1.11. RADIO HAZARDS (RADHAZ)

1. **General.** Ships are now fitted with a large number of high power transmitting equipment, radio communications, radar and sonar. These high power transmissions constitute a threat to:

a. Human life – because of the effects of radiation on the human body.

b. The Ship and Human life – radiation can cause the untimely ignition of explosive devices and combustible material.

Radio Hazards also includes certain other side effects which originate in the same area as the true radio hazard, e.g. the danger from rotating aerials and aural shock from the use of sirens.

2. **Organisation.** The orders for Radhaz are detailed and complex but when fully understood and correctly applied will not normally adversely affect the operational capacity of a ship; for example, by planning the route, and using only this route, for the embarkation and disembarkation of SEACAT missiles, restrictions on the use of transmissions can be minimised, and applied to the minimum amount of equipment. Therefore each ship must have a comprehensive and clear organisation to prevent hazards to men, equipment and material whilst retaining maximum operational efficiency.

3. **Responsibilities.** The Commanding Officer is responsible for the Radio Hazard Organisation but delegation or responsibility should be:

a. The S.C.O. for overall co-ordination and promulgation of the Ship's Radhaz orders. He should co-ordinate the advice to the Command on the operational aspects of Radio Hazards.

b. The W.E. Officer to advise on all technical aspects of Radio Hazards and in consultation with the Medical Officer advise on Safety Distances and Durations. Also to state what relaxations of normal precautions are required for W.E. personnel involved in maintenance and fault finding.

c. The O.O.W. (O.O.D.) to be responsible for the implementation of the Radhaz organisation and for the custody and correct use of the ship's Radio Hazard Board.

d. O.R.O., Sonar Controller, Lt Cdr(F). Provided that the Command is fully informed, the users of equipment should be allowed to apply restrictions to equipment under their control direct.

e. All Ships Officers and Departmental Heads for having a good understanding of the Radhaz orders so that they are aware when any of their men are subject to Radio Hazards and to ensure that any hazardous situations in their department is correctly described in the ships Radhaz Orders and for their correct application within their departments. They are responsible for applying to the O.O.W. for clearance in using equipment in a manner other than described on the Ship's Radhaz Board.

4. **Written Orders and Instructions in a Ship**

a. CAPTAIN'S STANDING ORDERS. These should include:

(1) The responsibility delegated to officers.

(2) A broad outline of where radio hazards exist, e.g. the ship's man aloft line, above which a man cannot go without permission.

(3) Where the Radhaz organisation is to be laid down in ships and in departmental orders.

b. SHIP'S RADIO HAZARD ORDERS. To contain the detailed orders for the correct application of the ship's Radio Hazard organisation. In some ships these are now produced separately from the Ship's Orders and distributed to all departments and interested authorities under the signature of the Executive Officer.

c. SHIP'S HAZARD BOARD. This board should be portable and displayed near the compass platform at sea and near the Q.M.'s harbour position in harbour. The Hazard Board should contain sufficient information to allow the O.O.W. to control the Hazard Organisation.

Duplicate Board to be kept in departmental offices with only that departments equipment shown. This board is not required for control but only for indicating what precautions are required for each situation affecting the equipment within the department.

5. **Restrictions Applied Direct by an Operational Officer.** There may be occasions when immediate action is needed to render equipment inoperative, e.g. operation of aircraft. On such occasions the Operational Officer must be authorised to order equipment to cease operation and to order the resumption of transmissions. This procedure is intended for situations where quick reactions are needed in order to maintain operational efficiency.

Should there be a conflict of requirements; for example, the rearming of a strike aircraft with electrically initiated missiles when there is a high precedence signal being transmitted on ship-shore, reference must be made to the Command.

6. **Production of Radhaz Orders.** The distinction between two possible types of precautionary action should be made.

a. If the equipment causing a hazard is operated frequently or is needed at short notice and without warning, the area it endangers should be permanently closed (i.e. made a 'Man Aloft Area') and entered only by permission of the O.O.W.

b. If the equipment is used very occasionally, or is used frequently but rarely pointed at an area of the ship, then the onus to take action is on the user or maintainer. He must request permission from the O.O.W. and thus ensure that the area has been cleared for the required time. These two arrangements can best be laid down by establishing a 'Normal' state for all equipment and areas concerned in the RADHAZ organisation, and then declaring what precautions must be taken when any one wishes to break the 'Normal' state. In the case of high power radars which can affect parts of the upper deck only when operated below a certain elevation or on certain bearings, it may well be possible under harbour or cruising conditions to ensure that the equipment is only operated on 'safe' elevations or bearings. If this is so the equipment when 'safe' can be termed to be in the 'Normal' state and it would then be the responsibility of the user department to produce such orders as to ensure that the O.O.W. is informed in good time when required to break the 'Normal' state. Once so informed the O.O.W. is then responsible for clearing and keeping clear those parts of the upper deck rendered 'unsafe'.

c. CHECK OFF LIST. The following is recommended as a 'Check Off' list for ships commissioning or for ships which have undergone structural or equipment changes:

(1) List all transmitting equipment (Radio, Radar and Sonar) with their frequency bands and emitted power.

(2) Check 'Horizontal Safety Distances' in areas in the vicinity of emitters within which a physical shock hazard exists.

(3) Establish 'safety distances and durations', boundaries, and an overall 'Man Aloft Boundary'. Check that permanent boundaries are marked and the necessary notices produced and posted. Ensure these notices can be read when it is dark.

(4) Establish the 'Normal' situation for high power radars (paragraph *b* above).

(5) Establish causes of physical, radiation and sonar hazards.

(6) Note special procedures for certain jibs (e.g. crane jibs must be handled with rubber gloves).

(7) List all inflammable and combustible material likely to be handled on board.

(8) List all Electrically Initiated Explosive Devices (EIED) normally handled on board.

(9) Establish which radiating equipment can affect the items in 7 and 8.

(10) Establish normal stowage and methods of embarkation of 7 and 8.

(11) List precautions necessary for normal stowed state and additional precautions when normal state is broken.

(12) Check the devices (keys, fuses) for ensuring silence of equipment.

(13) Design the Ship's Radhaz Board.

(14) Check individual department's check board.

Having completed the 'Check Off List' the Ship's Radhaz Orders can be compiled. On completion, ensure that the Ship's Book contains a copy.

Finally the Radhaz section in the Captain's Standing Orders should be written.

7. **The Ship's Radhaz Board**

a. It is important that any officer using the Radhaz Board should be familiar with its use. To facilitate this it is important that all Radhaz Boards should be similar in design.

b. CONSTRUCTION OF THE BOARD

Part A
A table in which the circumstances leading to the restriction should be placed on the left hand side and titles of equipment at the head of columns at the top.

Part B
The stowage for the safety devices and keys.

Part C
Ship Silhouette. A Silhouette or outline of the ship with guide lines from aerials to a key which matches with the aloft position on the left hand side of the table.

Part D
The board can be made as one complete unit or in parts but the part which contains the safety devices should be lockable and the key should be retained by the O.O.W./O.O.D.
A diagram of the principles explained above for a DLG is given in Fig. 1.

8. **Hazards to Personnel – Radar**

a. RADIATION. Personnel exposed to radiation from radar equipment can suffer deep burns of the body or at least superficial burning of the skin. The type of burns suffered depends on frequency emitted but it is most important to note that a person being subjected to deep body burns may not be aware that this is taking place. The great danger is from the main beam. Provided the aerial is functioning correctly the side lobes do not constitute a danger. A table of 'Safe Distances' has been established for radar equipment. These distances are calculated for the main beam. Similarly a table of 'Maximum Times' a person can spend exposed to the main beam has been worked out. The 'Maximum Time' may be 1 second or 5 minutes, depending on the type of equipment.

b. SAFETY PROCEDURES. Commanding Officers are responsible that the necessary orders cover the following:

(1) Man Aloft instructions must be applied when personnel climb aloft and are in danger of entering the main beam or when any visual examination is made of radiators, reflector, waveguides, cones or any other device emitting R.F. energy.

(2) During transmission periods these aerials are not depressed to illuminate normal working spaces.

(3) Precautions are taken when alongside or when adjacent ships are transmitting.

c. MECHANICAL DANGER. This arises from rotating aerials.

d. R.F. BURNS AND SHOCK. Physical contact with aerials, adjacent materials and structures can cause physical shock or burns.

9. **Communication Equipment.** The dangers are similar to those produced by radar equipment:

Radiation
R.F. burns and shock.

a. RADIATION AREA. The extent of the hazardous radiation area depends on frequency being used and the emitted power. The radiation hazard is not as dangerous as that from radar transmitters but personnel are not to be exposed for long periods. Each area in which this hazard exists is to be clearly indicated by a red line painted on the deck. This line is to have red arrows pointing from it to the source of the hazard. The extent of danger areas surrounding different emitters is laid down in detail in paragraph 15. On or near the source of danger is to be displayed a notice in red letters on a white background consisting of the following:

WARNING

DO NOT REMAIN WITHIN AREA SHOWN BY RED ARROWED LINE ON DECK FOR MORE THAN 2 MINUTES IN EVERY 20

As these notices cannot be illuminated in darken ship conditions the ship's Radhaz Orders should include regulations governing the access to these areas with particular emphasis on the danger during hours of darkness.

b. R.F. BURNS AND SHOCK

(1) Induced voltage may exist in wires, ropes, stanchion stays, etc., when these are close to transmitting aerials. Warning notices stating:

DANGER HIGH VOLTAGE DO NOT TOUCH

may have to be displayed on the outer framework of Base Tuner Outfits and the base pedestals of whip aerial outfits AWF(M) and AWL(M) depending on the type of earths fitted. Again details are in current DCIs.

(2) I.C.S. ships use the masts, funnels or superstructure as broadband aerials and because of the high power of transmissions used, any wire, rope, etc., hanging vertically in the vicinity of these structures is particularly dangerous.

(3) Sleeving – The sleeving of wires, etc., should be of PVC with a wall thickness of $\frac{1}{16}$ inch. This also applies to shackles and blocks of running stages, etc.

(4) Rubber Gloves – Rubber gloves must be worn by personnel when working with jibs and wires, hooks of cranes or on whip aerials when these are close to radiating aerials.

(5) Damage to equipment – I.C.S. Ships – Alterations to the ship's rigging can change the radiation pattern of the mast or structure to which the rigging is coupled and thus cause a mismatch in tuning which will result in damage to the transmitting equipment. No alteration is to be made to the rigging without reference to MOD (NAVY).

10. **Ships Fitted with Gas Turbo Generators.** When the turbine is running the funnel becomes charged with static electricity which can amount to 18,000 volts. Therefore personnel must not touch the funnel when the turbines are running.

11. **Steam and Noise.** A sudden loud noise can cause a man to lose his grip when aloft or he may be scalded by exhausting steam. Whenever a man goes aloft the engine room or other departments must be informed and the man must wear a lifeline.

12. **Dressing ship**

a. WIRELESS. Transmissions on equipments with outputs of 500W and more must not take place if the aerial is within a certain distance of the dressing lines. These distances are laid down in DCIs.

b. RADAR. Transmissions should be avoided from radar sets using open wire feeders which may be adjacent to dressing lines and downhauls. The use of rotatable aerials which may foul dressing lines or flags must be prevented. Where possible dressing lines and downhauls should be bonded to earth if wireless transmitters, whose aerials are within the safe distance of the dressing lines, with outputs exceeding 50W, are likely to be used.

13. **Hazards to Divers.** If a diver is subjected to a very loud or unexpected noise under water his hearing may be impaired or he may become disorientated. Modern sonar sets operate on audible frequencies and make a very loud noise.

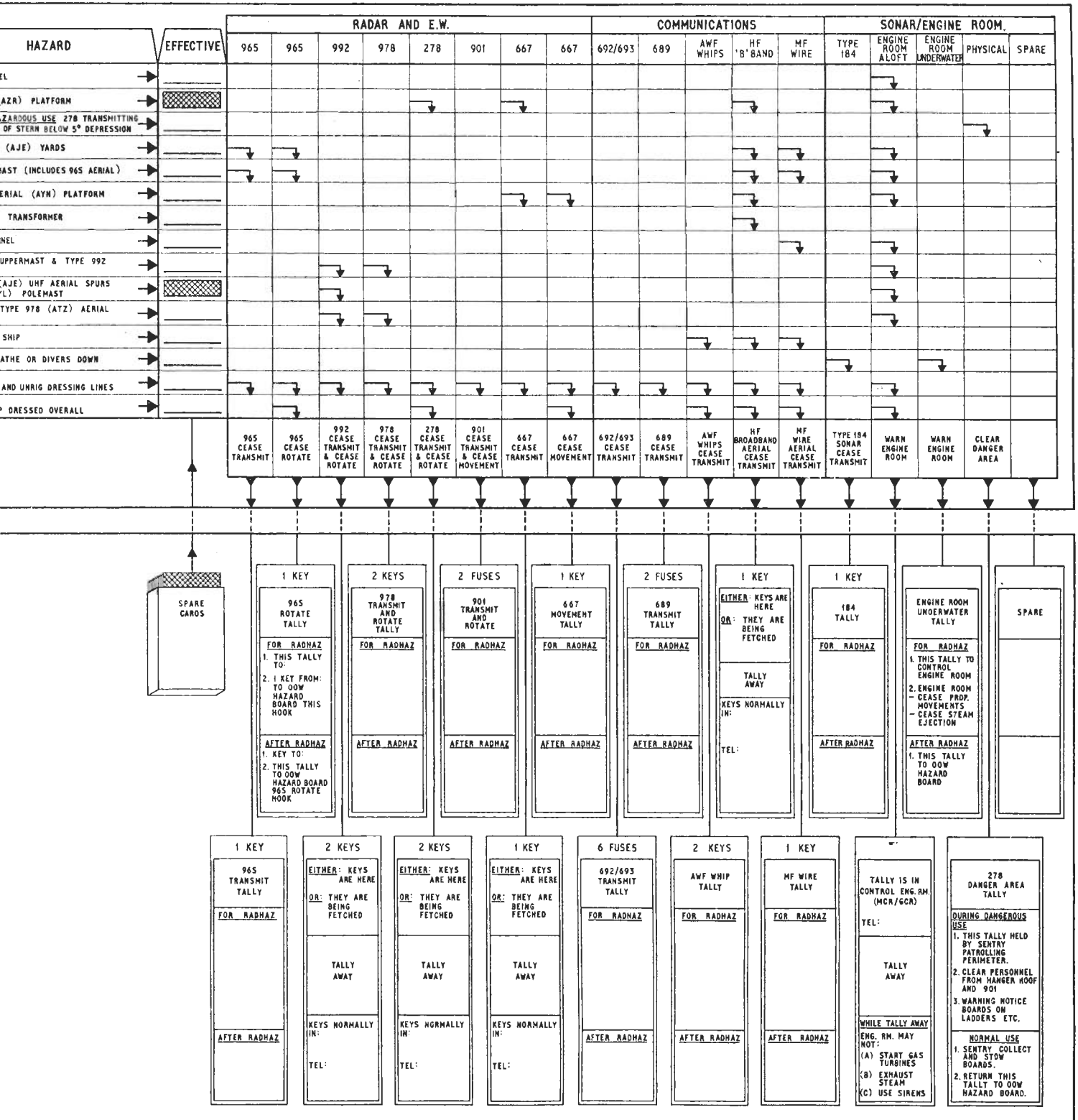
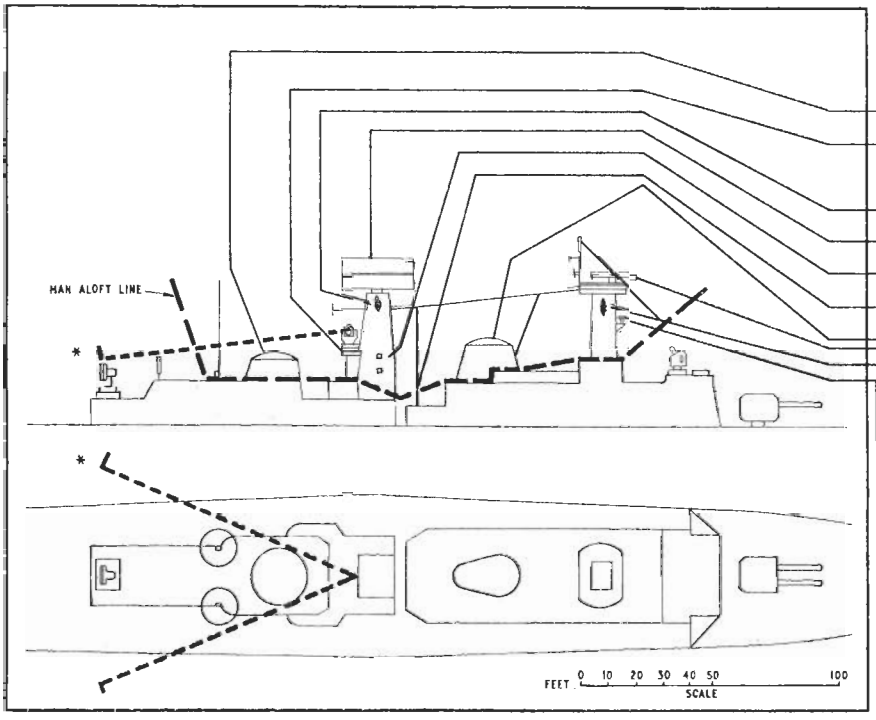


FIG. 1. RADIO HAZARDS (GMD CLASS)

PART C



PART A

	HAZARD	EFFECTIVE	965
	AFTER FUNNEL		
	TYPE 278 (AZR) PLATFORM		
*	TYPE 278 HAZARDOUS USE 278 TRANSMITTING WITHIN 20° OF STERN BELOW 5° DEPRESSION		
	UHF AERIAL (AJE) YARDS		
	UPPER MAIN MAST (INCLUDES 965 AERIAL)		
	TYPE 887 AERIAL (AYN) PLATFORM		
	HF MATCHING TRANSFORMER		
	FORWARD FUNNEL		
	FOREMAST - UPPERMAST & TYPE 992 PLATFORM		
	FOREMAST - (AJE) UHF AERIAL SPURS AND (JSE/AYL) POLEMAST		
	FOREMAST - TYPE 978 (ATZ) AERIAL PLATFORM		
	AMMUNITION SHIP		
	HANDS TO BATHE OR DIVERS DOWN		
	DRESS SHIP - RIG AND UNRIG DRESSING LINES		
	DRESS SHIP - SHIP DRESSED OVERALL		

965 CEASE TRANSMIT

PART B

SPARE CARDS

1 KEY

965 TRANSMIT TALEY

FOR RADHAZ

AFTER RADHAZ

NOTE :-

(1) EXAMPLE SHOWN IS FOR GMD CLASS OF SHIP A DESIGN FOR EACH CLASS OF SHIP WILL BE REQUIRED.

(2) INTENTION IS FOR THE FINAL DESIGN TO BE IN COLOUR.

a. ACTION BY COMMANDING OFFICER

(1) He should request the Port Authorities to promulgate the periods during which the set is operating.

(2) Ensure that diving in diving suits, including standard diving equipment does not take place within 40 feet of any part of a submarine when its set is switched on.

(3) Prohibit skin diving, or bathing within 50 yards of the ship or 100 feet of the submarine, when its set is switched on.

(4) Ensure that the Diving Officer is informed when a ship or submarine fitted with audible sonar equipment is present in harbour.

(5) Ensure that the Diving Officer has read relevant instructions on diving in the vicinity of ships and submarines.

b. DIVING OFFICER

(1) He is to ensure that any hazard restrictions necessary in his own ship are known by the O.O.W. before any diver enters the water.

(2) He is to be aware of the dangers from other ships as well as his own and ensure that the divers are informed of them.

14. **Hazards to Weapons and Explosive Devices**

General – As already stated in the introduction the second major hazard is that to both personnel and to the ship by the unintentional ignition of Electrically Initiated Explosive Devices or combustible material by radar or radio emissions. The range of sources of danger in this category covers most modern weapons and a number of fuels and has led to a considerable amount of detailed regulations.

The following E.I.E.D. are subject to Hazard regulations which must be consulted in formulating a ship's Radhaz Organisation:

a. SEASLUG Missiles.

b. SEACAT Missiles.

c. 2,000 lb, 1,000 lb and 500 lb bombs.

15. **Safety**

a. There are two types of hazard which may be encountered from HF wireless transmissions, RF Radiation Hazard and RF Shock and Burn Hazard.

(1) *RF Radiation Hazard.* An electric field exists in the vicinity of the transmitting aerial associated with Types 89Q, 603, 605, 640 and Outfits WBA and WBB. The extent of the field varies with the frequency to which the transmitter is tuned and the point along the vertical axis of the aerial from where the measurement is being taken. Tables 1, 2 and 3 below give the safe distances, measured horizontally from the centre line of the aerial, for the combinations of transmitter, aerial and frequency indicated in the tables.

TABLE 1. TYPE 640 – WHIP AERIAL

HEIGHT ABOVE DECK ON WHICH BASE TUNER IS MOUNTED (*ft*)	FREQUENCY		
	2 MHz	*4 MHz*	*6 MHz & above*
	Safe distance in feet from centre line of the aerial		
5	1	Less than 1	Less than 1
6	2	1	Less than 1
8	3	2	Less than 1
12 or more	4	3	Less than 1

TABLE 2. TYPES 603, 605, 89Q, 640, WBA AND WBB – WHIP AND WIRE AERIALS

DECK	TRANSMITTER	603/5 89Q	640	640	WBA	WBB
	Base Tuner	ETA1 Exposed	ETC Exposed	ETC Enclosed	ETA1 Exposed	ETB Exposed
	Aerial	Whip Aerials AWF(M) and AWL(M)				Cage or Roof
—	*Frequency Range*	*Safe distance in feet*				
Deck on which base tuner is mounted	2 MHz & below	$1\frac{1}{2}$	$1\frac{1}{2}$	2	3	1
	3 MHz	1	1	$1\frac{1}{2}$	2	1
	4 MHz & above	1	1	1	1	—
Decks $7\frac{1}{2}$ or more feet above base tuner deck	2 MHz & below	4	4	4	5	4
	3 MHz	3	3	3	4	3
	4 MHz	2	2	2	3	—
	6 MHz & above	1	1	1	$1\frac{1}{2}$	—

Notes

1. The safe distance is given for a height of 6 feet (the height of a man) above the deck.
2. The radius of the red circle painted on the deck would be the greatest of the distances shown above in the column for that transmitter.

TABLE 3. OUTFIT WBA – BROAD BAND AERIALS

DECK	FREQUENCY BAND	TRANSMITTER AERIAL	WBA			
			FOLDED MONOPOLE STRUCTURE			BICONICAL
			FOREMAST	MAINMAST	FUNNEL	
—	—	*Number of Transmitters*	*Safe distance in feet*			
7 feet above deck on which transformer is mounted (*see Note*)	1.5 to 5 MHz	8	—	2	—	—
	3 to 11 MHz	4	1	—	—	—
	5 to 11 MHz	8	1	—	—	—
	8 to 24 MHz	8	—	—	2	2

Note

The transformer is normally mounted on a 5 foot pedestal thus making the feed point 7 feet above the deck; if the transformer is mounted directly on the deck the distances given above should be doubled.

(2) *RF Shock and Burn Hazard.* An RF voltage may be induced in metal structures from a transmitter aerial. The size of the induced voltage will depend on the frequency and power of the transmitter, the height of the structure and the distance between the aerial and the structure. Table 4 gives the estimated minimum separation required between various transmitter aerials and ship structures to ensure that no danger to personnel exists from induced voltages.

TABLE 4. 500/1000W TRANSMITTERS – ALL TYPES OF AERIALS

SHIP STRUCTURES	AERIAL	WHIP OR WIRE		BROAD BAND			
		—		MAST			FUNNEL OR BICONICAL
	FREQUENCY BAND MHZ	1.5 to 24		1.5 to 11	1.5 to 7	5 to 11	8 to 24
	NUMBER OF TRANSMITTERS	1		4	8	8	8
	POWER	500 W	1000 W	1000 W			1000 W
		Minimum Separation between Aerial and Structure (Feet)					
Guardrails and stanchions		3	3	6	7	7	7
Awning wires and stanchions. Boat davit stays		6	7	12	12	15	15
Boat davits		8	10	20	20	30	30
Torpedo davits		6	7	12	12	15	15
Crane jibs of H feet in height		H	H	3H	4H	4H	4H
Receiver aerials. Mast and funnel stays of H feet in height		H	H	2H	3H	3H	3H
Upper deck structures and fittings of less than 6 feet in height		H	H	H	H	H	H

16. **Instructions Concerning Radio Hazards**

a. Details and instructions concerning radio hazards are promulgated in BR 2924, *Handbook for Radio Hazards*, and in current DCIs.

b. Ships' and Departmental orders should also contain details and instructions on RADHAZ.