting station's key stream. The operator would set the Hours/Minutes dials to the difference between 0000Z and the current Zulu time. The Hours dial was marked in 1-hour increments up to 23. Similarly, the Minutes dial was marked in 5-minute increments up to 55. The Reset switch would then be pressed. This would reset the flip-flops in the Key Generator and the Internal Clock and ensure that all these circuits started up from a desired, known, pre-set value. Internally, the reset signal was routed to the flip-flop stages through the Key Card, thus changing the initial 'set' state of the Key Generator. Pressing the Start switch would enable and start the clock which began to drive the flip-flop stages thus producing the key stream. Activating the Sync switch would give approximately 15 seconds worth of high clock speed, akin to a fast forward function.

If for example, the KWR-37 had dropped off-line at 14 hours into the broadcast day due to loss of ships mains power, and restoration took 15 minutes, the operator would set 14 hours, 15 minutes on the dials and hit the Start button. The machine would run in high speed for several minutes until the clock had advanced the key stream 14 hours and 15 minutes, at which time it would drop back down to normal speed and start searching for sync. This process forced the

KWR-37 in constantly comparing it's own internal timing to that which was being sent on the broadcast. If a clock comparison was unsuccessful, the clock would delete a pulse, effectively dropping it back in time by a small amount. Each time this pulse deletion occurred, an audible beep was sounded through a panel-mounted speaker. As the beep rate slowed, it told the operator that synchronization was approaching. After several seconds of silence the Sync light would illuminate and the Teletype attached to the '37 would start printing.

If the search for synchronization ran over several minutes duration, the '37 would alarm again with a steady, irritating, much-hated tone from the speaker along with the dreaded red Alarm light. Standard procedure called for resetting the machine and trying again. Since no two KWR-37's were exactly alike, the presence of the alarm did not mean that the machine stopped searching for sync. The alarm simply meant that the allotted amount of time had elapsed, during which, synchronization should have been attained. In many cases, the '37 achieved sync with the alarm sounding and the SYNC light on. At this moment, the operator would silence the speaker and everything would run normally. This was the official procedure for achieving synchronization.

In practice, however, it was an entirely different world. An operator would generally attempt the formal procedure. If this did not achieve results, a whole series of 'homebrew' remedies could be applied. Among these miracle cures for lack of sync were:
a) Pounding the front panel briskly just prior to pressing the START switch.
b) Opening the equipment drawer and hitting the tops of the circuit boards with some hard object such as a mallet or cleaning brush.
c) Opening the front door; removing the key card and cleaning the conductive tracks in the rear of the front door with a rubber eraser. This practice removed the plated silver on the tracks and was frowned upon.
d) Cleaning the conductive tracks with Teletype paper or paper money. Since Teletype paper contained trace amounts of oil to assist with lubrication, this practice was highly discouraged.
e) Rapid and vigorous spinning of the time-delay dials, followed by many shots on the RESET button.
f) Uttering foul, abusive language at the machine in order to let it know who was in charge.

MAINTENANCE
The KWR-37 was very old, tired and well past it's design life in 1968 and did not improve with age. Many technicians only had a modicum of training in the art of soldering. For the '37 family, this was a disaster as the most frequently performed corrective maintenance involved the replacement of wire lead vacuum tubes. One can only imagine the damage that was done to the printed circuit boards after 20 years of mediocre maintenance.

To ensure the highest reliability, crypto mechanics tried to turn out a machine capable of operating normally with only 1 volt of filament voltage to all the 6088 pentodes. The standard setting was 1.25 volts and was indicated by a front panel meter. Each pentode had a filament draw of 20 ma. If the unit ran properly at a reduced filament voltage, that meant that the tubes had strong emission and the unit would run reliably. As emission decreased, the operator could increment the filament voltage to restore normal operation. When the machine became unreliable at a setting of 1.25 volts, it was turned back to the maintenance depot. Checking for operation at a reduced filament voltage became known as margining. The 6814 triodes which used indirectly heated 6.3 volt filaments were not margined.

Later and unofficially, an extender board was developed which allowed individual circuit boards to be margined. Once each board ran reliably at one volt filament voltage, the filament supply to the entire machine was reduced. If it worked, it was considered ready for use. Testing each board individually improved the quality of the troubleshooting process. The majority of maintenance problems in the '37 originated in three areas of the machine: the 'S' circuit cards, (the ones containing the key stream flip-flops); the 'T' cards which combined the 'S' card outputs and the 'U' or alarm cards. Next, were the cards which allowed the '37 to run at high speed. The modified card extender was invaluable in finding these circuit faults and eventually won official approval. A maintenance bulletin was circulated among all KWR-37 holders documenting the modified extender, the construction details and stock numbers of the parts required".

John goes on to comment about his worst KWR-37 repair job." A technician had the '37 drawer open for maintenance. Innocently, a brand new Ensign, who was the Communications Officer noticed the activity and came over for a look. He must have been having a hard time at sea because of the large bottle of Maalox (stomach antacid) in his shirt pocket. As the Ensign leaned over to peek at the '37, the bottle fell out and broke on the top edge of the equipment drawer. Needless to say, the Maalox spilled throughout the machine and a large blue flash ensued as the power supply shorted out. Flames and smoke began issuing from the drawer. The tech had been sitting on the deck in front of the '37 cross-legged with his legs underneath the extended drawer. His burning trousers were quickly extinguished by the remainder of the Maalox running out of the equipment. In his haste to escape, the tech placed his full weight on the card rack and broke the motherboard in several places. The '37 was eventually repaired but the cost to repair, likely exceeded the value of the machine".

Mechanically, the '37 was about 22 inches wide, around 24 inches deep and 8 to 9 inches high with a case finished in navy cabinet grey. It was usually positioned on an equipment shelf. With a weight approaching 100 pounds, it was definitely a two man lift when it was being installed. All cabling plugged into the back of the unit.

OPERATING THE KWR-37 IN THE RCN

In the RCN, there was one minor difference in the manner that the KWR-37 machines were operated. Gregory McLean of Abbotsford BC details the difference and explains some operating practices. "In the RCN, the crypto cards were not destroyed daily. At the end of each month, when we had finished with that months pack, we returned them to the C.B. Officer (Confidential Book Officer). To ensure separation of duties, the CBO was not involved in communications. He was usually a junior officer with a number of unrelated duties. It was up to him to destroy used crypto and other classified materials at predetermined times. Sometimes, he requested help from communications branch personnel. On smaller ships, the CBO could be the Communications Officer.

The KWR-37's went out of sync frequently. Static or other interference could cause the machine to loose sync. One did not have to actually hear the hateful 'out of sync beeping'. You knew you had a problem when the teletype machine began printing garbage. It was possible to tell just from the sound. The MARK and SPACE lights on the face of the '37 flashed in sync with the incoming radioteletype signal. When out of sync, they glowed continuously and gloatingly.

In some installations, where diversity reception was fitted, two '37's copied the same broadcast on two different frequencies. It was rare to lose both signals simultaneously but if the entire broadcast was lost, and were in company with other ships, we could ask another ship for any of the missed messages. Alternately, reruns of the specific messages could be requested from the shore station. Sometimes, if a jackstay transfer was scheduled, the other ship could pass the missed messages by jackstay. We could not pass lost messages inter-ship because inter-ship crypto used an off-line machine and that could compromise the on-line system. If traveling alone, or everybody missed the messages, one ship would request the shore station, via ship-shore circuit, to rebroadcast the missing messages by referencing their sequence numbers.

I took my maintenance and repair course in Stadacona. We did six weeks in a secure room. There were no notes and nothing could be taken from the room. The exams were of the open book variety. On board ship when one had exhausted all means of repairing a blinking, beeping KWR, you shut it off. Sometimes when you turned it back on it worked fine. Other times, I exchanged certain circuit cards from a good machine to the unruly one. Cleaning the contacts behind the card door seldom worked. Sometimes we found small cracks in the key cards. We really did not have the proper equipment to repair 37's at sea".

During its in-service life, the security of KWR-37 system was compromised on at least two different occasions. When the USS Pueblo was captured in 1968, the North Koreans acquired fully working KWR-37's along with active key lists. The Pueblo was a spy ship that went on a routine ELINT mission down the North Korean coast. She was carrying a regular fit of crypto gear and confidential materials and should not have had that aboard during such a mission. When the ship was captured, the crew had no way of quickly destroying the classified materials, so the Koreans got it intact. When word got back to Washington that Pueblo was captured with a full fit of materials, all hell broke loose, world wide.

Naturally, there was a mad scramble to quickly change all of the key lists held by KWR-37 'customers'. In the mid 1980's, it was discovered that the infamous Walker spy ring was selling active key lists (i.e. the actual IBM style punched cards) to the Communists. Once again, the key lists had to be quickly changed. It's important to note that simply possessing a machine was insufficient to copy the traffic. Any adversary had to be in possession of the active key lists as well. By the early 1990's, any remaining KWR-37 crypto receivers were taken out of service and destroyed. This sounds like a sad ending, but such is life in the world of cryptography.
In 1962, aboard HAIDA, a pair of KWR-37's were fitted on steel racks, and a canvas cover blocked them from view as the crypto receivers were considered top secret. One device was assigned for HF/LF decoding while the other unit served to decode UHF radioteletype traffic as implied by the existing wiring. If a Radioman who had security clearance for the coding systems left the RCN, it was mandatory that no information about the coding systems be divulged for a period of six years. As with the KL7 crypto machines, all of the KWR-37 crypto receivers fitted on Canadian ships was owned by the National Security Agency of the United States and was loaned to North Atlantic Treaty Organization member countries including Canada.

1.2.4 - Model 14 T-D (Transmitter-Distributor). A T-D is the official name for what is otherwise a paper tape reader. Perforated paper tape was fed into the transmitter- distributor for transmission of messages over a radio link. The tape was positioned under a clip and over a lineup of 5 metallic sensing pins. These pins opened or closed electrical contacts depending on the presence of absence of holes. A sprocket wheel fed the tape past the sensing pins and produced the Baudot code required for RATT transmission.

1.2.5 - Model 14 Typing Reperforator with Keyboard. A reperforator was a motor driven machine which received electrically transmitted signals and converted these signals into code combinations perforated on a paper tape. Simultaneously, the unit printed the message on the tape. It is worthy to note that the printing lagged behind the perforated holes by six characters. Example - If the letter A was punched on the tape, it would be printed a distance of six characters later.

Messages could be prepared in advance and sent at routine times. This would maximize system efficiency as the punched tapes could be checked for accuracy prior to transmission. Some of the tapes were used to call shore stations or other ships. Tapes could be formed into continuous loops when multiple passes of the same message had to be sent. An example of this would be a calling tape: CFH CFH de CGJD CGJD K . If these tapes became worn out, the reperforator could be connected up to the paper tape reader in order to regenerate the original tape.

Two different types of tape were used in RATT operation. Some tapes had holes punched completely through the tape. This was called chad tape and was not used at sea. The other type was called chadless tape, since the reperforator does not completely remove the circular piece of paper but leaves it secured to the tape by a small uncut portion of paper. Chadless tape had the advantage of tidiness but was somewhat awkward to roll up by hand.
The RCN actually encouraged Radiomen to read chad type tape and encouraged them to keep a sample on hand at all times and study it during their spare moments!

1.2.6 - Model 15 Page Teletypewriter. A teletypewriter is little more than an electrically operated typewriter. The prefix "tele" means at a distance. Coupled with the word typewriter, it forms a word meaning 'typewriting from a distance'. The Model 15 machines, originally installed in 1957, were capable of printing at 60 words per minute. In 1962, they were replaced with faster Model 28's as a pre-requisite for the new, now encrypted broadcast system called JASON. This system incorporated the KWR37 on-line crypto receiver. For purposes of metering transmission speed, a standard word was considered to be six characters in length.

RADIOTELETYPE
When Radioteletype (RATT) was first introduced to the fleet, broadcast traffic could be cleared at speeds of 60 wpm as compared to the 25 wpm speed of the CW fleet broadcast. Teletype equipment was manufactured by the Teletype Corp. of Skokie Illinois. Normally, Model 15's had to be checked weekly and receive a tune up every month. The major maintenance interval was usually six months but could be shorter than that, depending upon the amount of usage. Machines were usually refurbished by returning the dirty or faulty mechanism back to a repair depot, removing the signaling coils and motor, and immersing the remainder in a 45 gallon drum of kerosene or diesel fuel for 24 hours. Several other drums would serve as rinsing

stations. The mechanism, was then left to dry, followed by a complete tear down and inspection for badly worn or damaged parts. It was easier to do it this way, as opposed to searching for worn parts when the mechanism was in an assembled state. Afterwards, the mechanism would receive a generous coat of lubricating oil, followed by mechanical adjustments.

Maintenance was normally handled by the " Green Empire" which was the Electrical Branch of the Royal Canadian Navy. If machine adjustments were required and the Green Empire was not available, then the adjustments might be attempted by the radio operators.
There was one quirk about Teletype operation aboard ship. Because of the plane in which the Model 15 was mounted, the carriage in the machine would slow down in an upward pitching sea. Sometimes, the strain was so much that the drive gears would strip! This problem was overcome with the introduction of Model 28 teletypes. In this design, a bulky mechanical carriage was replaced with a small, lightweight 'print block'.

In order to avoid fatigue while operating the Teletype, good posture was very important. Function keys such as FIGS and LTRS could be very confusing to use when compared with a regular typewriter. It became important for the operator to practice and develop a good keyboard rhythm in order to overcome these problems. From a signaling viewpoint, the RATT system used the Baudot code in which mark and space conditions were converted to produce a signal that had a frequency shift of 850 Hertz. Back in the 1950's and 1960's when tube receivers lacked good stability, it was necessary to use a 'wide' frequency shift to compensate for receiver drifting. As receiver designs improved, a frequency shift of as little as 170 Hertz became popular because it used up less space in the radio spectrum. This became the standard radioteletype 'shift' in the amateur radio bands and remains to this day. There are still a few a few isolated commercial stations using wide shift teletype, but these too, will eventually become obsolete.

1.2.7 **RAK Receiver**
Designed in the 1930's, this six tube regenerative receiver was capable of receiving signals between 15 and 600 kc. Tuning was accomplished through the use of circular, geared logging scales for both coarse and fine tuning. To determine an actual frequency, one had to look at the dial reading then consult a 'tuning graph'. Since these graphs were not that accurate, most operators calibrated the receiver by noting the dial positions after stations of known frequency were identified.

On HAIDA, the sole purpose of this unit was to receive low frequency RATT signals and provide input to the frequency shift converter. It still receives remarkably well despite its antiquated design. When compared to the CSR 5A, the RAK provides superior performance on the low frequency radio bands. On Dec 7, 1962, the RAK was re-positioned from Radio 1 to the Message Centre. The RAK aboard HAIDA was built by RCA Victor in Montreal and weighs 74 pounds. It is interesting to note that this receiver was still in use by the RCN in 1962.

1.2.8 - REC10 Rectifier. The REC10 was a rectifier that provided a 120V DC, 100 or 200 milliampere power source to the Teletype Distribution Panel.

1.2.9 - Speaker Panel in Rack. The sole speaker in this rack was intended to monitor either the CSR 5A or RAK audio output by moving a jack to either receiver.

1.2.10 **- FSC107 Frequency Shift Converter**
This unit converted RATT signals from either a CSR 5A or RAK receiver into pulses which controlled a current loop. In the case of HAIDA, the FSC107 had a dedicated connection to one of the teleprinters through the Teletype Distribution Panel. Audio input signals to this unit were represented with 2975/2125 hertz tones. The frequency difference between these tones is 850 Hz, hence defining the 'frequency shift' of the entire system. There was a small CRT mounted in the 107 unit which was used to monitor the quality of the received signal.

1.2.11 **- Teletype Distribution Panel**
The TT23-SG Teletype Panel was intended for general shipboard use to facilitate the interconnection of various pieces of equipment such as teletypes, frequency shift converters/keyers and tone terminals. There were six channels available and each channel could have its loop current monitored and adjusted individually. The Teletypes and the KWR-37's each had their own separate 'plug' boxes which could be interconnected to the panel. Equipment interconnections were dedicated and hardwired within the TT23. In case of equipment failure, the connections could be re-configured with the use of patch cords. Northeastern Engineering Inc. of Manchester, New Hampshire produced the first examples of these units in 1947 for the US Navy Department. The unit installed on HAIDA is S/N 182 dated 17/09/51.

OTHER EQUIPMENT

Man Aloft Board
This was a key depository for all equipment which was equipped with "safe to transmit " keys. Cabinets for the Man Aloft Board came in all shapes and sizes. All radio transmitters had to be disabled while the ship was under any of the following conditions - being refueled; refueling aircraft; ammunition being loaded or unloaded; man aloft; ship being dressed; ship being lighted. When the keys were returned back to this panel, it signified that all radio transmitters and radar were secure. The key to the board was held by the Officer of the Day in harbour or the Officer of the Watch while at sea.

Safety precautions were also necessary whenever personnel were working aloft. Aloft, meant anyone working above the flag deck level. One hazard to be reckoned with was the fact that the 35 foot whip antenna presented a potential danger within a ten foot radius if the frequency was above 10 MHz. Did the navy know something back in the 1960's or was this a general precaution ? From radar, there was a two-fold hazard. One had to worry about radiation and mechanical antenna rotation.

When aloft, it was stressed that safeguards must be taken against electrical shock, falling, choking from funnel gas and the dropping of tools. Personnel aloft had to be supervised at all times. There was a documented case in the United States Navy, of a man who was working aloft while the funnel exhaust was blowing his way. He worked in the fumes for a half hour and then came down complaining that he couldn't stand it any longer and would have to wait for the wind to change. About an hour later, he collapsed and was taken to hospital where he died later that day.

APPENDIX XI

RADIO ROOM 2 DESCRIPTION - 1962 FITTING

LOCATION : On the lower deck, below the main mast on the port side.

YEAR OF INSTALLATION : 1950. Restoration completed on August 27, 1994.

CREW COMPLEMENT : 2

PURPOSE OF THIS ROOM : Main transmitting room for high frequency radio teletype and CW transmissions. This was also a backup to Radio 1 if it was put out if action. Radio 2 also provided additional radio circuits if Radio 1 was overloaded. When HAIDA was first commissioned, this was the HF/DF office.

TELEPHONE CONNECTIONS: Connects with Message Centre and Radio 3.

DESCRIPTION OF EQUIPMENT

_2.1_ - Channel Amplifier Units
See description in Radio 1 Section.

_2.2_ - CM11 Transmitter/Receiver
There were two units installed in this room. Neither unit was fitted with a CW key since they were remotely controlled from Radio 1. Two operators were still required to switch crystals and tune up the equipment. One CM11 was connected to the 35 foot whip antenna on the port side while the other connected to a flattop antenna.

_2.3_ - PV500 Transmitter and Variants
The Canadian Marconi PV500 HM was first built in 1943 and it was a high powered, CW/ICW only transmitter, capable of operating in the range between 3 to 19 Mc. Power input was 500 watts over this frequency range. Break-in keying could also be used. The HM2 variant of the PV500 operated up to 28 Mc, however, power input was reduced to 300 watts above 19 Mc. There were four, switch selectable, master oscillators that could be preset to the most often used frequencies. Alternately, four crystal controlled frequencies were also available. In addition, Interrupted CW (ICW) could be sent and tones of 400, 700 and 1000 cycles per second could be selected from the front panel. In talking with former telegraphists, there is no evidence to support the use of ICW.

Physical Dimensions: 63" H x 37" W x 25.25" D
Weight: 620 to 695 pounds depending on variant. An additional 285 pounds if used with a rotary converter.
Power requirements : 120 VAC, 60 Hz, 1800 watts or rotary converter.
Antenna Impedance : 5 to 200 ohms resistive.
When used in RATT service, the PV500 was keyed by a frequency shift keyer which was connected to the teletype distribution panel in the Message Centre. Normally, the T-D was the input device, however, the Teletype could have been used for that same purpose, but with less

efficiency. As with the majority of the equipment, the PV500 was attached to the remote control system, but someone still had to manually change frequencies and tune it up.
Keith Kennedy, of Surrey B.C., states that "PV500's were notorious for ground loop problems and one made sure that you kept one hand in your pocket while tuning them. Placing your hand on the cabinet to brace yourself against the ships roll could result in a really fine 'attention grabber' in the form of an AC buzz. Many Radiomen tuned the PV500 HM2's by watching the power amplifier through the front panel window. When the plate was cherry red but not white, the final stage was considered to be tuned. As an additional tuning aid, a small fluorescent bulb was taped to the antenna feed line and the final would be tuned for maximum brightness. On some PV500's, the front bottom left power supply cover panel can be found somewhat dented. This was normal and was caused by having to kick it there in order to ensure that the power supply interlock engaged.

Since there was no drive level control on the PV500 HM2, there was excessive drive at lower frequencies and insufficient drive at high frequencies. Multiplier stages had to be detuned to obtain the desired drive levels. To reduce chirp on CW, the multiplier stages were keyed while the oscillator was held on for the duration of a 'word'. This reduced chirp to the first letter of each word sent and permitted the use of break-in operation. In the PV500 HM3, there were design changes to overcome deficiencies of the previous models. A driver stage and drive level control were added. Frequency shift keying capability was added. In the previous models, there was a large power loss in the trunking to the antenna, so the antenna tuner was removed from the transmitter and was re-designed for remote operation".

The PV500 HM currently on display was acquired from HMCS Griffon Naval Reserve Division in Thunder Bay Ontario, but HAIDA was fitted with the PV500 HM2 when she was paid off.

2.4 - Transmission Line Tuner - E886

This unit was fitted to CM11 #3 on Oct 29/62. Internally, it contained several fixed and one variable inductor which could be switched in or out. Also installed, was transformer-rectifier assembly whose purpose is not known. At this time, it is not known how the E886 operated in conjunction with the CM11. The unit which is on display is a replica and was built by the author.

2.5 - XFK107 Frequency Shift Keyer

The Frequency Shift Keyer converted the 60 milliampere current loop from Radio 1 into control signals which would then frequency shift key the PV500 transmitter. With frequency shift keying, mark and space signals, in essence, cause the transmitter to be FM modulated with a fixed frequency deviations.

A frequency shift keyer was used in lieu of the oscillator stage in the PV500 transmitter. The keyer produced an RF carrier of constant amplitude and frequency which would be shifted 850 Hz depending upon whether a mark or space condition was being sent. For low frequency operation, the frequency shift was 200 Hz. Keyers used by the navy produced a carrier signal in the range of 2 to 5.5 Mc with selectable shifts of up to 1000 Hz. In later variations, keyers could operate in the 1 to 6.7 Mc range. *(Photo by John Paszkat)*

2.6 - Other Information

Just like Radio 1, this room is lined in sheet copper to reduce radio frequency interference both inbound and outbound. In order to realize the full benefits of shielding, the door to Radio 2 would have to remain closed when operating. It was not a place for a Sparker who was susceptible to claustrophobia.

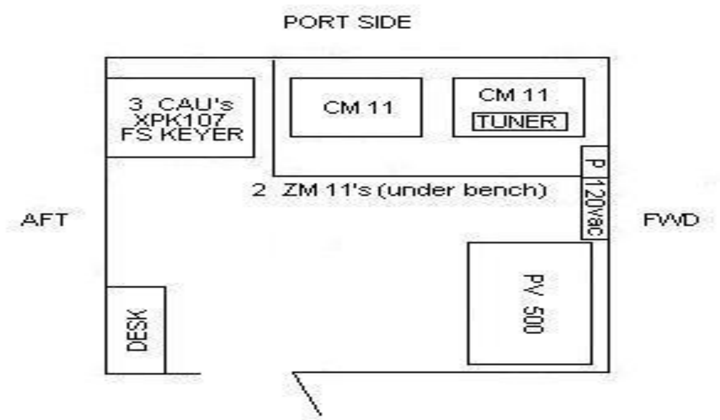
In 1984, a Korean war vet had indicated that there was a false compartment on the port side of Radio 2 where spare tubes and parts had been stored. Perhaps they were still there. Unable to contain his curiosity, HAIDA's Electrical Officer, Lt. Frank Moore disassembled the paneling and did indeed find the hidden niche. Unfortunately, there were no treasures to be discovered. CM11 #3 was fitted with a hybrid transmission line. From this CM11, a bare, 5/16 diameter copper tube was suspended on standoff insulators. A feed through insulator passed the RF signal from the ceiling of Radio 2 to the exterior of the lower deck. Attached there was a length of RG 18/U coax, stripped, so only the dielectric jacket remained. Finally, this co-ax connected to the port aft whip antenna. (RG 18/U coax is one inch in diameter using a #6 solid copper wire centre conductor).

Taken in May 1957, this aft, port side view of HMCS Iroquois illustrates the trunking from Radio 2 to the aft. port whip antenna. Originating at deck level to the right of the door, it traversed the exterior bulkhead and mated with the bottom portion of the antenna sponson. HAIDA's trunking was similar in appearance. *(Photo courtesy of Lawrence Redman)*

On many older ships, open wire transmission line was commonly used because coaxial cable was rather new and had not been produced in a type that would handle the required power levels. Open wire line had its advantages in that the radio operator could tune the transmitter over a wide frequency range. Among the disadvantages, were safety and the difficulty of preserving watertight integrity. In many instances, it was within handy reach of the unsuspecting seamen even though there were 'Danger - WT Transmitting Antenna' signs posted in the appropriate spots. This hardly constituted sailor-proofing. In other circumstances, the open line was fitted with a metal enclosure (trunking) or a wire mesh screen which took up space, a resource which was always in short supply on a ship. Open line also had the potential to cause mutual interference to other wiring within the ship.

Once suitable coaxial cable was developed, most of the open wire transmission line was removed. The ease of installation, the saving of space, maintenance, and improved watertight integrity were advantages which could not be dismissed. Co-ax cables were also manufactured with armour which among other advantages, prevented or severely retarded the spread of fire. Stew Patterson of Dawson Creek, B.C. relates a humorous anecdote while he served aboard HAIDA. "I remember Radio 2 very well as it was my cleaning station and I spent many hours polishing brass in there. The PV500 was a very fickle piece of equipment and at times you would get zapped while trying to tune it. Peter Foote (alias - Panic Pete Feet) was the P2 at that time and was very nervous around that beast.

John Ovens and myself were sent down to clean up Radio 2. While we were down there, the P2 came down to tune up the PV500. Meanwhile, John started to mischievously glance at the tool box in which he stored his diving weights. John then glanced at me, then back to the tool box. Without a word, he picked up the toolbox and dropped it behind the P2. Peter almost went through the deckhead but we made a quick exit through the door and up the ladder. Thank goodness he stayed airborne long enough for us to get a head start or we would have been tuned up much better than the PV500".



RADIO 2 AS FITTED EQUIPMENT - 1962

Appendix X

RADIO ROOM 3 DESCRIPTION - 1962 FITTING

LOCATION: Port side, flag deck, below lattice mast.
YEAR OF INSTALLATION: 1950. Restored May 26, 1996.
CREW COMPLEMENT: None. This room was normally unmanned and remotely controlled unless frequencies had to be changed and equipment tuned up. Could be locally controlled under emergency conditions.
PURPOSE OF THIS ROOM: It was purely an equipment room and provided four additional UHF circuits.
TELEPHONE CONNECTIONS: Connects with Radio 2 and Message Centre.
It's a tight fit in this room. There is only about 2 feet between the front of the equipment and the forward bulkhead.

DESCRIPTION OF EQUIPMENT

3.1 **- AN/URR35 Receiver**. See description in Radio 1.

3.2 **- Channel Amplifier Unit**. See description in Radio 1.

3.3 **- TED3 Transmitter.** See description in Radio 1.

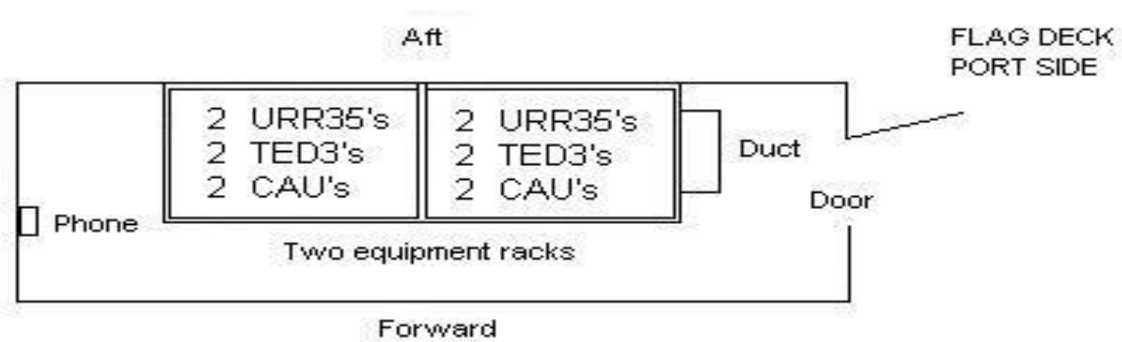
There were four AN/URR35 UHF receivers, four TED3 UHF transmitters and Channel Amplifier Units located in two equipment racks. Mounted over the racks, was a galvanized, sheet metal exhaust vent to carry away the excess heat produced by the equipment.

3.4 **- AT-150/SRC and AS-390/SRC UHF Antennas**
The three TED transmitters and URR35A receivers in Radio 1 were attached to Model AT-150/SRC dipole antennas which were mounted on the ends of the lower yardarms of the foremast. In Radio 3, the UHF gear, which provided four out of the seven UHF channels, was attached to Model AS-390/SRC stub antennas which were mounted on the ends of the upper yardarms of the foremast.
Comparisons between the two antennas can be expressed with the following table:

	AT-150/SRC	**AS-390/SRC**
Description	Broadband co-axial dipole antenna	Broadband co-axial stub antenna
Frequency range	200 to 400 MHz	200 to 400 MHZ
Nominal Impedance	52 ohms balanced	52 ohms unbalanced
Polarization	Vertical	Vertical
Power Input	300 watts maximum	300 watts maximum
Manufacturer	Technical Appliance, Sherburne NY or Bird Electronic	Bird Electronic, Cleveland Ohio
Alternate Name	AS-5042/URC	AS-5041/URC

Antenna Comparison Table

When at sea and in exercises, at least six, if not all seven, UHF circuits were in use all the time, so there wasn't much opportunity to select which circuit would go to which antenna, except when first setting up before sailing. The radiomen knew which antennas gave the best coverage, and there were many factors that entered into this, including the mast shadow and the radiation pattern of the antenna itself. When time was available, and it seldom was, an aircraft and other ships were employed in order to construct a pattern for each antenna. Given the knowledge that was available to the PO Tel, and the COMMO or OPSO, the most important circuits would be assigned to the best antennas (eg PRITAC, and CIP(P). The antenna with the most suitable pattern would be assigned to the air control circuits such as ASP(P). As the voyage went on, or as the exercise progressed, there would be frequent changes of the COMPLAN, plus equipment breakdowns, so that circuits would get moved around from one transmitter to another, and the best constructed arrangement would soon be sacrificed to expediency. HAIDA was the first ship in the RCN to be fitted with UHF capability.



RADIO 3 EQUIPMENT AS FITTED - 1962
(Top View)

Not to scale

APPENDIX XI

RADIO ROOM 4 DESCRIPTION - 1962 FITTING

LOCATION: Located on starboard side below the lattice mast.

YEAR OF INSTALLATION: Before 1956. Restored to 1962 configuration on Aug 1, 1993.

CREW COMPLEMENT: 2 - Anyone working in this room would have to be cleared for top security. See PERSONNEL in this section.

PURPOSE OF THIS ROOM:
This was the electronic warfare room. It was capable of providing direction finding services in the MF radio bands plus the interception of radar transmissions in the super high frequency (SHF) bands.
For monitoring and recording of tactical radio traffic using a Hammarlund general coverage receiver and tape recorder.
Provided two-way high frequency communications between electronic warfare rooms.

TELEPHONE CONNECTIONS: Connects to Radio 1, the OPS room and the bridge.

GENERAL INFORMATION

According to Cdr. R.A. Willson of Toronto (Ret'd), Radio 4 or its equivalent, depending on the type of ship, was also known as the Electronic Warfare room (EW), Electronic Warfare Control Room (EWCR), EW Shack, or EW Hut. In the Fleet or Task Group Communications Plan there would have been an EW Primary communications circuit, EW(P) in the UHF Range and an EW Secondary circuit, EW(SEC), in the MF/HF Range. EW(P) would be used as the control circuit for tactical EW and EW(SEC) used when units were outside UHF range. In Radio 4, the EW(P) circuit was provided via the RCU mounted on the forward bulkhead. EW(SEC) may also have been used as a "yak" circuit if the Radio Silence Policy permitted, since it was not normally monitored in the Ops Room or on the Bridge like the EW(P) circuit.

DESCRIPTION OF EQUIPMENT

4.1 - AN/SRC 501 Transceiver

The AN/SRC 501 was designed primarily for marine installations, and intended for ship-to-ship or ship-to-shore communications over short distances. In the RCN, it was used to provide a secondary communications circuit EW(SEC) between electronic warfare rooms using the high frequency radio band. It was generally used when ships were beyond UHF line of sight range. Radiotelephone transmission and reception used any one of four, crystal controlled frequencies in the 2 to 4 MHz band. Optionally, the receiver section could be continuously tuned for reception in the 0.5 to 1.5 and 1.5 to 4 MHz bands. Twelve watts of power was delivered to an antenna-tuning unit in the base of a 19-foot whip mounted on the starboard side of the bridge. One former CS rating offered his personal comment about the operation of the AN/SRC 501. "Its main use was an intercom between Radio 4's. A good megaphone was just as good, if not better".

4.2 - AN/UPD 501 Receiver

The UPD501 was a High Probability Radar Early Warning directional finding receiver which was used to detect radar emissions on the SHF radar bands and gave some indication of the wavelength in use, bearing, and the antenna rotation period. The receiver was connected to a horn antenna which was mounted on the foremast top and connected to the receiver by RG55/U coax. Initially, the UPD 501 horn antenna (circa 1953) was designed to monitor X band radar only. 1N23WE diodes located in the antenna housing acted as signal detectors.

Changing these diodes could be a very interesting experience in harbour, let alone at sea. In the 1970's, a two-band version (X and L) was introduced. Later, the antenna was re- designed for coverage of multiple radar bands. The multiband version was a two-piece, symmetrical unit. Each vertical section was 34 inches long and consisted of four cylindrical modules that were bolted together. An example of the 501 antenna from HMCS Mackenzie covered the K, S and X radar bands. The design of the UPD501 was simple. In the set itself, there were four, wide-band radio frequency amplifiers, one for each of the antenna bearing angles. The outputs of the amplifiers would be applied to the four plates of a cathode ray tube and the relative signal strength caused a blip to appear on a CRT. This blip was appropriately deflected to visually indicate the relative bearing of the incoming signal. In the absence of any signal, a spot of light would simply appear in the centre of the CRT. Upon receipt of a radar emission, an audible alarm was also triggered. This alarm could be monitored by a loudspeaker or headphones. Pat Barnhouse, a former Electrical Officer and Radioman Special aboard HMCS HAIDA outlines a serious problem with the original UPD 501 antenna design and how it was rectified when he stated: "Our ship had an inoperative UPD 501 set. It turned out that the crystal detectors in the horns had been burned out as a result of receiving an overload of RF from a nearby high powered radar, probably an SPS 10 or 12 sitting close to us in Halifax harbour. The problem was that there were no shutters on the original UPD 501 horns to protect the sensitive 1N23 mixer diodes and this burnout problem became endemic. Replacement was compounded by the horn placement on the bottom of that flat plate at the top of the mast extension, requiring a dockyard crane to effect replacement. The later multiband versions of the 501 came with the antennas mounted in "cans" that had shutters over the horn mouths.

There was only one drawback to the UPD501 - it could not be used if the ship's own radar was operating. The UPD 501 system was still fitted on older RCN ships right up to the mid 1990's however, it is not known if it was actually used up to that time.

James Dean, VE3IQ of Ottawa, gives a brief insight on developments beyond the UPD501 system. "When I was in the Electronic Warfare section of NDHQ in 1967 we developed an electric "pop-up" emitter identification system called the Electrofile for the IRE and DDH 280 class of ship. This was the first form of automation to speed up the process of identifying radar emitters. It moved the state of the art from operators having to look up possible emitters in a book (a really slow process) to a rapid presentation of a list of possible emitters given the frequency, pulse repetition rate and power level. This system then became the forerunner of today's CANEWS automated system. By far, the most prevalent emissions were in the X band and especially around 10 GHz. This was a very popular frequency because in the ITU Table of Frequency Allocations, there is a Radio Location allocation at 10 GHz. Due to the large amount of available equipment using klystrons and magnetrons, it was a neat countermeasures idea to bury warship navigation /surface radar in amongst all the commercial radars".

***4.3* - FM12 MF/DF Receiver**
Designed by Marconi in 1942, this was a tuned radio frequency, direction finding receiver with a frequency range of 42 to 1060 kc and required 220 VAC input power. The FM12 was considered to be a D/F 'outfit' or system and it incorporated the Model FMB receiver. In 1943, the outfit was re-designed for use in submarines and was known as the FM11 which incorporated the FMA receiver. On HAIDA, input power was supplied by a 120 to 220 step up transformer. Power consumption was 60 watts. A directional, fixed frame antenna, was mounted over the wheelhouse and was connected to the FM12 inputs via dual connector blocks and RG57 coax. The STB INNER VERTICAL was the 'sense' antenna for the FM12 and Marconi recommended that the aerial be 30 to 40 feet in length. A wall mounted, gyro repeater provided reference bearings for the operator.

The FM12 was a very good direction finding set for its day. In taking a bearing, the use of the multi-purpose switch was very important. An operator would first tune in the signal of the target station with the Aerial switch in the search position. Then, with the switch in loops, a minimum strength on the outside compass scale of the goniometer was found. Lastly, the operator would place the Aerial switch in the sense position and would rotate the goniometer slowly clockwise. If the signal faded away, the minimum position was the true bearing. Had the signal risen, it indicated a reciprocal bearing and true bearing would be found 180 degrees on the opposite side of the scale.

This unit was originally fitted in Radio 1, however, Jack Raine of Vancouver states that in the '43 to '44 period, the FM12 aboard HAIDA was not used for the stated purpose of intercepting enemy radio transmissions. Instead, it was used as a navigational check to aid in operations in the area of Scapa Flow to Russia, Iceland and Spitsbergen. When HAIDA was transferred to the Plymouth Command in 1944, the unit was not used to the best of his knowledge. The FM12 was mainly used for navigational direction finding. On occasion, it would be used to get a MF bearing on a 'target'. This could be another naval vessel, a merchant vessel or any vessel in distress. On Nov 20 1962, the FM12 was moved from Radio 1 to Radio 4. It must have been quite a job as the FM 12 weighs 211 pounds.

***4.4* - SP600-JX Receiver**
In the late 1950's, the standard EW/HF receiver both ashore and afloat was the SP600 which was far superior to the CSR5 family. Many Chief Radiomen would give a fair 'price' to have one installed in Radio 1, particularly to copy the fleet broadcast. Eventually, the SP600 was fitted into main radio offices only because the Racal series of receivers were being introduced into EW service and supplementary shore stations. The SP600JX was a twenty-tube general coverage receiver made by the Hammarlund Manufacturing Company and provided coverage in the bands of 0.5 to 54 MHz. The J in the model number indicated that MIL spec components were used in the design and the X means that the unit was equipped with crystal control. In Radio 4, the SP600 is connected to the STBD OUTER VERTICAL antenna using RG22/U (95 ohm) coax. Two characteristic features of this receiver were the gold plated tuning capacitor and frequency coverage up to 54 MHz.

***4.5* - WEBCOR Tape Recorder**

The Webcor recorder can be best described as a suitcase style, reel-to-reel, portable tape recorder, made by Webcor. It was shuttled between Radio 1 and 4, which likely explains why there is no listing of this gear on the electrical diagrams. When stationed in Radio 4, the recorder was connected to the SP600 receiver and was used to monitor CW traffic from Russian Electronic Intelligence Ships (ELNIT) operating on the 4 and 8 MHz bands. These were the famous Russian "fishing trawlers". When HAIDA returned to port, the tapes were sent to Glouchester Ontario for analysis by naval intelligence.

PERSONNEL

Ken Macdonald of Downsview, Ontario provided an excellent narration regarding operations in Radio 4. "In the 1960's, Radio 4 was manned by members of CS (Communications Supplementary Branch) who were not regular radio operators. This secret branch went under many names but officially it was known the CS branch. Duties of CS operators included the interception and analysis of "opposition" emissions, both radio and radar.
Security at CS training schools was very tight but not in the form of armed guards and barbed wire. Trainees were indoctrinated on the political picture and drilled on the sensitive nature of the work. In order to maintain the highest level of secrecy, CS operators were taught to be 'Operator-Maintainers' thus eliminating radio maintenance personnel and to be 'Writers' thus eliminating the need to use Supply and Secretariat services.

ABRS "Spud" Roscoe copies a message from the SP600 receiver in the Electronic Warfare office aboard HMCS SWANSEA in January 1961. Note the chain which holds down the typewriter in case of heavy seas. Pictures such as this were forbidden by the RCN. This is how it would have looked aboard HAIDA. *(Photo courtesy Spud Roscoe)*

When a CS operator terminated his duties permanently, he went through a de-indoctrination process which included signing documents relinquishing SECRET 'CODEWORD', TOP SECRET, SECRET, and CONFIDENTIAL knowledge and a promise never to divulge such without clearance from the Minister of National Defence. In 1952, a few CS operators were collected from various stations around the country to take a course in RCM (Radio Countermeasures) and RADCM (Radar Countermeasures) after which they were dispatched to HMC Dockyard, Halifax. These ratings were not allowed to explain their duties, had to be secretive, and couldn't tell anyone the ships they were boarding. (They didn't even know themselves). They were simply not welcome on the dockyard. What most people didn't know was the reason for their presence - to be involved in the Canadian development of the UPD501 and its operational tests.

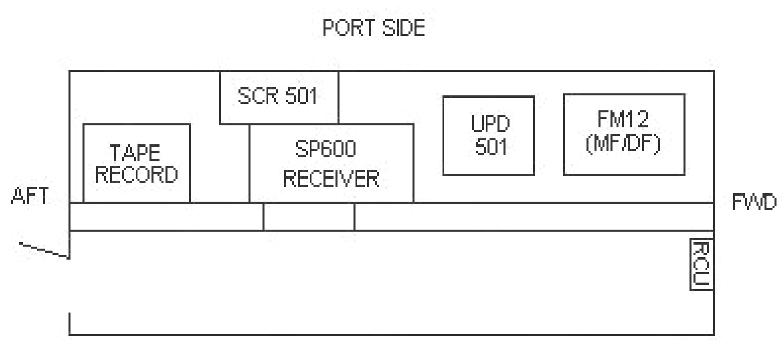
It took almost ten years to convince the captains of vessels to rely on Radar, yet, when the CS personnel showed up aboard ship, they requested that the Radar be shut down because it jammed the 'D/F' and also gave away the position of the ship! It probably took another ten years to reverse this thinking.

In 1953, electronic warfare rooms were also installed in HMCS Huron and Iroquois for operations in the Korean theatre and each had a CS operator (P/O or L/S of a high Trade Group) drafted on board. There is an incident worth relating about secrecy. On HMCS Iroquois, the new CS op was just drafted but not informed about the protocol of a CS being introduced to the CO. The following day, the Commanding Officer was making his rounds of his new ship and told the Executive Officer that he wanted to inspect Radio 4. Upon hearing this, the CS operator refused to let the CO or XO climb the ladder to Radio 4 and immediately dashed up the ladder to padlock the door. Furious, the CO had him thrown off the ship onto the jetty with all his kit. This was three days before sailing time to the Korean conflict. Next day, a three-ring commander arrived in Halifax and gave the CO his indoctrination, however, the poor CS was never the most popular person in the eyes of the CO ever again.

Since Radio 4 was considered a top security area. The door was labeled with a sign warning one of this fact and it was always kept locked up when not in use. Since assess was so restricted, it was also a good place to catch up on lost sleep. This wasn't so bad considering these CS ratings copied CW at 35 WPM in languages such as plain language English, plain language foreign and Kata-Kana ".

Spud Roscoe, a former CS rating from Weymouth, Nova Scotia remembers SWANSEA's captain Gordon Clark who became one of HAIDA's C.O.'s . "He could sail a ship across hell and back, have a complete volunteer crew with each one thoroughly enjoying the trip. Clark would get a good giggle out of a statement like that. He also would be most interested in amateur radio along with everything else that was going on in his ship. When I was aboard SWANSEA, the Russian fleet off the coast of Nova Scotia used to have their own broadcast station on 2 mHz. When they played fast Russian music, Clark wanted to know about it. I used to tune it in and he would come into Radio Four and enjoy the broadcast.

Spud sums it up succinctly. "Radio 4 was a lot of fun most of the time, a lot of bull some of the time, and unfit for human habitation the rest of the time. Come to think of it, that was the Navy. Radio 4 was simply part of it."



RADIO 4 EQUIPMENT AS FITTED - 1962
(Top view)
Not to scale

APPENDIX XII
ENGINEERING DEPARTMENT

The Engineering Department is responsible for the operation and maintenance of the boilers, engines, gear room, auxiliary machinery spaces and tiller flats.

The main machinery layout for HMCS HAIDA has three boilers each in separate compartments. Boiler room number one is below the break in the fo'csle followed by number two and number three going aft. The engine room is the next compartment aft. It contains two engines (turbines) and just aft of the engine room is the gear room where the gear box and thrust block is located. The shafts run aft of the ship and the shaft is supported by the Plummer blocks located below in the ship offices compartment it then passes through the hull at the glands and stern tubes. The out board end of the tail shaft is supported by the "A" bracket.

The following is a description of the main areas and equipment in these spaces.
BOILER ROOM: There are three boiler rooms on the ship. Each one contains an Admiralty three-drum boiler capable of producing saturated and super heated steam at 350 PSI. Boilers one and two are back to back so that they can use the forward funnel. Number three boiler uses the after funnel.

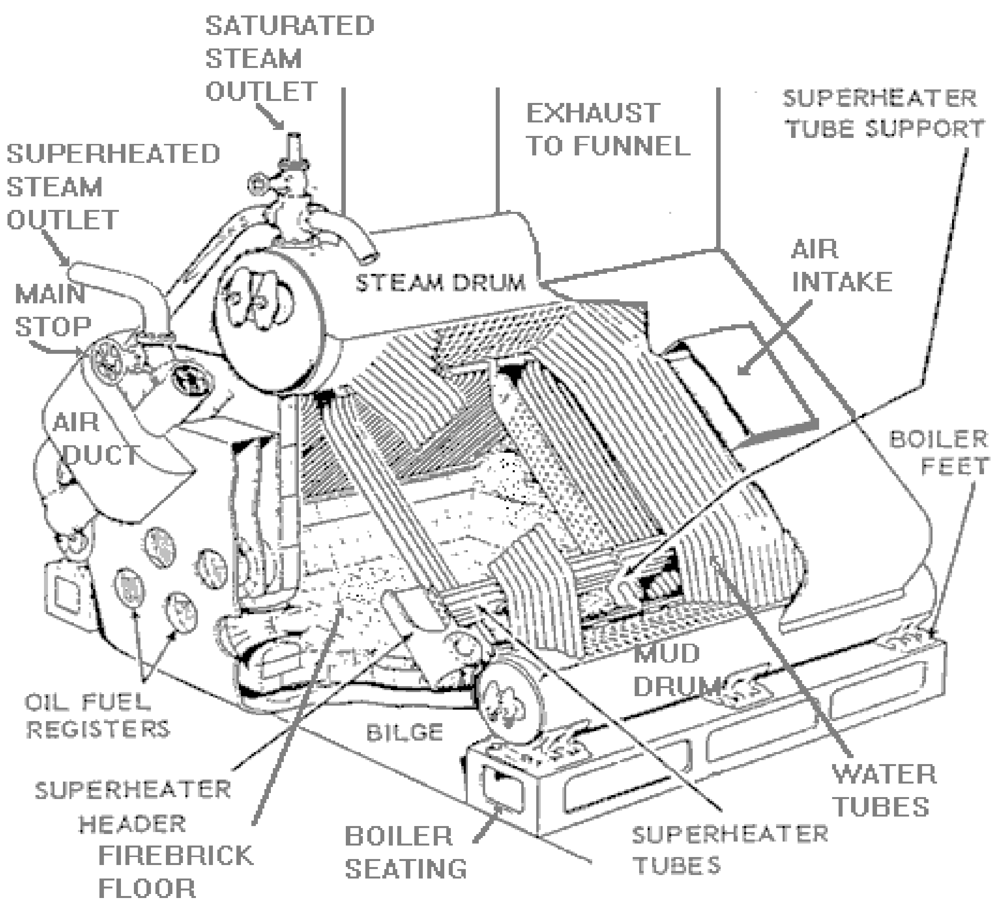
The saturated steam is used for domestic purposes such as heating the ship and operating reciprocating engines. The super heated steam is used for all the turbine operated equipment and is produced from the saturated steam by passing it through a Melesco super heater built into both sides of each boiler. It consists of two headers on each side of the boiler. The saturated steam enters both headers, then passes through the super heating tubes that run horizontal (4 passes) in the boiler then back out to the second header. At the top of each discharge header is the main stop valve for the superheated steam. Between the headers are the pressure relief valves for each boiler.

The air supply to each boiler room comes from two turbine driven fans located in front of the boiler. These fans emptied into the boiler room causing the room to be pressurized to create the proper airflow for combustion in the boiler. The air pressure is monitor by use of manometers, one located in the boiler room and the other in the engine room. To enter or leave the boiler room when it was in operation, you had to pass through an air lock to prevent disturbing the airflow. The air enters the boiler through ductwork on the top rear of each boiler. The duct carries the air along the top and then down the front of each of the registers.

The fuel for the boilers is BUNKER "C" oil which is a slightly refined crude oil. It is drawn from the tanks (four forward and four aft) of the engineering spaces, by steam driven reciprocating pumps, one in front of each boiler. The oil is passed through a preheater where the temperature is increased to 225 F before entering the boiler through the sprayer nozzles, known as an Admiralty Pattern 13, which atomizes the fuel mixing with the air supply just prior to burning. Fresh water is fed to the boiler from two sources into the bottom of the steam drum through the float control that maintains the proper water level. The main source is from the pre-heater located in the engine room. The second source is the auxiliary pumps located beside the fuel pumps in each boiler room. The auxiliary feed pumps draw their non-preheated water from the boiler feed tanks in number two boiler room.

When the boiler is flashed up from a cold state, they used lighting-up equipment known as a "U" tube. The "u" tube assembly consists of fuel nozzle, a pipe bent in a shape of a u and hoses connecting the "u " tube to the nozzles and the fuel supply. In the hose between the tube and the nozzle is a thermometer to show fuel temperature. The oil is supplied by an electrically driven pump or by a hand pump. A small fire is lit inside the boiler using cotton waste or rags soaked in diesel fuel. The "U "tube which is placed in side the boiler over the cotton waste and the fuel nozzle is opened. The temperature is being monitor as the fuel is being heated and the "U" tube is extracted part way after the fuel reaches combustion temperature. The correct combustion mixture is maintained by use of an electric fan. The fan is used until sufficient steam has been generated to operate the turbo fans.

There is another type of a "U" tube known as a "buck roger ". It mixes the fuel with compressed air, in a "y" piece prior to burning. This eliminates the use of an electric fan. The ship has two variation of this devise.



Auxiliary equipment in each boiler room is listed below.
Number one boiler room:
<u>A bogey boiler:</u> This is a small diesel fuel fired boiler used to produce what is known as domestic steam. This steam is used to heat the ship and the hot water when the main boiler is

shut down. It is a non-automatic boiler and required a full time watch keeper.

Number one diesel generator: A 225-volt, 100-kilowatt air-cooled generator driven by a GM Cleveland 3-268A diesel engine. This is a three cylinder, two-cycle engine with 268 cubic inch displacement per cylinder. The pistons are 6½" diameter and have a seven-inch stroke. There are four exhaust valves in each cylinder head. The speed is controlled by a mechanical governor and operates at a maximum speed of 1200 rpm. A manual on the engine is available for review, but cannot be removed from the ship.

Diesel driven air compressor: This is a Lister single cylinder, four-stroke engine with an integrated two-stage air compressor with a 1300-PSI output. It has a spring-loaded manual governor and operates at 800 rpm. It has a large flywheel and has a removable crank for starting.

Chernikeeff log compartment: This area houses the gland that allowed the Chernikeeff log head to penetrate below the hull. This unit produces electrical pulses that are directly proportional to the forward speed of the ship. The electrical signal is sent to the control box in the operation room.

Number two boiler room

There are four water storage tanks in this area. Two are located on each side of the boiler running full length of the boiler room. The forward tank on each side is for fresh water storage, the aft two are for boiler feed water. There is a small electric driven water transfer pump mounted on top of the port fresh water tank.

Number three boiler room

Turbo driven air compressors: There are two high-pressure turbine driven air compressors, located on the port and starboard side of the ship. Their use is for charging the air vessel of torpedoes to 3,000 lbs per square inch. Prior to the 1950 refit, high air was also used for air blast in the 4.7 inch guns and also supplies the air starter on the diesel generators. The output from the air compressors goes through pressure reducing regulators for air blast cleaning of the boilers.

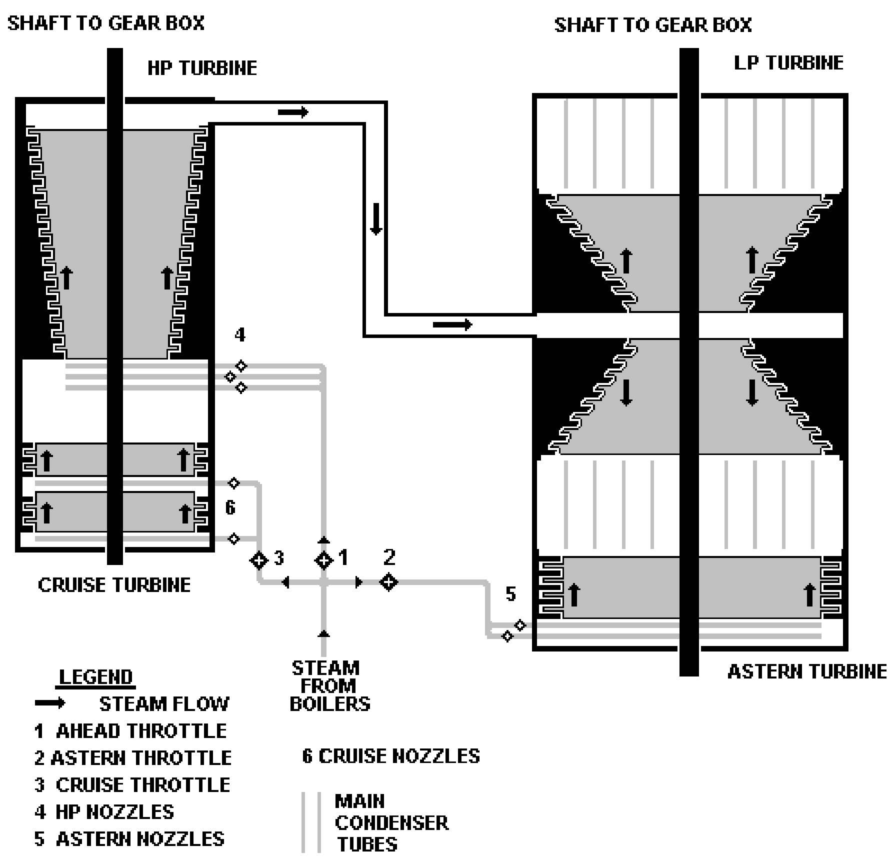
Lighting up pump: This pump consists of two pumps driven by a common electric motor. Each pump has a manual clutch between the pump and motor. One is for feeding water to the boiler and the other is for fuel to the light up nozzles.

ENGINE ROOM

The super heated steam passes through separate pipes from each side of the boiler, and then enters the engine room as six separate pipes, three port and three starboard. At the point where the pipes enter the engine room on the forward bulkhead there are two sets of emergency shut off valves that can be operated from within the engine room or from just between the engine room hatches. These valves are used in case a steam line is damaged or a leak occurs. From the emergency shut off valves the steam goes to the maneuvering valve assembly on the top of each of the low-pressure turbines. The maneuvering valves are known as the throttles.

There are two main gauge panels on the main level of the engine room. The one between the throttles has at the top, the telegraphs from the wheelhouse. The lower portion has the pressure gauges and tachometers for the main engines. On the forward portion of the platform there is a second panel that has all of the gauges for each boilers. The upper gauges show boiler pressure, and the next one down shows fuel oil pressure, the third set shows the boiler room air pressure (manometer), the bottom set shows the feed water pressure. The duty engineer could tell the status of the equipment by watching these panels.

The main engines are Parson's Turbines and consist of four assemblies. The two large units in the middle are the low-pressure turbines with the astern turbine in the front of the housing. The outer smaller units are the high-pressure turbines with the cruising turbine in the front of each housing. The low-pressure turbine rotors are two sets of blades facing away from the centre. The cruising turbine goes ahead only. When underway the steam passes through the high-pressure turbine, through the cross over pipe then through the low-pressure turbine. The amount of steam (thus speed) entering the turbines is controlled by the throttles. The large wheel is the ahead throttle, while the smaller wheel the astern throttle the two wheels on the inside are for the cruising turbines the angle of the blades in the astern turbine is the reverse of the ahead turbine causing the shaft to turn in the opposite direction.



<u>Main Condenser:</u> The regenerative condensers are fitted under each low-pressure turbine. At each end of the condenser shell are tub plates, which are connected by large numbers of tubes. The seawater is drawn in through the inlets in number three boiler and passes through a

strainer there. It comes into the engine room, through the circulating pump, through the tubes in the condensers and discharges back to the sea in the gear room. The exhaust steam from all the turbines enters at the top of the shell and comes in contact with the outside surfaces of the sea – the water-cooled condenser tubes. As the steam hits the tubes it is chilled and condenses back into water. The condensate then falls to the bottom of the condensers.

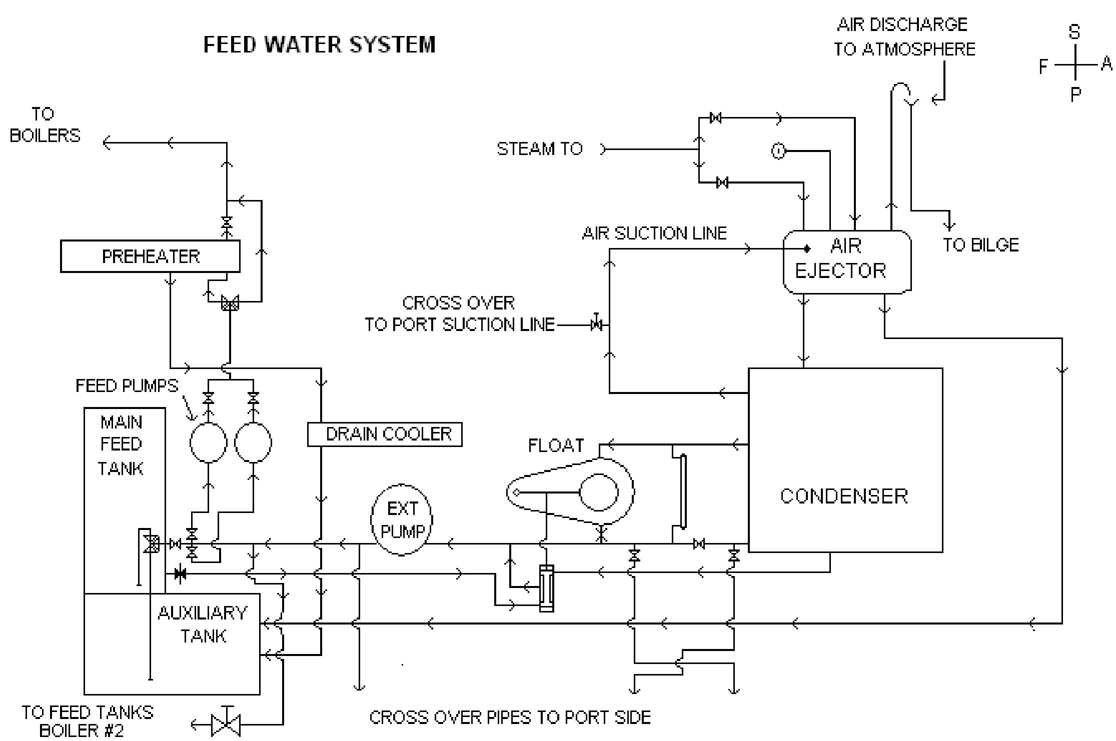
The extraction pumps remove the condensate from the condenser through the suction line back to the main feed tank.

The main feed pumps transfer the feed water from the tank to the preheater which is located above the main feed tank and back over to the boilers. This is known as a closed feed system.

A two-stage air ejector is incorporated with the condensers to removed gases from the closed loop system. The removal of air from water supply, removes a source of corrosion. It also makes it easier to maintain the vacuum in the condenser.

The servo feed controller is a float-controlled piston–type valve. This ensures that the condensate level in the condenser well is always maintained, thus making certain that the extraction pump does not lose suction. The main feed tank is also connected to the closed feed system via the feed controller. Feed water is taken from, or returned to this tank, as required, to keep the proper amount of water in the system.

The six pumps in the feed water system are all steam turbine driven.



The above drawing shows how the water is drawn from the condensers and heads back to the boilers for reheating. When you look down in to the bottom of the engine room what you see is the above drawing on the starboard side. It is repeated on the port side plus there are cooling lines that are not shown here for simplicity. When junior engineering people are learning their trade, they have to make drawings like the ones shown in this section to help understand how it all works.

EVAPORATORS

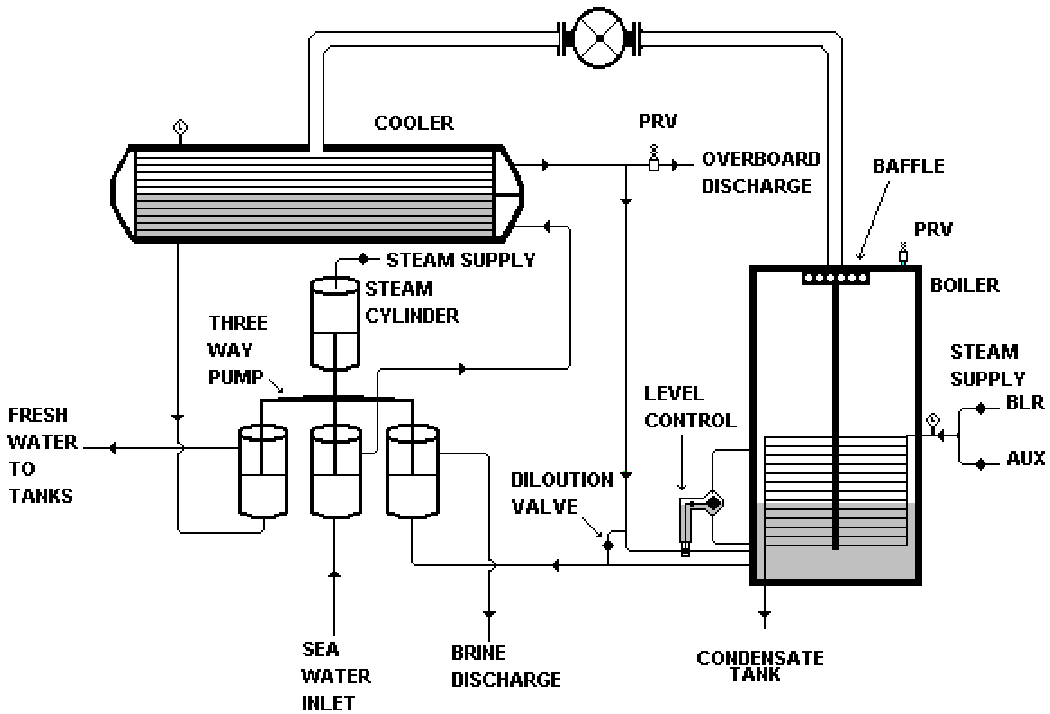
There are two evaporators located in the engine room which produce distilled water from seawater, for domestic and equipment use. Below is the description of the original unit on the port side forward of the engine room.

In operation, the feed water regulator allows sea–water to enter the lower portion of the shell until it is just above the coils. Live steam is then admitted to the cools causing the seawater to boil. The steam from the boiling seawater passes up wards through the baffle, which reduces carry-over of seawater with the steam. The steam now passes through a control valve. This is a globe valve fitted at the top of the evaporator to control the amount of steam passing from the evaporator to the condenser. This valve therefore assists in the control of the volume to the evaporator shell. The steam next passes to the condenser. This is a large surface condenser, cooled by the seawater. The steam is condensed into distilled water. This distilled water is then carried away from the bottom of the condenser by the freshwater pump and led either to the domestic or the make-up feed tanks.

All the pumps associated with this evaporator are driven by a single reciprocating engine. The pump is fitted with three barrels; the seawater fitted under the steam cylinder. The brine and the water pumps are located on either side. The seawater pump is fitted directly under the steam cylinder, with the brine and water pumps on either side.

The second evaporator, starboard side forward, is referred to as a 25 ton per day unit. We believed this unit was installed in the late fifties. It operates very much like the older unit except it uses a vacuum pump to lower the pressure in the condenser. This allows the seawater to boil at a lower temperature.   There were four liquid transfer pumps and one vacuum pump, all having electric motors. There are only two of the pumps still fitted, the other three are missing. One obvious piece that is still present is a water meter showing now much water was produced.

The electronic monitoring systems for both evaporators have been vandalized to a point where you can hardly recognize what they were.



TURBO GENERATORS

There are two turbo-generators fitted in the engine room, which have non–condensing type engines. Number two turbo located on the port side and feeds the forward switchboard. Number three turbo on the starboard side and feeds the after switchboard. Both generators are force air, water-cooled units. The turbo–generators produce direct current at 225 volts and their output is 200 kW each. The cooling water for the two generators comes from a small electric driven sea–water pump mounted under the port generator.

The exhaust steam from these turbines plus the six pumps is generally used for evaporator boiler heating. Any surplus steam in this section, is emptied into the main condensers through a relief valve on the port main condenser, or a manual valve on the starboard main condenser. The steam from the preheater and the air ejectors is converted to water by a third condenser known as the drain cooler on the starboard side of the engine room. It gets its cooling water from the starboard circulating pump. The air ejectors are also cooled by water from the same pump.

GEAR ROOM

The gear room contains the two main gear boxes that house the reduction gears between the turbines and the propeller shaft. There is one gearbox for each propeller shaft (port and starboard). Both the high pressure and low-pressure turbines feed into the same gear box. The ratio is approximately 10 to 1. This would give you 300 RPM shaft to 3000 turbine RPM. The shaft gear is a large diameter while the two drive pinions from the turbines are a much smaller diameter. The total combined output of both systems is 44,000 shaft horsepower that drove the ship at a maximum speed of 35 knots. (68kph).

There is a forced lubrication system for each gear box and turbine combination. Each system has its own storage tank lube oil pump and lube oil cooler. The oil is pumped out of the tank by a steam turbine driven pump, passes through the cooler then to the bearing in the turbines and gearbox. There are sprayer nozzles in the gearbox to keep the gears covered. The oil returns to the tank via gravity. During the four hour shut down (turbine cool down) there is a small electric pump to supply lubrication to both systems. Each pinion is connected to its respective turbine by a flexible coupling to avoid upsetting the accuracy of the mesh. This coupling allows axial (fore and aft) movement to the pinion.

The Mitchell thrust block is located just after the gear box in the gear room. When the propeller revolves, it exerts a thrust on the shaft, which in turn exerts a thrust on the ship. This thrust is transmitted from the propeller shaft to the ship by means of a thrust block. It is a vertical bearing, supplied with lubricating oil from the same system that feeds the main bearings.

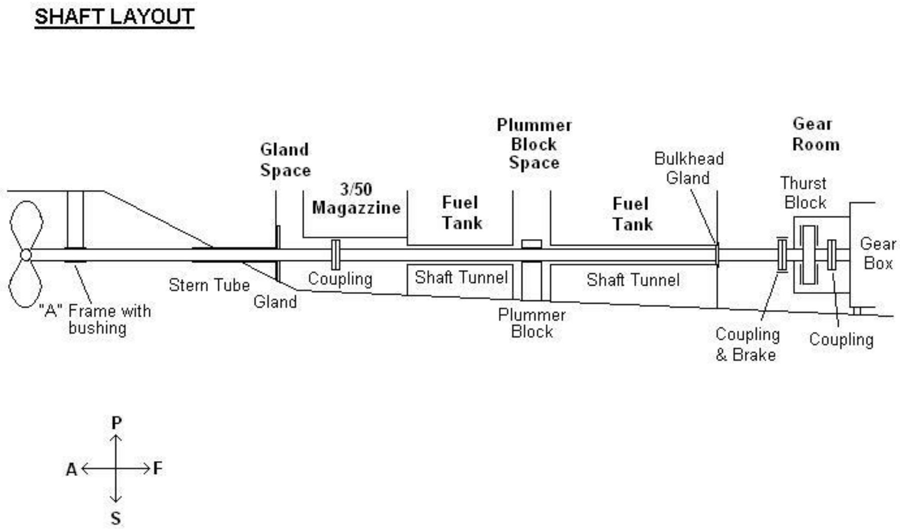
The brake for the shaft is located just after the thrust block also located in the gear room.

The shafts run through the ship at a slight angle and run through the fuel tank, in a tunnel to the plummer block which is located on the ships flats. The plummer block is fitted to take the weight of the shaft. They are self-contained bearings having a lubricating oil sump of their own.

The shaft continues through a second fuel tank, under the 3”/50 magazine to the gland compartment that is very small and located under the wardroom flats. The gland is a semi sealed tube that allows the turning shaft to go through the hull with out water coming in.

There is a hollow steel tube, called the stern tube, which is riveted to the ship’s frame, and bored true when in position. This tube carries a bushing to form a bearing surface for the shaft. The bearing surface of the stern tube is made of white metal (grease lubricated).

Outside of the hull of the ship, after the shaft has passed through the stern tube, there is generally a length of shafting with the propeller secured to its extreme end. The weight of the shaft and the propeller thus requires a bearing to support it. This bearing takes the form of a bracket, known as the “A” bracket, built into the ship’s frame in a similar manner to the stern tube.



Other equipment in the gear room is the number four diesel generator for electrical power. This is an exact duplicate of the one in the number one boiler room. The after electrical switchboard is located here. The steam turbine driven fire and bilge pump is located on the lower port side and is the primary fire-fighting unit. This unit in conjunction with a series of valves can bring sea water into the ship to the fire main, or pump water from any compartment, and discharge it over board or a combination of the above. There are two electric versions of this pump known as the hull and fire pumps. One of these is fitted in the after lower mess deck and the other is in the wardroom flats. There are two steam ejectors fitted in each of the five main engineering spaces to pump out the bilges. There are no moving parts to these devices. The high-pressure steam goes up through the middle of the unit creating a vacuum on the suction lines that go down to the bilge. All ten units are mounted just under the main deck and discharge into the sea.

THE STEERING SYSTEM

The helm (main steering wheel) is located in the wheelhouse below the bridge, forward of the operations room. HMCS HAIDA has an electro–hydraulic system that has two main parts (a) telemotor system which transmits wheel movements from the wheelhouse to the tiller flats (b) the steering gear system which includes the hydraulic pumps systems and the rudder gear.

(A) Telemotor system: Is a hydraulic circuit which carries pressure generated in the transmitting cylinders by movements of the wheel, to telemotor cylinders in the tiller flat. This enables the steering gear to be operated from a position (or positions) remote from it.

The system is filled with glycerine and distilled water or hydraulic oil. A movement of the wheel turns the pinion in the transmitter. This moves the rack – and the plunger attached to it -- up or down. Since the system is completely filled with a virtually non–compressible fluid, the movement of the plunger causes a rise in pressure in one side of the connecting pipe system and a fall in pressure in the other. This moves the receiver in the tiller flat in the required direction. There are pressure gauges mounted at the wheel locations to show that it is working correctly.

The system is kept full of liquid by a replenishing tank on the transmitter. One of the duties of the upper deck stoker was to top up the replenishing tank on his rounds.

HMCS HAIDA's main wheel is fitted with two transmitters (known as duplex transmitters). Each set of two cylinders is connected to a pair of pipes, one set is on the starboard side and the other runs along the port side, to two separate receivers which are mechanically connected. The advantage of this arrangement is that, if one pair of pipes is damaged, steering can still be carried out without having to operate any valves. If one unit of a duplex transmitter or one of the receivers is damaged they can be disconnected while the system still operates on the other set.

(B) The steering gear is operated by two hydraulic Hele–Shaw swash plate pumps driven by an electric motor. The pumps are of the bye direction and output type. They supply hydraulic fluid as required, to the tiller gear. This tiller gear consists of hydraulic rams which are linked to, and move the rudder post.

The ram cylinders, pumps and connecting pipes, are charged with hydraulic oil. To compensate for any loss of oil, a replenishing tank is provided, which is connected to the system through a non–return valve.

A movement of the wheel causes a corresponding movement of the telemotor receiver cylinder. This movement is transmitted to the steering gear by levers. These levers pivot and move the pumping control of the hydraulic pump by means of its actuating rod. This causes the pump to discharge hydraulic fluid to either of the rams. The rudder is thereby moved, and the lever, which is fixed to the tiller or rudder post, moves the lever which now pivots about so as to return the rod to its original position. The pump then ceases to discharge and the rudder stops until the wheel is moved again.

These are two of the six ways to steer the ship the other four are as follows.
(3) Emergency conning position is located at the front end of the after super structure. It would be used if the forward wheelhouse was damaged and put out of service. This is a single transmitter going to a single telemotor in the tiller flats. There is also a lever at that position that opens bypass valves which are located in the gear room. These valves are in the two sets of lines going forward to the wheelhouse. Opening the bypass allows the two forward telemotors to move freely.

(4) There is a manual wheel which is located in the tiller flats. There is a gyro compass repeater fitted so a helmsman can steer the course from this location.

(5) All the above systems require the electric steering motors to operate. If both of them have failed, the rudder can be turned by operating a small hand pump fitted in front of the rams.

(6) Now if all the above fails the two main engines would be used. The port engine would be set at a fixed speed and the starboard engine speed would be altered by information sent down on the engine revolution counter from the bridge to the engine room or by sound powered phone.

Refrigeration system

There are two refrigeration systems which are located below the forward lower mess on port side. The large unit is for the freezer compartment located next to the refrigeration unit. The other unit is for the cold room (fridge) which is accessible from the sonar dome space and is located on the starboard side. The freezer unit has a water-cooled condenser and the cool room has an air cool condenser. Both units use Freon 22 refrigerant.

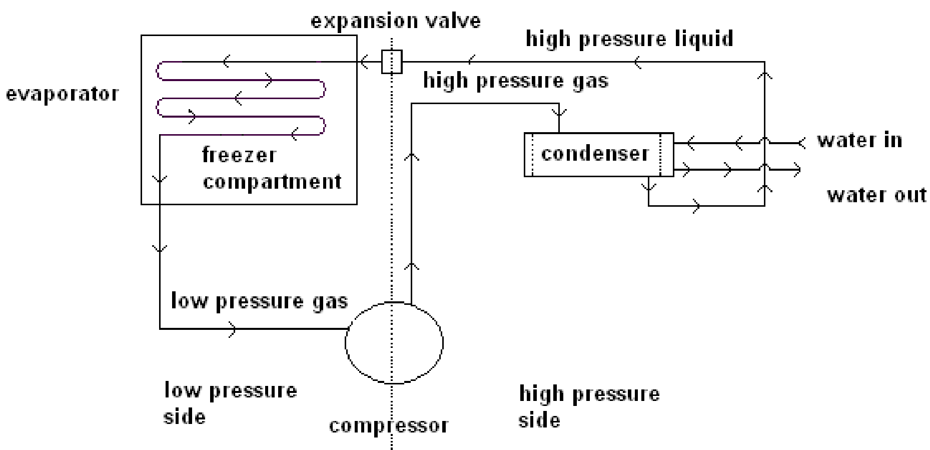
The first thing that you must understand about refrigeration is that it cools a space and its contents, and maintains the space at a lowered temperature. To cool something you remove heat from it. So refrigeration is a process of cooling by removing the heat. This is accomplished by circulating an appropriate fluid, called a refrigerant, through a closed circuit. During the cycle of operation the fluid undergoes changes of state from a liquid to a gas and back to a liquid again. Where the liquid changes from a high pressure to a low-pressure gas in the expansion valve, heat is absorbed from the surrounding area, therefore lowering the temperature. In practical refrigeration, the process of evaporation occurs under controlled conditions at the place which is to be cooled; e.g., the cabinet of a domestic refrigerator. This occurs inside coiled tubes.

The low-pressure gas now passes through the compressor and is sent on to the condenser unit as high-pressure gas.

When the high-pressure gas comes in contact with the cooled tubes in the condenser it reverts back to a high-pressure liquid. The condenser actually transfers all the heat picked up in the evaporator plus the heat put into the gas from compressing the vapor. The high-pressure liquid now heads back to the evaporator to start the cycle all over again.

The other system for the cool room works the same way except it uses an air-cooled condenser instead of a water-cooled condenser. This was acceptable because the amount of heat is not as great as it is with the freezer.

THE REFRIGERATION SYSTEM



Domestic fresh water:
There are four domestic freshwater holding tanks. Two in number two boiler room and two under the store room in the forward part of the ship. The pressure pump for the system is in the forward lower mess deck. The steam heated, hot water tank is in the number one boiler room. There is a small circulating pump on the side of the tank to circulate the water in a closed loop to all the wash spaces. This was done to stop the waste of water while you were waiting for the hot to arrive.

HMCS HAIDA TANK CAPACITIES
OIL FUEL TANKS

TYPE OF FUEL ----- BUNKER FUEL OIL
DIESEL FUEL OIL

TONS AT 38.5 CUBIC FEET PER TONS OR 240 GALS PER TON.

TANKS	FRAMES #	95%	100%

# 1	STBD - 57 - 66	69.65	73.33
# 2	PORT - 57 - 66	69.65	73.33
# 3	STBD - 66 - 74	55.30	58.21
# 4	PORT - 66 - 74	55.30	58.21
# 5	STBD - 140 - 149	76.61	80.64
# 6	PORT - 140 - 149	76.61	80.64
# 7	STAB - 149 - 156	53.67	56.49
# 8	PORT - 149 - 156	53.67	56.49

TONS AT 42.6 CUBIC FEET PER TON

DIESEL FUEL CENTRE FWD	70 - 74	20.09	21.14
DIESEL FUEL CENTRE AFT	140 - 144	9.33	9.82

FRESH & FEED WATER TANKS

TONS AT 36 CUBIC FEET PER TON

TANKS	FRAME #		95%	100%
FRESH WATER	FWD	7 - 10		12.01
FRESH WATER	FWD	14 – 18		4.91
FRESH WATER	FWD	25 – 30		12.28
FRESH WATER	PORT	86 – 92	9.21	9.70
FRESH WATER	STBD	86 – 92	9.21	9.70
FEED WATER	PORT	92 – 98	9.80	10.32
FEED WATER	STBD	92 – 98	9.80	10.32
FEED WATER	CTR	110 – 118	21.29	22.41
FEED WATER	CTR	110 – 118	9.89	10.41

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