SUPPLEMENT
TO THE TENTH EDITION

(Including FCC Element VIII
on Ship Radar Techniques)

RADIO OPERATING
QUESTIONS AND ANSWERS

by J. L. Hornung

Edited by
Alexander A. McKenzie

NEW YORK TORONTO LONDON
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The opinions or assertions contained herein are not to be construed as official or reflecting the views of the Navy Department or the Naval service at large.

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PREFACE TO TENTH EDITION SUPPLEMENT

In the period since 1947, there have been many changes in radio law, both at the international level (as a result of the International Telecommunication Convention, Atlantic City, 1947) and in the Rules and Regulations of the Federal Communications Commission. Increased use of radio for navigation and safety of aircraft, radar pilotage of ships, the rapid growth of the general mobile radio services that include police, fire, railroad and taxi dispatching, as well as new problems associated with broadcasting and television, have made necessary continual revisions of licensing and operating requirements.

For the convenience of those preparing to take examinations qualifying them as operators of radio stations, the Federal Communications Commission publishes a "Study Guide," listing a large number of questions on topics that are covered in the examinations. As the laws and regulations change, the "Study Guide" questions are modified to reflect the new requirements.

Ideally, the student should have before him a pile of documents about a foot high from which he could extract the latest and most correct answers to all the technical and legal questions. Actually, such a practice would be both expensive and inefficient. It is for these reasons that the author has brought together the "Study Guide" questions and their present, correct answers.

Because of the many changes and revisions that are even now going on, it has been thought advisable to issue this supplement to the Tenth Edition of "Radio Operating Questions and Answers" rather than to publish a complete, new

eleventh edition at this time. However, such a new edition is in preparation and will be available shortly after the next complete revision of the FCC "Study Guide" is published.

The student is urged to use this supplement and its associated Tenth Edition of "Radio Operating Questions and Answers" as a signpost in his study of the many aspects of radio theory and operating technique. Standard textbooks and schools, correspondence and resident, are available for those who need good grounding in the fundamentals.

It is particularly urged that the prospective operator equip himself with the latest legal information, either from the FCC, in Washington, D. C., or from the nearest FCC Field Engineering Office. A most useful document, together with its latest revisions, is "FCC Rules and Regulations, Part 13—Rules Governing Commercial Radio Operators," for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., at a price of 5 cents.

The author thanks the many individuals among his associates and in the radio industry who have contributed to this volume by suggestion or specific information from their particular fields. He is grateful for the assistance rendered by Mrs. Gladys T. Montgomery, Washington Editor, on the staff of ELECTRONICS magazine.

J. L. HORNUNG

YONKERS, N. Y.
July, 1951

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HOW TO USE THIS BOOK

This booklet is a supplement to the Tenth Edition of "Radio Operating Questions and Answers." In these two books together are the answers to all questions given in the "Study Guide," prepared by the Federal Communications Commission. The "Study Guide" is now being revised by FCC; but as it stands, its complete content is made up of a booklet revised in July, 1948, and several mimeographed supplements. The questions asked in some of the earlier supplements already appear in the Tenth Edition. The rest are given in this booklet.

It will be explained later what elements are necessary for the various classes of commercial operator license examination. Equally important, it is also explained which questions make up the new, renumbered elements. For example, old Element 2 in the "Study Guide" is now part of new Element III, and it is likewise part of new Element VI! However, the table following and the notes throughout the text make it all clear.

In addition to the answers, this booklet also contains an Appendix with latest information on Q codes, standard abbreviations, and changes in the use of the International Morse Code. None of these changes has yet been published outside legal documents bearing upon the International Telecommunication Convention, Atlantic City, 1947.

STUDY GUIDE

Class of License	New Examination Elements						What to Study	
	1	2	3	4	5	6	Tenth Edition	New Supplement
Radiotelegraph First	x	x			x	x	Pages 1–17* Pages 18–101 Pages 266–426*	Element I Element II Element V
Radiotelegraph Second	x	x			x	x	Pages 1–17* Pages 18–101 Pages 266–426*	Element I Element II Element V
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Restricted Radiotelephone Permit	No oral or written examination							
Aircraft Radiotelegraph Endorsement	First- and second-class radiotelegraph operators only by examination in Element VII						Pages 427–511	
Ship Radar Endorsement	First- and second-class radiotelegraph or radiotelephone operators by examination in Element VIII							Element VIII

* Omit 131.06, on page 7, and 131.07, on page 8. Omit 3.160 and 3.161, on page 146; 3.162 and 3.163, on page 147; 3.166, 3.167, and 3.168, on page 148; 3.169, 3.170, and 3.171, on page 149; 3.174, on page 150; 3.229, on page 173, through 3.249, on page 179. Also omit 5.149, on page 298, and 5.154, on page 300; 5.292 through 5.296, on page 337.

ELEMENT 1

BASIC LAW

There are 70 questions on basic law, beginning page 1 of the Tenth Edition, "Radio Operating Questions and Answers." Stop at 131.06, on page 7. There will be 10 examination questions based on this material.

—Ques. 131.06. Can any station be licensed under the Communications Act without first obtaining a construction permit from the Federal Communications Commission?

Ans. Yes. Government, amateur, or stations upon mobile vessels, railroad rolling stock, or aircraft require no construction permit.

Ques. 131.07. What class of land stations must, within the scope of normal operations, exchange radio communications or signals with ship and aircraft at sea?

Ans. Every land station open to general public service between the coast and vessels or aircraft at sea must so communicate.

Ques. 131.08. Where Government and private or commercial radio stations on land operate in such close proximity that interference with Government transmission cannot be avoided in simultaneous operation, during what periods must interfering private or commercial stations refrain from operation?

Ans. At all such places, the non-Government stations must not use their transmitters during the first fifteen minutes of each hour, local standard time.

Ques. 131.09. In general, must cargo ships of United States registry of less than 1,600 gross tons be equipped with an efficient radio installation in charge of a qualified operator or operators before leaving or attempting to leave any harbor or port of the United States?

Ans. No. But it is unlawful for any ship of the United States, other than a cargo ship of less than 1,600 gross tons, to be navigated in the open sea outside a harbor or port without such a radio installation.

Ques. 131.10. What class of passenger ships of United States registry must be equipped with a radio direction-finder apparatus (radio compass) before leaving or attempting to leave a harbor or port of the United States?

Ans. Any passenger ship of the United States of 5,000 gross tons or over must be equipped with a radio direction finder.

Ques. 131.11. How many qualified operators must, for safety purposes, be carried aboard a compulsorily radio-equipped ship of United States registry not fitted with an auto-alarm?

Ans. At least two qualified operators are required.

Ques. 131.12. When must the auto-alarm be in operation during the navigation of a ship fitted therewith, outside a harbor or port?

Ans. It must be in operation at all times during navigation when the operator is not on watch.

Ques. 131.13. What is the maximum fine, other than a forfeiture, and the maximum prison sentence provided for a person's willful and knowing violation of the Communications Act?

Ans. A fine of not more than $10,000 or by imprisonment for a term of not more than two years, or both.

Ques. 131.14. What is the maximum fine, other than a forfeiture, provided for a willful and knowing violation of a rule or regulation of the Federal Communications Commission, or any treaty or convention to which the United States is a party?

Ans. A fine of not more than $500 for each and every day during which such offense occurs.

Ques. 131.15. Must a person be a citizen of the United States in order to hold any class of radio-operator license or permit from the Federal Communications Commission?

Ans. Yes. The FCC has been given power to license only citizens of the United States.

Now turn back to 141.01, on page 8, of the Tenth Edition of "Radio Operating Questions and Answers," and read through 191.05, on page 17. That is the end of Element I.

ELEMENT II

BASIC OPERATING PRACTICE

There are 59 questions on basic operating practice, and they are all contained in this supplement. Do *not* study any of the *old* Element 2 questions; they have all been dropped from *this* section in the "Study Guide." There will be 50 examination questions based on this material.

Ques. 2.01. For what term are commercial radio-operator licenses normally issued?

Ans. Commercial operator licenses are normally issued for a term of 5 years from the date of issuance.

Ques. 2.02. Is the holder of a radiotelephone third-class operator permit authorized to make technical adjustments to the transmitter he operates?

Ans. A third-class radiotelephone operator may make technical adjustments only under the supervision and responsibility of a person holding a first-class or second-class commercial radio-operator license, either radiotelephone or radiotelegraph, as may be appropriate for the class of station involved.

Ques. 2.03. List three classes of stations which may not be operated by the holder of a radiotelephone third-class operator permit.

Ans. 1. Stations transmitting television.

2. Stations transmitting telegraphy by any type of Morse code.

3. Any broadcast station, except 10-watt noncommercial FM, remote pickup and STL (Studio Transmitter Link).

4. Coastal telephone stations at which the power in the antenna of the unmodulated carrier wave is authorized to exceed 250 watts.

5. Coastal harbor telephone stations over 250 watts (except Alaska).

6. Ship or aircraft stations (except those employed solely for telephony under 250 watts).

Ques. 2.04. How often should station identification be made at a base or land radiotelephone communications station?

Ans. The name (and geographical location as approved by the Commission) of a coastal harbor station shall be announced upon the completion of each communication with any other station and at the conclusion of each transmission made for any other purpose.

(*a*) Each station in these (Public Safety Radio) services which is capable of being identified by transmission of its

assigned call signal shall transmit such call signal at the end of each transmission or exchange of transmissions or once each fifteen minutes of the operating period, as the licensee may prefer.

(*b*) In lieu of the requirement above, mobile units communicating with a base station which transmits on the same frequency may transmit, once during each exchange of transmissions, any unit identifier which is on file in the station records of such base station.

(*c*) In lieu of the first requirement, mobile units communicating with a base station which transmits on a different frequency may transmit, once during each exchange of transmissions, any unit identifier which is on file in the station records of such base station and the assigned call signal of either the mobile station or the base station.

(*d*) Stations which are entirely automatic in their operation, including automatic modulation of the carrier, will be considered for exemption from the requirements of paragraph (*a*) of this section in specific instances, upon request.

Ques. 2.05. What broadcast stations, if any, may be operated by the holder of a radiotelephone third-class operator permit?

Ans. A third-class radiotelephone operator may not operate any broadcast station except noncommercial FM with power ratings of 10 watts or less, remote pickup broadcast, and ST transmitter, provided that

1. The operator is prohibited from making any technical adjustments.

2. The equipment is so designed that it maintains a stable frequency output within the limits specified on the station license.

3. Technical adjustments are made by or under the supervision of a person holding a first-class or second-class operator license, whichever the station license warrants.

Ques. 2.06. What daily attention should be given to the antenna tower lights at a radio station?

Ans. The licensee of any station having an antenna supporting structure required to be illuminated shall

1. Make a daily check of the tower lights, either by visual observation or by observation of an automatic indicator.

2. Every three months: inspect automatic lighting devices and also measure the voltage under load conditions at the socket of each light required to be installed (or compute the value from observation at some designated point).

3. (See also Ques. 2.07.)

Ques. 2.07. What should an operator do if he observes any failure of a code or rotating beacon light at the radio station he operates?

Ans. In the event of a failure of a code or rotating beacon light, the operator shall report this failure immediately by telephone or telegraph to the nearest Airways Communication Station or office of Civil Aeronautics Administration. Further notification shall be given by the same means immediately upon resumption of the required illumination.

Ques. 2.08. What entries regarding tower lights are required in station records or logs for stations whose antenna or antenna supporting structure is required to be illuminated?

Ans. Log entries must include

(1) Time the tower lights are turned on and off each day, if manually controlled.

(2) Time the daily check of proper operation of the tower lights was made.

(3) In event of any observed failure of a tower light,

(I) Nature of such a failure.

(II) Date and time failure was observed.

(III) Date, time, and nature of the adjustments, repairs, or replacements made.

(IV) Identification of Airways Communication Station (CAA) notified of the failure of any code or rotating beacon light not corrected within 30 minutes, and the date and time such notice was given.

(V) Date and time notice was given to the Airways (CAA) Station that required illumination was resumed.

(4) Upon completion of the periodic inspection required at least once each three months,

(I) Date of the inspection and the condition of all tower lights and associated tower lighting control devices, together with the socket voltages measured under load at the sockets or computed from measurements under load at other points.

(II) Any adjustments, replacements, or repairs made to ensure compliance with the lighting requirements and the date such adjustments, replacements, or repairs were made.

Ques. 2.09. Should a radio station that is operated by a licensed operator be a licensed radio station?

Ans. Yes. No radio transmitter shall be operated except under and in accordance with a proper station authorization granted by the Federal Communications Commission.

Ques. 2.10. Why is it important to avoid unnecessary calls by radio communication?

Ans. Unnecessary calls and communications by radio shall be avoided in order to prevent interference and to give an opportunity to others sharing the frequency.

Ques. 2.11. It is advisable to be courteous in radio communications as it is in other forms of communication?

Ans. Yes, the operator should be courteous at all times.

Ques. 2.12. Why is it a good policy to be brief in radiotelephone conversations?

Ans. 1. Emergency calls may be blocked until you are off the air.

2. Long conversations will interfere with other persons desiring to use the same frequency.

Ques. 2.13. Immediately prior to calling a station, why should the operator listen on the operating frequency?

Ans. Prior to a call, the operator should listen in on the operating frequency to make certain that his call will not interfere with communications already in progress.

Ques. 2.14. State two reasons why station identification should be clearly made by a radio transmitting station.

Ans. Station identification is necessary because

1. It speeds up communications among stations.
2. It enables monitoring stations clearly to identify calls.

Ques. 2.15. Why is it advisable during your absence from your radiotelephone-equipped vehicle always to lock the cab or compartment in which the radio equipment is located?

Ans. The cab or compartment that houses the radiotelephone equipment should be kept locked in the absence of the operator to prevent unauthorized persons from tampering with or operating the equipment.

Ques. 2.16. Why is it undesirable to leave a radiotelephone communications transmitter on the air during periods when voice transmissions are not in progress?

Ans. It is illegal to do so because carrier radiation from the transmitter will cause interference with other communications even when voice is not transmitted.

Ques. 2.17. When routine radio communications are unreliable, owing to static or fading, should the operator continue transmitting or wait for more favorable conditions?

Ans. It is a good practice to wait until adverse conditions have subsided. Transmission during a period when fading or static occurs may interfere with other stations not experiencing these atmospheric effects to the same degree.

Ques. 2.18. Are there any ill effects to radio communications if the operator shouts into the microphone?

Ans. Shouting into the microphone will probably result in a distorted signal and production of spurious, interfering signals on other frequencies.

Ques. 2.19. Is the working distance range of a transmitter affected by the loudness of speech spoken into the microphone?

Ans. Yes, to some extent. The working range, particularly for AM transmitters, is affected, but the operator must be certain that his voice will be reproduced intelligibly; otherwise, because of distortion, the working range will approach zero.

Ques. 2.20. Is it a good practice to shield the microphone with the hands when speaking into a microphone in a noisy location?

Ans. Yes, cupping the hands around the microphone top will tend to reduce the amount of extraneous noise transmitted.

Ques. 2.21. When using the microphone at a radiotelephone station, should the operator speak directly into the microphone or away from the microphone?

Ans. The operator should generally speak directly into a microphone. However, with older types, such as the carbon-granule, he should speak across the microphone, so as to avoid the effect known as "microphone hiss," which is caused by the breath striking the diaphragm of the microphone.

Ques. 2.22. For most effective operation, how far should the microphone be held from the speaker's lips?

Ans. The microphone should be held from 2 to 6 inches from the speaker's lips.

Ques. 2.23. When speaking over a radiotelephone communications station, how should the operator adjust his voice: that is, should he speak in one tone of voice as much as possible, or should he articulate all his words and expressions?

Ans. The speaker should articulate all his words and expressions and should avoid speaking in a monotone as much as possible. However, he should try to maintain a fairly constant level, to prevent overmodulation.

Ques. 2.24. In radiotelephone communications, why should the operator use well-known words and phrases and simple language as much as possible?

Ans. Well-known words and phrases ensure accuracy and save time from undue repetition of words. They also facilitate better interpretation due to possible vocabulary limitations.

Ques. 2.25. What is meant by a phonetic alphabet in radiotelephone communications?

Ans. A phonetic alphabet is a word list that is useful in identifying letters or words that may sound like other letters or words of a different meaning. (See Appendix for standard word list.)

Ques. 2.26. Give an example of the use of a phonetic alphabet in transmitting a word that is difficult to understand.

Ans. The numeral 2 (two)
T as in Tom
W as in William
O as in Oboe (See Appendix for standard word list.)

Ques. 2.27. What is indicated by the transmission of the word ROGER as the reply to a radiotelephone communication?

Ans. The word ROGER indicates that all of the last transmission has been received.

Ques. 2.28. What is the significance of the word OVER when transmitted at the end of a radiotelephone communication?

Ans. The word OVER indicates that the transmission is over and that an answer is expected.

Ques. 2.29. What is indicated by the word OUT when transmitted at the end of a radiotelephone communication?

Ans. The word OUT means that the transmission is ended and that no reply is expected.

Ques 2.30. Frequently the word WILCO is used in radiotelephone communications. Is this word generally used as a phonetic, or is it used as a procedure word? What does it mean?

Ans. WILCO is a procedure word and means: "The message was received and will be complied with."

Ques. 2.31. In radiotelephone communication, what would be a good choice of words to use if you wanted to request the operator at the other end of the circuit to speak more slowly?

Ans. "Speak slower" would be the proper words to use in the aviation service.

Ques. 2.32. Can a radio operator always consider his radiotelephone conversations completely confidential and not heard by other persons?

Ans. No. Radio signals normally travel in every direction, and any person who has the necessary equipment may receive them.

Ques. 2.33. What is the difference between "simplex" and "duplex" radiocommunication systems?

Ans. In a simplex operation, the stations in communication operate at the same frequency. In a duplex operation, the stations in communication do not operate on the same frequency.

Ques. 2.34. In calling a station by radiotelephony, how many times does the calling station generally repeat the call sign or name of the called station in each calling transmission? How many times does the calling station repeat its own call sign or name in each calling transmission?

Ans. The called station's sign or name is repeated not more than three times. The calling station repeats its own sign or name not more than three times.

Ques. 2.35. Why should the operator wait several seconds after turning on a transmitter before pressing the push-to-talk button?

Ans. The push-to-talk button should not be pressed for a few moments after the transmitter is turned on, in order to permit the tubes to reach their proper operating temperature.

Ques. 2.36. Why is it a good practice to remove a transmitter from the air while changing from one frequency to another?

Ans. It is a good practice to remove the transmitter from the air while changing from one frequency to another to avoid interfering with other stations operating on either the old or new frequency. In some cases, the transmitter may be damaged if left on during the frequency change.

Ques. 2.37. If you are alone in a radio-equipped automobile, why is it advisable to stop the car before using the radio equipment?

Ans. It is advisable to stop the car because

1. The operator-driver can concentrate on the transmission and reception of messages.

2. The hazard of driving without due attention to circumstances which may arise is avoided.

3. Spurious noises caused by the car in motion are avoided.

4. Reception at VHF or UHF may be facilitated by parking in a favorable location, such as a hilltop, or away from tall buildings.

Ques. 2.38. Why is it advisable to keep the engine in an automobile running, with the battery charging, while using the radiotelephone for long periods in the car?

Ans. The radio battery may become discharged if used for long periods of time; therefore, the engine should be kept running to maintain a charge in the battery.

Ques. 2.39. If a given mobile radiotelephone station is powered by a storage battery, what indication might an operator have that the battery needs recharging or other service?

Ans. A decrease in radiation as indicated by the antenna radio-frequency ammeter, plate-current milliammeter, or filament voltmeter. The car lights may be very dim, and the starter slow in turning over. Other service requirements may be determined by a careful check of the specific-gravity reading and the voltage output of each cell under no-load conditions. The latter test should preferably be made with a high-resistance type of voltmeter.

Ques. 2.40. In receiving radio signals in an automobile, is reception usually better in the open country and hilltops or in valleys and underpasses?

Ans. Reception is usually better in the open country and on hilltops.

Ques. 2.41. If a radiotelephone operator desires to make a brief test of a transmitter, what would be a good choice of words to use in the test?

Ans. "This is KB2185, testing." Tests of this nature should be as short as possible.

Ques. 2.42. If radio communication is difficult in an automobile parked at the wayside, what might the operator do to improve communication?

Ans. To improve communication, the operator should turn off his transmitter and find a more suitable location nearby from which to make his transmissions. (See also 2.37 and 2.40.)

Ques. 2.43. What is the purpose of the squelch control or switch on a radiotelephone communications receiver?

Ans. The squelch control on a receiver is used to prevent noise and static from being heard through the loudspeaker when the receiver is in the stand-by position.

Ques. 2.44. When receiving weak signals on a radiotelephone communications receiver, should the squelch switch be placed in the "on" or "off" position? In what position should the switch be placed when receiving strong signals?

Ans. The squelch decreases the sensitivity of the receiver; therefore, when receiving weak signals, the squelch switch should be in the "off" position. When receiving strong signals, the squelch switch should be in the "on" position.

Ques. 2.45. During periods of severe static, in what position should the squelch control be normally set?

Ans. In cases of severe static, the squelch switch should normally be in the "on" position. However, it may be necessary to leave squelch off and tolerate the noise so as to intercept weak signals.

Ques. 2.46. If a radiotelephone communications receiver has an "electric eye" to indicate correct tuning, how does the "eye" normally indicate the correct tuning when receiving a signal?

Ans. The eye will normally close when the receiver is properly tuned. However, since there are several types and a number of different circuits, the operator must determine the characteristics of that used on his particular receiver.

Ques. 2.47. What is the purpose of a fuse in a transmitter or receiver circuit?

Ans. Fuses are put into electrical circuits to protect the equipment when electrical-power faults such as short circuits or other abnormal overloads occur.

Ques. 2.48. When replacing a fuse in a transmitter or a receiver, why should the rating of the replacement be the same as that recommended by the manufacturer?

Ans. The replacement should be exactly the same as that recommended by the manufacturer so that if future faults occur, the fuse will burn out to prevent possible damage to the equipment.

Ques. 2.49. If a 5-ampere fuse in a circuit "blows out" after a long period of normal operation, what size fuse would be appropriate for replacement?

Ans. A 5-ampere fuse would be appropriate for the replacement after the reason for the increased current has been ascertained. It is never advisable to increase the capacity rating of the fuse beyond normal requirements.

Ques. 2.50. List two precautions that should be observed when replacing a tube in a receiver or a transmitter.

Ans. 1. The replacement should be of the same type number as the tube that was removed.

2. All sources of power should be disconnected from the transmitter or receiver.

3. Defective rectifier tubes should not be replaced until a test is first made to determine a possible leak or short circuit in the filter capacitor.

4. Avoid burning the hands on a tube that has been heated for a long time.

Ques. 2.51. If smoke is observed emerging from a transmitter or a receiver, what should the operator do immediately?

Ans. 1. Disconnect all sources of power to the equipment.
2. If flames can be detected, a carbon-dioxide type of fire extinguisher should be used to extinguish the flames.

Ques. 2.52. Why is it important that a fire extinguisher that is to be used for fighting fires in transmitters involving high voltage be of a type designed for fighting electrical fires?

Ans. A nonconducting type of extinguishing agent should be used, so as to prevent additional short circuits from causing a larger electrical fire, or shocking the person operating the extinguisher.

Ques. 2.53. Generally speaking, what is the approximate dependable working distance range of a transmitter working in an automobile?

Ans. A VHF mobile transmitter has a working range of from 5 to 35 miles, depending upon the surrounding terrain and effective output power.

Ques. 2.54. Why is it a good policy to make a daily test of a transmitter when it is in stand-by for long periods between transmission?

Ans. Daily tests of the transmitter may reveal any faults or defects, which if corrected immediately will not hamper the transmitter's operation when it is needed.

Ques. 2.55. Is it a good practice to make entries of station operation in a radio log prior to operating the station?

Ans. No. The log must reflect the exact operation of the equipment and the times of operation, not how it was proposed to operate it. It would, however, be proper to enter the date,

name of the operator coming on watch, or other preliminary data of this nature.

Ques. 2.56. When does the radio day, that is, the 24-hour period covered by a complete set of station records, of a station in continuous service, generally begin and end?

Ans. The 24-hour period covered by a complete set of station records generally begins at midnight, local standard time, and ends the following midnight.

Ques. 2.57. In reference to electric shock, what is meant by artificial respiration, and how is it administered?

Ans. Artificial respiration is administered for the purpose of restoring normal breathing to a person who has had a sufficient electrical shock to cause his respiratory system to cease functioning or become very faint in its operation. It is applied in the following manner:

1. The person is laid face down on a floor or level spot, with his legs spread apart and his head resting on one side of his face.
2. The person giving the aid kneels, resting one knee between the victim's legs and the other to one side.
3. The following steps are then performed:
   a. The hands are placed on each side of the victim's body just above the small of his back.
   b. With the hands in this position, pressure is applied in a downward direction.
   c. The pressure is then removed.
   d. The person administering the aid returns to a normal kneeling position.

This process is continued until normal respiration occurs within the victim.

Ques. 2.58. What should the operator at a radio station do immediately if he sees a person fall into contact with a high-voltage circuit?

Ans. 1. All power should immediately be removed from that circuit (assuming the switch is quickly accessible).

2. Pry the victim loose from the contacts with a dry board, dry wooden stool, or chair; avoid bodily contact with the victim.

3. The operator should call a doctor.

4. The operator should give first aid to the person until the doctor arrives.

Ques. 2.59. During electric storms, is it safe for a person to stand near high antennas or near antenna lead-ins?

Ans. It is not safe to stand near a high antenna or an antenna lead-in. This can be compared with standing under a tree during an electrical storm. If the tree cannot leak off enough of a charge, the difference in potential between the tree and the atmosphere becomes high enough to break down the air gap between them, and everything in the vicinity of the tree is affected.

Even though the antenna lead-in may conduct the discharge safely to ground, the high currents may melt small particles of metal and spray them about. In addition, the high current induces a secondary current into nearby objects.

This is the end of Element II.

ELEMENT III

BASIC RADIOTELEPHONE

There are 537 questions on basic radiotelephone theory. Most of them appear (some with different numbers) in the Tenth Edition of "Radio Operating Questions and Answers." The last 9 are in this supplement. Start

with 2.01, page 18, of the Tenth Edition; and read through 3.227, on page 171. Omit 3.160 through 3.163, 3.166 through 3.171, and 3.174. Also omit 3.229 through 3.249. Then study the questions below, numbered S3.01 through S3.09. In the examination, there will be 100 questions based upon this type of material.

Ques. S3.01. In accordance with the Commission's Rules and Regulations, what is the primary standard for radio-frequency measurements of radio stations in the various services?

Ans. The primary standard of frequency for radio-frequency measurements shall be the national standard of frequency maintained by the National Bureau of Standards, Department of Commerce, Washington, D.C. The operating frequency of all radio stations will be determined by comparison with this standard or the standard signals of station WWV of the National Bureau of Standards.

Ques. S3.02. What is meant by carrier frequency? Carrier wave?

Ans. Carrier frequency is the frequency of the transmitter output when the modulation is zero. The carrier wave of a frequency-stabilized system is a wave generated at a point in the transmitting system and subsequently modulated by the signal intelligence.

Ques. S3.03. Define land station; base station; mobile station; experimental station; domestic fixed service; public correspondence; facsimile; fixed service; Industrial Radio Services; Industrial, Scientific, and Medical Equipment; Land Transportation Radio Services; Public Safety Radio Services; and Citizens Radio Service.

Ans. A land station (FL) is a station in the mobile service not intended for operation while in motion.

A base station (FB) is a land station in the land mobile service carrying on a service with land mobile stations.

A mobile station (MOZ) is any mobile station other than a television pickup station.

An experimental station (EX) is a station utilizing Hertzian waves in experiments, with a view to the development of science or technique. This definition does not include amateur stations.

Domestic fixed service is a fixed service intended for the transmission of information between points, all of which lie within the 48 states and the District of Columbia, except for the domestic haul of international traffic.

Public correspondence is any telecommunication that the offices and stations, by reason of their being at the disposal of the public, must accept for transmission.

Facsimile is a system of telecommunication for the transmission of fixed images, with a view to their reception in a permanent form.

Fixed service is a service of radiocommunication between specified fixed points.

Industrial Radio Services are any service of radiocommunication essentially operated by, and for the sole use of, those enterprises which for purposes of safety or other necessity require radiocommunication in order to function efficiently; the radio transmitting facilities of which are defined as fixed, land, or mobile stations.

Industrial, Scientific, and Medical Equipment is radio transmitting equipment or other devices employing Hertzian waves for industrial, scientific, or medical purposes, including the transfer of energy by radio, and which are not intended to be used for radio communication.

Land Transportation Radio Services are any service of radio communication operated by, and for the sole use of, certain land transportation carriers; the radio transmitting facilities of which are defined as fixed, land, or mobile stations.

Public Safety Radio Service is any service of radiocommunication essential to either the discharge of non-federal governmental functions relating to public-safety responsibilities or

the alleviation of an emergency endangering life or property; the radio transmitting facilities of which are defined as fixed, land, or mobile stations.

Citizens Radio Service is a radio communication service of fixed, land, or mobile stations, or combination thereof, intended for use by citizens of the United States for private or personal radiocommunication (including radio signalling, control of objects by radio, and other purposes).

Ques. S3.04. What is the frequency range included in the following frequency subdivisions: MF (medium frequency), HF (high frequency), VHF (very high frequency), UHF (ultrahigh frequency), and SHF (superhigh frequency)?

Ans. The frequency ranges, together with their abbreviations, are shown in the table below:

Frequency	Range, kc	Range, mc
VLF (very low frequency)	10–30 kc	
LF (low frequency)	30–300 kc	
MF (medium frequency)	300–3,000 kc	0.3–3 mc
HF (high frequency)	3,000–30,000 kc	3–30 mc
VHF (very high frequency)	30,000–300,000 kc	30–300 mc
UHF (ultrahigh frequency)	300,000–3,000,000 kc	300–3,000 mc
SHF (superhigh frequency)	3,000,000–30,000,000 kc	3,000–30,000 mc
EHF (extremely high frequency)	30,000,000–300,000,000 kc	30,000–300,000 mc

Ques. S3.05. Explain what is meant by the following types of emission: F0, F1, F2, F3, F4, and P0 emission.

Ans. Type F emissions are frequency or phase modulated, and type P emissions are pulsed. Type A emissions indicate amplitude modulation. The complete list of the various combinations is shown in the table below.

FCC Emission and Modulation Symbols

Type of Modulation or Emission	Type of Transmission	Symbol
1. Amplitude	Absence of any modulation	A0
	Telegraphy without the use of modulating audio frequency (on-off keying)	A1
	Telegraphy by the keying of a modulating audio frequency or audio frequencies or by the keying of the modulated emission (special case: an unkeyed modulated emission)	A2
	Telephony:	
	Double side band, full carrier	A3
	Single side band, reduced carrier	A3a
	Two independent side bands, reduced carriers	A3b
	Facsimile	A4
	Television	A5
	Composite transmissions and cases not covered by the above	A9
	Composite transmissions, reduced carrier	A9c
2. Frequency (or phase) modulated	Absence of any modulation	F0
	Telegraphy without the use of modulating audio frequency (frequency shift keying)	F1
	Telegraphy by the keying of a modulating audio frequency or audio frequencies or by the keying of the modulated emission (special case: an unkeyed emission modulated by audio frequency)	F2
	Telephony	F3
	Facsimile	F4
	Television	F5
	Composite transmissions and cases not covered by the above	F9
3. Pulsed emissions	Absence of any modulation intended to carry information	P0
	Telegraphy without the use of modulating audio frequency	P1
	Telegraphy by the keying of a modulating audio frequency or audio frequencies, or by the keying of the modulated pulse (special case: an unkeyed modulated pulse)	
	Audio frequency or audio frequencies modulating their pulse in amplitude	P2d
	Audio frequency or audio frequencies modulating the width of the pulse	P2e
	Audio frequency or audio frequencies modulating the phase (or position) of the pulse	P2f
	Telephony:	
	Amplitude-modulated pulse	P3d
	Width-modulated pulse	P3e
	Phase- (or position-) modulated pulse	P3f
	Composite transmissions and cases not covered by the above	P9

Ques. S3.06. What are the requirements for posting of operator license for (a) the operator performing duties other than, or in addition to, service or maintenance, at two or more stations, and (b) the operator performing service or maintenance duties at one or more stations?

Ans. In the first case (*a*), the operator must post his license or permit of the diploma form at one such station and must post a verification card, Form 759, at all other such stations. An operator performing maintenance (*b*) must either post his license or have on his person a verification card, whenever the transmitter on which he is working is actually in operation. If the maintenance operator also performs operating duties, he must, of course, comply with the requirements for (*a*) above.

Ques. S3.07. If service or maintenance logs are required to be kept at a radio station, what entries are required to be entered in the log?

Ans. Where a log or service records are required and when service is performed that may affect the proper operation of the station, the responsible operator must sign and date an entry in the log or maintenance record. The entries consist of details of work performed; his name and address; class, serial number, and expiration date of his license. If the operator is regularly employed at the station full time, it is required only that he give the details of the work performed.

Ques. S3.08. In communication services such as the Public Safety Radio Services, (a) what percentage of modulation is normally required when amplitude modulation is used for radiotelephony, and (b) what maximum frequency deviation arising from modulation is permitted when phase or frequency modulation is used for radiotelephony?

Ans. For amplitude modulation (*a*), the percentage must normally be maintained about 70, but not to exceed, 100 per cent; for phase or frequency modulation (*b*), the maximum

deviation must not exceed plus or minus 15 kilocycles from the unmodulated carrier.

Ques. S3.09. In communication services such as the Public Safety Radio Services, how often should (a) transmitter frequencies be measured, (b) transmitter power be measured, and (c) percentage of modulation be measured? What entries relative to technical measurements are required to be entered in station records?

Ans. The transmitter frequency (*a*) must be measured at initial installation; when any change is made that may cause a change in frequency or stability; at least every six months for crystal-controlled transmitters; and at intervals not over a month for transmitters without crystal control. Transmitter power (*b*) must be measured at initial installation; when any change is made that might increase power input; and at intervals not to exceed six months. The percentage of modulation (*c*) must be measured at initial installation; when any change is made that might affect the modulation and at intervals not to exceed six months.

The station records must contain a notation of these various check measurements and must show whether the plate current or cathode current has been used to determine input power. The name of a qualified measurement service, together with address and the name of the person making the measurement, must be shown. Power and percentage of modulation can be determined at a test bench, provided the load conditions are the same as in actual service. If this is done, it is also necessary to make a receiving test after the transmitter has been reinstalled to ensure that it is working properly.

This is the end of *new* Element III.

ELEMENT IV

ADVANCED RADIOTELEPHONE

There are 284 questions on advanced radiotelephone theory, and all of them appear as Element 4 in the Tenth Edition of "Radio Operating Questions and Answers." Study from Ques. 4.01, on page 180, through Ques. 4.284, on page 265. There will be 50 examination questions based on this material.

ELEMENT V

RADIOTELEGRAPH OPERATING PRACTICE

There are 38 questions on radiotelegraph operating practice, and all of them appear in this supplement. Do *not* study any of the *old* Element 5 questions in the Tenth Edition of "Radio Operating Questions and Answers" at this time. There will be 50 examination questions based upon the type of material contained below.

Ques. 5.01. List three classes of stations which may not be operated by the holder of a radiotelegraph third-class operator permit.

Ans. A radiotelegraph operator third class may not operate broadcast stations, ship stations licensed to use A3 or F3 emission for communication with coastal telephone stations, a radiotelegraph station on board a vessel required to be equipped by treaty or statute, or coastal telegraph or marine-relay station open to public correspondence.

Ques. 5.02. Is the holder of a radiotelegraph third-class operator permit authorized to make technical adjustments to a radiotelephone transmitter? To a radiotelegraph transmitter?

Ans. Such operator may make only operational types of adjustments to a radiotelephone transmitter that will not result in improper operation or any unauthorized radiation. He may not make technical adjustments to a radiotelegraph transmitter. Needed adjustments are made in the presence of or by an operator holding a first-class or second-class license.

Ques. 5.03. Where should the operator on duty at a manually operated radiotelegraph station normally post his operator license or permit?

Ans. He must post it at the transmitter, or at the operating position if that is at a different location.

Ques. 5.04. What are the requirements for station identification at radiotelegraph stations in the Public Safety Radio Services?

Ans. Each station in these services must transmit its call signal at the end of each transmission (or exchange of transmissions), or once each fifteen minutes. Mobile units communicating with a base station on the same frequency may use a unit identifying signal (like "car 15" or "pumper 4") each time if such identifier is on file at the base station. Mobile units on a different frequency may use an identifier during each exchange, together with the assigned call of either the base station or the mobile unit. Automatic stations are usually exempted from this requirement on request.

Ques. 5.05. What is the radiotelegraph distress signal? Urgent signal? Safety signal?

Ans. The distress signal is $\overline{\text{SOS}}$, sent as one character. The urgent signal is XXX. The safety signal is TTT.

Ques. 5.06. The speed of radiotelegraph code transmission in cases of distress, urgency, or safety must not, in general, exceed what speed?

Ans. In general, such messages should not be sent at a speed exceeding 15 words per minute.

Ques. 5.07. What radiotelegraph signal is generally used in a call "to all stations"?

Ans. The call to all stations is CQ.

Ques. 5.08. What is meant by the following radiotelegraph operating signals?

R, $\overline{\text{AS}}$, $\overline{\text{IMI}}$, C, $\overline{\text{BT}}$, K, $\overline{\text{AR}}$, $\overline{\text{VA}}$, DE

Ans. R means "understood" or "received ok"; $\overline{\text{AS}}$ means "wait"; $\overline{\text{IMI}}$ is a question mark or indication that something is not understood (when used after a Q signal, it asks a question); C means "yes"; $\overline{\text{BT}}$ is a break or space; K is an invitation to transmit, usually following a call sign or end-of-message operating signal; $\overline{\text{AR}}$ indicates the end of a message, even though more messages may be coming during the whole transmission; $\overline{\text{VA}}$ is the end of a transmission or series of them, sometimes termed the "Signoff"; DE comes from the French meaning "from" and is used between the call letters of the called station and the calling station.

Ques. 5.09. If a radiotelegraph operator makes an error in transmitting message text, how does he indicate that an error has been made?

Ans. By sending a series of dots, officially eight, although the number may vary in actual practice.

Ques. 5.10. When testing a radiotelegraph transmitter, what signals are generally transmitted?

Ans. Usually a series of V's, three groups of three, followed by the station call letters three times.

Ques. 5.11. In order to avoid confusion in transmitting numbers involving a fraction, how should such numbers be transmitted? Give an example of such a number, showing how it should be transmitted.

Ans. The ordinary fraction bar is sent as $\overline{\text{TF}}$. When a fraction and whole number must be sent, the hyphen $\overline{\text{BA}}$ is used. For example, $1\ ^{3}/_{32}$ is sent as

$$1\overline{\text{BA}}3\overline{\text{TF}}32$$

Ques. 5.12. What is meant by the preamble in a radiotelegraph message? What information is usually given in the preamble?

Ans. The preamble of a radiotelegraph message is that part that precedes the actual message itself. The preamble usually includes a prefix denoting the type of message, the serial number, the check or word count, the office of origin and its call letters, the time of filing, the day of the month on which it was filed, and routing instructions. The sender is charged only for the part of the telegram that comes after the preamble.

Ques. 5.13. In addition to the preamble, what parts does a radiotelegraph message contain?

Ans. A complete message is made up of preamble, address, text, and signature.

Ques. 5.14. What is meant by a service prefix or indicator in a radiotelegraph message?

Ans. A service prefix, like RP or OBS, indicates the type of message and the handling it must be given.

Ques. 5.15. What does "word count," or "check," mean in a radiotelegraph message?

Ans. Word count, or check, as given in the preamble, indicates the number of words that are charged for in the

part of the message after the preamble. When certain service indicators showing how the message is to be handled appear in the preamble, they are also subject to charge.

Ques. 5.16. At what time, or times, does the serial numbering of radio messages begin? Does the period of numbering vary in some services?

Ans. Messages are numbered beginning with Nr 1 at 0000 midnight, GMT. In a purely local service, message numbering may begin at midnight, local standard time.

Ques. 5.17. Code or cipher groups are often used in radiotelegraph messages for what purpose?

Ans. Code or cipher groups are used sometimes for purposes of secrecy, to conserve charges in transmitting intelligence that would otherwise require a greater amount of plain language, or, as in the weather code, to reduce the amount of time necessary to disseminate essential public information.

Ques. 5.18. Immediately following the transmission of a radiotelegraph message containing figures or odd symbols, why are such figures sometimes collated?

Ans. The amount of information in figures and odd symbols is usually greater than that in plain language, and errors are less easily detected. For this reason, such symbols are collated or confirmed to ensure accuracy.

Ques. 5.19. If receiving conditions are bad and you want the transmitting station to send each word or group twice to facilitate reception, what operating signal would be appropriate to use?

Ans. Transmit each word or group twice; QSZ.

Ques. 5.20. In general, what is the purpose of a service message in radiotelegraph communications?

Ans. A service message (SVC) is one that is sent from one station to another and concerns a message already initiated, such as reporting that a message cannot be delivered or requesting further information on it.

Ques. 5.21. Why are Q signals or other arbitrary selected procedure signals used in radiotelegraph communications?

Ans. By their shortness and universal use, these special signals save a great deal of operating time. They are also distinctive and cannot be confused with message content.

Ques. 5.22. What is meant by the following signals: QRA, QRM, QRN, QRT, QRZ, QSA, QSV, QUM, QRL?

Ans. As questions, these signals are followed by a query signal IMI. Without, they mean, respectively: the name of my station is ____; I am being interfered with; I am troubled by static; stop transmission; you are being called by ____; the strength of your signals is ____ (1 to 5); transmit a series of V's; distress traffic is ended; I am busy. (See also the complete list of Q signals in the Appendix.)

Ques. 5.23. If the signal strength of a radiotelegraph signal is reported on a scale of 1, 2, 3, 4, 5, what scale number would indicate a very strong signal? What scale number would indicate a very weak signal?

Ans. High numbers indicate strong signals; QSA 5 is the strongest. Low numbers indicate weak signals; QSA 1 means a scarcely perceptible signal.

Ques. 5.24. If, upon being called by another station, a called station is busy with other traffic, what should the operator of the called station do?

Ans. He should so indicate (QRL) and also ask the calling station to wait (QRX) or (AS) a specified number of minutes

or until a specified time. Distress or urgent calls take precedence over other operations.

Ques. 5.25. Describe a procedure of radiotelegraph transmission in which one station calls another. Give an example.

Ans. If WLKH is calling KNIV, the calling procedure would be as follows:

KNIV, KNIV, KNIV de WLKH, WLKH, WLKH K

Ques. 5.26. Describe a procedure of radiotelegraph transmission in which one station answers the call of another. Give an example.

Ans. If KNIV hears the call of WLKH, he answers as follows:

WLKH, WLKH, WLKH de KNIV, KNIV, KNIV R K

Ques. 5.27. What is meant by the statement: "A station is open to public correspondence"?

Ans. Such a station, being at the disposal of the public, must accept suitable messages for transmission.

Ques. 5.28. Should the speed of transmission of radiotelegraph signals be in accordance with the desire of the transmitting or receiving operator?

Ans. The transmitting operator must adjust his speed of transmission in accord with the desire of the receiving operator.

Ques. 5.29. After long periods of listening to a CW telegraph signal of constant tone, what adjustment can the operator make to a radio receiver to relieve hearing fatigue?

Ans. He can adjust the setting of the beat-frequency oscillator to give a different or more pleasing pitch, or he can slightly detune a tuned-radio-frequency receiver to accomplish the same effect. Retuning a superheterodyne instead of

adjusting the beat oscillator will accomplish the effect but may result in a slight loss in sensitivity.

Ques. 5.30. What is meant by break-in operation at a radiotelegraph station?

Ans. Break-in operation means an arrangement of equipment so that the operator can hear signals from the other station between letters or even between the intraletter spacings. If the other station wishes to break the sending, he can therefore do so without waiting for the conclusion of a transmission.

Ques. 5.31. How should the automatic volume-control switch be set for reception of CW radiotelegraph signals on a communications receiver designed for both radiotelephone and radiotelegraph reception?

Ans. It is generally desirable to turn the automatic volume-control switch off when receiving CW signals and maintain the radio-frequency gain manually. On some receivers, the AVC can be left on, but the receiver will block on strong local signals, particularly if the gain control is set high.

Ques. 5.32. Explain the use of the crystal-filter switch on a communications receiver.

Ans. A crystal filter is often provided on a communications receiver to narrow the pass band of the receiver, thereby reducing the effects of noise and interfering signals on adjacent frequencies. When it is desired to use the crystal filter, the switch is turned on and the desired signal tuned in until it is at maximum strength. If the pitch of the signal is not satisfactory at maximum signal strength, the beat-frequency oscillator is then adjusted to obtain the proper pitch. The tuning at maximum signal is very critical. A phasing control is often furnished with the crystal filter. When this control

is manipulated, it is often possible to get a better ratio of desired-to-undesired signal strength.

Ques. 5.33. What adjustment should be made to a radiotelegraph receiver if the receiver "blocks" on the reception of strong signals?

Ans. The automatic volume control should be turned off and the radio-frequency gain reduced until the signal is received without blocking.

Ques. 5.34. Describe how to adjust a communications radio receiver for the reception of weak CW signals.

Ans. Most operators find that it is desirable to increase the audio-amplifier gain to maximum and raise the radio-frequency gain to sufficient level to copy the weak CW signals. The beat-frequency oscillator must, of course, be on and the AVC off.

Ques. 5.35. How should a radiotelegraph receiver be adjusted for the reception of type A2 emissions?

Ans. Although the beat-frequency oscillator can often be left on, it is generally more satisfactory to turn it off when receiving tone-modulated (A2) telegraph signals. In other respects, the receiver is generally adjusted as it would be for reception of radiotelephone signals. If there is danger of blocking, especially from the local transmitter during break-in, the AVC should be turned off.

Ques. 5.36. Sometimes a given radiotelegraph transmitting station can be heard at more than one place on the tuning dial of a receiver. Is this always an indication that the station is transmitting on more than one frequency?

Ans. No. The transmitter signal may be beating with some locally generated oscillation in the receiver. Images, having a frequency for which the receiver is tuned, plus twice

the intermediate frequency, are a most frequent source of unwanted signal in superheterodyne receivers.

Ques. 5.37. How should a manual radiotelegraph transmitting key be adjusted for good operation? Is the adjustment always the same for slow as it is for high speed?

Ans. The adjustment of a transmitting key is mostly a matter of operator preference. However, it should generally be adjusted so that the contacts are about $\frac{1}{32}$ inch apart and have sufficient tension to break the contact sharply, but not so much as to tire the hand. Although the adjustments are essentially the same for all sending speeds, some fast operators tend to keep the contacts close together and the spring tension light so as to have the key more flexible to manipulate. They tend to depress and raise the key manually rather than to punch it and allow the spring to return it.

Ques. 5.38. Describe how an automatic key, or "bug," should be properly adjusted to send good readable radiotelegraph signals.

Ans. A bug key has a multiplicity of adjustments, most of them interdependent. For best readability, the bug should be adjusted for the speed at which most sending is to be done. The main consideration is to transmit dots and dashes in such a relationship that the dash is equal to three dots. The adjustable weight on the dot-forming arm has the greatest effect upon dot speed. The length of the dot is determined both by the arc of swing of the arm and upon the dot-contact adjustment. At slow speeds, the dots should ideally be longer in length than they are at high speeds. The various tension, travel, and contact adjustments for the dash portion should then be adjusted until the operator has no trouble forming perfect characters at the chosen speed. A bug adjusted for high speed will sound choppy at slow speed, making it difficult for inexperienced receiving operators. A slow bug at high speed will send dashes that are nearly the

same length as the dots and will similarly cause copying difficulties.

This is the end of *new* Element V.

ELEMENT VI

ADVANCED RADIOTELEGRAPH

There are 895 questions on the theory of advanced radiotelegraph operations, and all of them appear in the Tenth Edition of "Radio Operating Questions and Answers," under the *old* Elements 2, 5, and 6. Study 2.01, on page 18, through 2.311, on page 101. Then turn to page 266 and study 5.01 through 5.291, on page 336. Omit 5.292 through 5.296, on page 337. Study from 6.01, on page 338, through 6.295, on page 426. There will be 100 examination questions based upon the information contained in Element VI.

ELEMENT VII

AIRCRAFT RADIOTELEGRAPH

There are 266 study questions on all aspects of aircraft radiotelegraph and navigation, and all of them appear in the Tenth Edition of "Radio Operating Questions and Answers." Study 7.01, on page 427, through 7.266,

on page 511. Only qualified radiotelegraph operators may obtain the Aircraft Radiotelegraph endorsement for their licenses after taking an examination of 100 questions based upon the material in Element VII.

ELEMENT VIII

SHIP RADAR TECHNIQUES

There are 69 questions about commercial marine radar and its operation, and all of them are contained in this supplement. Only first- and second-class radiotelegraph or radiotelephone operators may obtain the Ship Radar endorsement on their licenses after passing an examination containing 50 questions based upon the material below.

Ques. 8.01. What are the FCC license requirements for the operator who is responsible for the installation, servicing, and maintenance of ship radar equipment?

Ans. All adjustments and tests during installation and maintenance must be performed by or under the supervision of a person holding a first-class or second-class radiotelephone or radiotelegraph license with ship radar endorsement. Persons not holding such licenses may replace fuses or receiving-type tubes.

Ques. 8.02. Who may operate radar in the Ship Service?

Ans. The master, or person designated by him, may operate a ship radar station licensed for shipboard use in the Ship Service.

Ques. 8.03. Under what conditions may a person who does not hold a radio operator license operate a radar station in the Ship Service?

Ans. Any person may operate such a station if the equipment is licensed, meets frequency-stability requirements, if the operation of the equipment is in accordance with radio law, if such person is subject to the authority of the master of the vessel, and if such adjustments and tests are made by a properly licensed operator.

Ques. 8.04. Who may make entries in the installation and maintenance record of a ship radar station?

Ans. Such entries must be made by or under the supervision of the operator concerned in each case, but the licensee has joint responsibility for the accuracy of the record.

Ques. 8.05. What entries are required in the installation and maintenance record of a ship radar station?

Ans. The following entries must be signed by the responsible operator concerned: Date and place of the initial installation; any steps necessary to remedy interference; nature of any complaint of interference since arising; reason for the trouble leading to the condition complained of, including the name of the faulty component; remedial measures taken and date thereof; the name, license number, and date of the ship radar operator endorsement of the first-class or second-class operator performing the work.

Ques. 8.06. Who has the responsibility for making entries in the installation and maintenance record of a ship radar station?

Ans. The licensed operator doing the work, but the licensee has an equal responsibility to see that the entries are accurately made.

Ques. 8.07. Within what bands of frequencies do ship radar transmitters operate?

Ans. Within 3,000 and 3,246 megacycles; 5,460 and 5,650 megacycles; 9,320 and 9,500 megacycles. These frequencies lie in what are very often referred to as the 10, 3, and 1.5 centimeter bands, respectively.

Ques. 8.08. May fuses and receiving-type tubes be replaced in ship radar equipment by a person whose operator license does not contain a ship radar endorsement?

Ans. Yes.

Ques. 8.09. Explain briefly why radar interference to a radiotelephone receiver is frequently characterized by a steady tone in the radio loud-speaker.

Ans. The magnetron in a radar transmitter is pulsed by a series of square waves generated in the modulator section of the transmitter. Since this wave train must have appreciable amplitude and because a square wave is made up of a large number of frequencies, there are emissions of considerable strength on up into the radio-frequency spectrum. The pulse recurrence rate (PRR) occurs at an audio frequency in the order of 1,000 pulses per second. The radio-frequency emissions resulting from the square-wave modulation are similar to ICW transmissions and appear in bands with varying intensity for various communications receivers.

Ques. 8.10. Describe how various types of interference from a radar installation may be apparent to a person when listening to a radio communications receiver.

Ans. The sources of interference from a radar installation are of two general types: (*a*) noise and (*b*) signals arising from the method of pulsing. Among the sources of noise are commutator noise, high-voltage arc over, and occasionally noise from imperfect contact between slip ring and brush.

All these noises are characteristic of static and sparking. The interference arising from the pulse recurrence rate of the modulator used to key the magnetron is a tone of about 1,000 cycles appearing throughout the radio-frequency spectrum. It is sometimes concentrated in bands of greater intensity. The frequency range of these bands is different for various receivers.

Ques. 8.11. How are the various types of radar interference recognized in (a) auto-alarm equipment and (b) direction-finding equipment?

Ans. (*a*) Interference in the auto-alarm is indicated by the red light being illuminated. Listening on the monitor jack of the alarm equipment will also indicate the type of interference. (*b*) Listening to the head telephones or loud-speaker connected to the DF equipment.

Ques. 8.12. On what frequencies should the radar serviceman look for radar interference to communication receivers on ships equipped with radar?

Ans. He should particularly check to see that no interference is being caused to the frequencies: 100–200 kilocycles; 350–515 kilocycles; 1,850–1,950 kilocycles; and 2–30 megacycles.

Ques. 8.13. In checking a direction finder for interference caused by radar equipment, would it be a good policy to check for interference while the DF loop is being rotated?

Ans. Yes. If the interference were coming from radar equipment on another vessel nearby, the orientation of the loop would determine the source. If interference were equally strong in all directions, it could safely be assumed that interference was coming from equipment on the same ship.

Ques. 8.14. List at least two types of indications on a Loran scope that signifies that a radar installation is causing interference to the Loran.

Ans. Noise from a radar installation shows up as "grass" on the slow-sweep display on a Loran scope, generally obscuring all but the strongest Loran signals. Spikes, usually moving to the right or to the left, indicate interference from the radar modulator. Occasionally these spikes may stand still on the slow-sweep display but usually begin moving right or left in a few moments.

Ques. 8.15. Is there any likelihood of a radar installation causing interference to radio receivers if long connecting lines are used between the radar transmitter and the radar modulator?

Ans. Yes. The connection between the magnetron oscillator and the pulsed modulator sections of the radar transmitter should be connected by as short a line as possible, properly terminated to avoid standing waves on the outer sheath, solidly connected at both ends, and properly grounded at both ends. All modern commercial radar equipments follow this practice to avoid generating pulse-type interference.

Ques. 8.16. What steps might be taken by a radar serviceman to eliminate a steady-tone type of interference to radio communication receivers, or interference to Loran receivers evidenced by "spikes"?

Ans. Since this type of interference is caused by radar modulator pulses, the line between modulator and magnetron should be checked for defective grounds at each end. Power leads into the radar equipment should be adequately filtered. As a last resort, it may be necessary to relocate the communications receiver or the Loran antenna in order to reduce pickup of the interfering signals.

Ques. 8.17. What steps might be taken by a radar serviceman to eliminate "grass" on a Loran scope or motor-generator noise in communication receivers?

Ans. If it is not possible to install filters directly on commutators or other sources of noise interference, the power

line to Loran and radio communications equipment should be equipped with noise filters. In addition, the frames and cabinets of all receiving equipment and the housings of motor generators should be solidly grounded.

Ques. 8.18. Name at least four pieces of radio or electronic equipment aboard ship that might suffer interference from the radar installation.

Ans. Among the equipment that might suffer interference are auto-alarm, Loran, Decca navigator, Consol, direction-finder, radio communications, and VHF ship-shore radio-telephone equipment. Under certain conditions, electronic intercommunication equipment might also be affected.

Ques. 8.19. Why is it important that all units of a radar installation be thoroughly bonded to the ship's electrical ground?

Ans. All radar, radio, and power equipment should be well bonded to the ship's electrical ground to avoid currents being carried by cable sheaths or other conductors between various units. Good grounding helps more than anything else in the elimination of interference. Of equal importance is the fact that if equipment is left "floating," harmful or annoying voltage gradients may exist between equipment and ground. The harmful effects of electrical shock are often secondary, like the fall from a ladder, owing to an involuntary reaction to slight shock.

Ques. 8.20. What may cause bright-flashing pie sections to appear on a radar PPI scope?

Ans. Flashing pie sections on the PPI scope, sometimes called "spoking," result from failure of the automatic volume-control circuit. While the most frequent cause of this type of failure is generally failure of the AVC crystal itself, the effects of failure of the magnetron, frequency shift of the

magnetron, or failure to key the magnetron with good square-wave pulses would manifest themselves in the same manner.

Ques. 8.21. What symptoms on a radar scope would indicate that the radar-receiver mixer crystal is defective?

Ans. Weak signals or lack of any signals on the PPI scope, especially when testing with the echo box, might indicate that the mixer crystal was defective.

Ques. 8.22. What tests may a radar serviceman make to determine whether or not the radar-receiver mixer crystal is defective?

Ans. There is usually a switch provided so that the crystal test current can be measured. This current should generally be about 0.4 milliampere. A standard tester for crystals, such as that ordinarily carried by a service-company employee is safe and accurate. A 20,000-ohm-per-volt meter can also be used to check the front-to-back current ratio. With the test probes in one connection, there should be infinite resistance. Do not use an ohmmeter of lower resistance, or the crystal may be damaged by too high a measuring current. Be careful in removing and replacing crystals, to avoid static discharges that may damage them.

Ques. 8.23. In a radar set, what are indications of (a) a defective magnetron, (b) a weak magnet in the magnetron, and (c) defective crystal in the receiver converter stage?

Ans. A defective magnetron (*a*) may be indicated by high magnetron current or no current, overload or underload breakers open, bright-flashing pie sections on the PPI scope. A weak magnet (*b*) is indicated by high magnetron current or opening of the overload breaker. A defective crystal in the receiver converter stage (*c*) is indicated by weak signals on the PPI scope, particularly when testing with the echo box.

Ques. 8.24. What precautions should a radar serviceman take when working with or handling a magnetron to prevent weakening or damage to the magnetron?

Ans. The magnetron should be handled carefully and when removed from the equipment should be placed so that it can not fall or so that tools or other heavy material can not fall upon it. In particular, avoid cracking the glass or breaking the seal between glass and metal parts. Avoid bending or hitting the metal envelope or cooling fins. Prevent damage to the wave-guide connection and exclude dirt from this section. Be careful not to bend or break leads through the glass heater and heater-cathode terminal insulator. Avoid mechanical strain on these connections.

Care must be observed in handling the magnet. Do not heat it or strike it with a screw driver or other tool.

Ques. 8.25. What precautions should a radar serviceman observe when making repairs or adjustments to a radar set to prevent personal injury to himself or to other persons?

Ans. Possible injuries are of mechanical and electrical origin. Among the first are cuts and abrasions caused by striking sharp parts of the equipment, cuts sustained by implosion of the cathode-ray tube owing to careless handling, including poisoning by the fluorescent-screen materials, and burning the hands and arms from contact with hot vacuum tubes, particularly the metal types. Electrical injuries include shock from high-potential wires and connections and capacitors.

Whenever possible, turn off all equipment and allow it to cool before working on it. Be sure that the main power switch is off, and discharge all capacitors with a semipermanent ground lead. Wear gloves and glasses when handling cathode-ray tubes. Use a handkerchief or other cloth to protect the hands when removing hot tubes.

If it is necessary to maintain the equipment with power on,

always have a competent assistant standing by who has been instructed how to turn off the main power and administer first aid in case of accident.

Ques. 8.26. Is there any danger in testing or operating radar equipment aboard ship when explosive or inflammable cargo is being handled?

Ans. Yes. The superhigh frequencies used are capable of heating many materials and can therefore cause fires or explosions. For example, there have been instances in which photoflash bulbs have been ignited within their cartons when placed near radar equipment.

Ques. 8.27. What considerations should be taken into account when selecting the location of the radar antenna assembly aboard ship?

Ans. Other things being equal, the antenna assembly should be mounted as high and as clear of obstacles as possible. Its weight must be taken into consideration and adequate support provided for it. The location must also permit proper installation and adequate support for the wave guide between the transmitter and the antenna. It must be accessible for necessary maintenance. The antenna should be placed so that obstructions are toward the stern rather than in any forward direction.

Ques. 8.28. Describe briefly the construction of a wave guide. Why should the interior of the wave guide be clean, smooth, and dry?

Ans. Wave guides are commonly constructed of brass tubing having a rectangular cross section. The brass is commonly plated with silver to increase the conductivity, and the silver is in turn protected from corrosion by a flash plating of rhodium, gold, or other protective metal. The ends of the wave-guide sections are equipped with special flange joints so that they can be connected together to ensure

good mechanical and electrical junctions. Because of the manner in which the microwaves travel in a wave guide, the interior surface must contain no electrical discontinuities. Dirt or corrosion resulting from excessive moisture will spoil the proper propagation of the wave through the guide.

Ques. 8.29. When installing wave guides, why should long, perfectly level sections of wave guides be avoided? Why is a small hole about ⅛ inch in diameter sometimes drilled on the underside of an elbow in a wave guide near the point where it enters the radar transmitter?

Ans. It would be desirable to maintain wave guides under pressure of dry air or gas so that the guide would not breathe in moisture from the surrounding air. Since it is not always possible to maintain it under pressure, the wave guide should be installed so that it slopes gently. If moisture accumulates, it can then run off to a point at which absorbent material or a drain is provided. Because it is difficult to pressurize certain sections, such as the wave guide near a rotating joint where the guide is connected to the antenna, it is often necessary to drill a small drain hole through which condensed moisture can escape.

Ques. 8.30. Why are wave guides used in preference to coaxial lines for the transmission of microwave energy in most shipboard radar installations?

Ans. The losses in coaxial lines at superhigh frequencies (microwaves) are very much higher than in wave guides. Because of the very large physical size required at lower frequencies, wave guides are not generally used outside the microwave region.

Ques. 8.31. Why are rectangular cross-sectional wave guides generally used in preference to circular cross-sectional wave guides?

Ans. The losses in circular wave guides are greater than those in rectangular wave guides. However, a round wave

guide is often used at rotating joints because of the greater simplicity in construction.

Ques. 8.32. Describe how wave guides are terminated at the radar antenna reflectors.

Ans. The wave guide in a commercial marine radar is customarily coupled to a horn or wave-guide nozzle. Radio-frequency energy from this horn falls upon a parabola-section reflector and is reflected as a narrow beam.

Ques. 8.33. What precautions should be taken when installing vertical sections of wave guides with choke coupling flanges to prevent moisture from entering the wave guide?

Ans. The end of the wave guide bearing the choke section should always hang down to avoid collection of moisture in the choke joint. When provided, the gasket should be inserted between the choke and the plain flange and the bolts taken up sufficiently to make a weatherproof joint.

Ques. 8.34. Why are choke joints often used in preference to flange joints to join sections of wave guides together?

Ans. Choke joints prevent loss of energy from a wave-guide junction, even when the joint is not mechanically tight. It is difficult to confine the energy within a wave-guide junction made up of a simple flange joint.

Ques. 8.35. Draw a longitudinal section of a wave-guide choke joint, and explain briefly its principle of operation.

Ans. Refer to Fig. 8-1. The choke joint is used so that there will be only a small loss or reflection at the gap J. This means that the impedance of the gap J must be as close as possible to zero. It is achieved by making the distance $\lambda_G/4$ appear like a short circuit at the inner surface of the guide, when λ_G is the wavelength in the guide. The impedance

of the slot opening into the gap J is made infinite by proportioning its depth to be equal to $\lambda_A/4$ when λ_A is the free-space wavelength of the source. The slot can conveniently be thought of as a short length of coaxial line terminated in a short circuit at the far end.

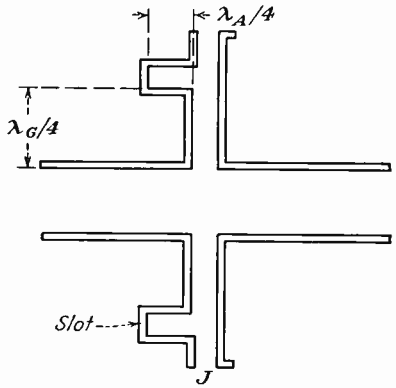

FIG. 8-1. Wave-guide choke joint.

Ques. 8.36. Describe how a radar beam is formed by a paraboloidal reflector.

Ans. Refer to Fig. 8-2. The antenna or source of radiation is located at the focus F of the parabola, which has a character-

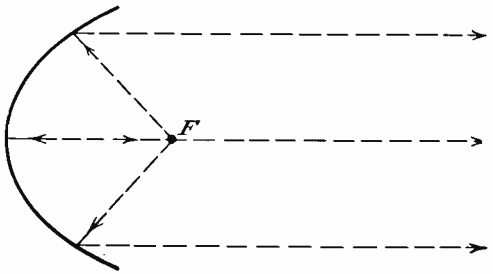

FIG. 8-2. Elementary parabolic reflector.

istic such that the resulting beam of radiated energy appears to come from many properly phased antennas. Any line drawn from the focus to the surface of the reflector will be reflected along a line parallel to those already drawn in the figure. It is customary in commercial marine radar to use a section of a parabola, sometimes called a "truncated parabola," to form the type of beam desired.

Ques. 8.37. What effect, if any, does the accumulation of soot or dirt on the antenna reflector have on the operation of ship radar?

Ans. Normal accumulation of soot or dirt has little noticeable effect on the operation of the ship radar. However, dirt on the plastic cover over the end of the wave-guide nozzle or horn will adversely affect operation. Moreover, this plastic cover should never be painted with ordinary paint.

Ques. 8.38. What is the purpose of an echo box in a radar system? Explain the principle of operation of the echo box. What indications may be expected on a radar scope when using an echo box and the radar set is operating properly? When the radar set is not operating properly?

Ans. An echo box is used to test the radar system in the absence of signals or when it is desired to compare performance with a previously attained standard. The echo box is actually a high-Q resonant cavity that is caused to ring by receiving energy from the radar transmitter. Since the ringing dies out relatively slowly, a portion of the energy is picked up by the radar receiver to give a PPI display. The length of the radial spoke or spokes from the center of the cathode-ray tube is a relative measure of the effectiveness of the system, as compared to a past setting. On some commercial equipments, the echo box tests only the output of the transmitter. On others, it tests the output of the wave-guide horn. When the

radar is operating properly, the radial line or lines on the PPI scope should extend out some distance from the center. If the equipment is not functioning properly, the length of these lines will be short compared to those obtained with some known previous setting of controls.

Ques. 8.39. Draw a block diagram of a radar system, labeling the antenna, duplexer, transmitter, receiver, modulator, timer, and the indicator.

Ans. See Fig. 8-3.

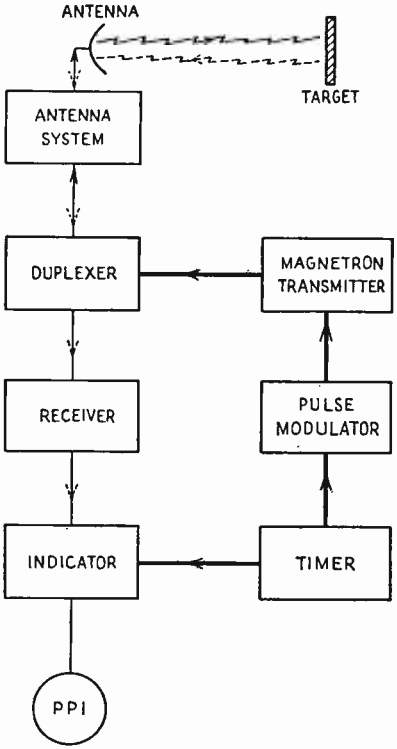

FIG. 8-3. Block diagram of a radar system.

Ques. 8.40. Explain briefly the principle of operation of a radar system.

Ans. Refer to Fig. 8-3. The purpose of a radar system is to gain knowledge about the presence, general size, and distance of above-water obstacles to navigation. In order to simplify commercial equipment, one antenna is used both for transmitting and receiving. A duplexer is provided so that power from the transmitter will not damage the sensitive receiver. This duplexer also prevents the loss of the received signal in the transmitting equipment. The heart of the radar system is the timer that sends out regular signals to operate the modulator. The modulator keys the magnetron transmitter on and off so that it sends out a uniform series of short pulses. The timer also sends blanking signals to the indicator so that any local signal leaking into the receiving system will not be displayed on the plan position indicator (PPI) oscilloscope tube. The indicator also provides distance-marker circles that facilitate accurate determination of the distance from the ship to the obstruction. The receiver converts radio-frequency energy into video signals that are displayed on the PPI scope.

Ques. 8.41. Draw a simple block diagram of a radar duplexer system, labeling the wave guide, the T-R box, anti T-R box, the receiver, and the transmitter.

Ans. See Fig. 8-4.

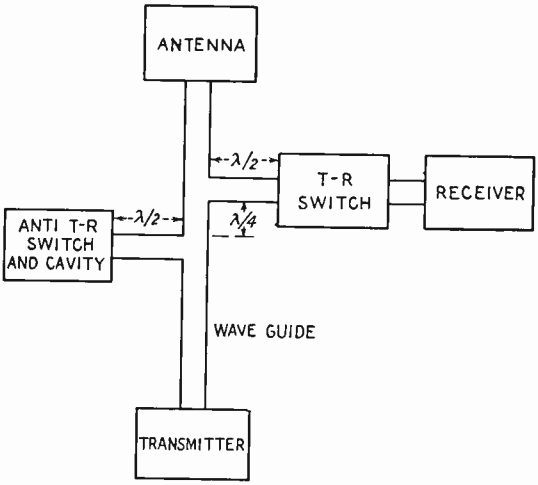

FIG. 8-4. Radar duplexer system.

Ques. 8.42. Draw a simple block diagram of a radar receiver, labeling the signal crystal, the local oscillator, the AFC crystal stage, the IF amplifier, and the discriminator.

Ans. See Fig. 8-5.

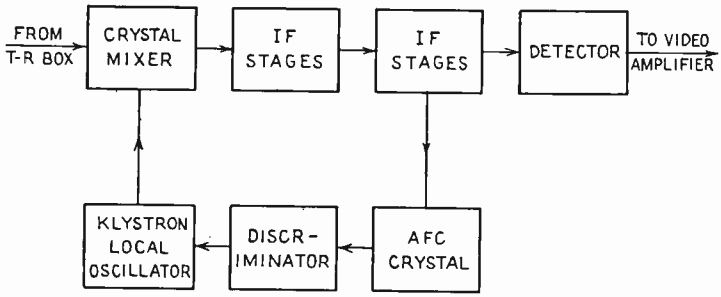

FIG. 8-5. Block diagram of radar receiver.

Ques. 8.43. Draw a simple cross-sectional diagram of a magnetron, showing the anode, cathode, and the direction

of electronic movement under the influence of a strong magnetic field.

Ans. See Fig. 8-6.

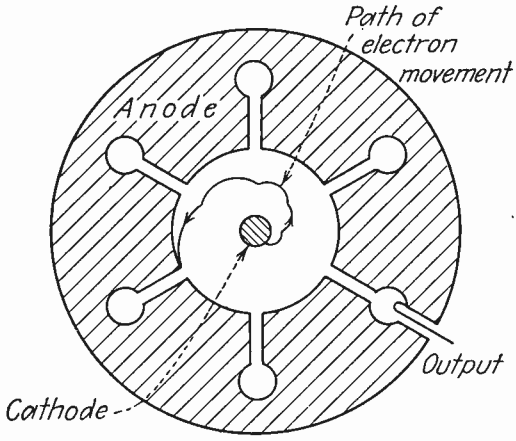

FIG. 8-6. Cross section of a cavity magnetron.

Ques. 8.44. Explain briefly the principle of operation of the magnetron.

Ans. Refer to Fig. 8-6. Electrons are emitted from the cathode when the magnetron is keyed or turned on by the modulator. Some of these return to the cathode and do no useful work. Others, like that for which the path is drawn, finally reach the anode. In their movement past the slots leading to the various cavities, they give up energy and cause the magnetron to oscillate. A strong magnetic flux is set up, usually by a permanent magnet, along the direction of the cathode. In the simple drawing, only the end of the cathode is shown. If the magnet is weakened, the electrons, instead of spiraling along the cathode, will go more directly to the anode, increasing the current to dangerously high values. Output is taken from a probe in one of the cavities.

Ques. 8.45. Why is the anode in a magnetron in a radar transmitter normally maintained at ground potential?

Ans. Although the anode must be maintained at a positive voltage, it is more convenient for mechanical reasons to ground the anode. The cathode, therefore, is carefully insulated and maintained at a large negative potential.

Ques. 8.46. Draw a simple frequency-converter circuit (mixer) as frequently used in radar superheterodyne receivers, and indicate which is the crystal stage.

Ans. See Fig. 8-7.

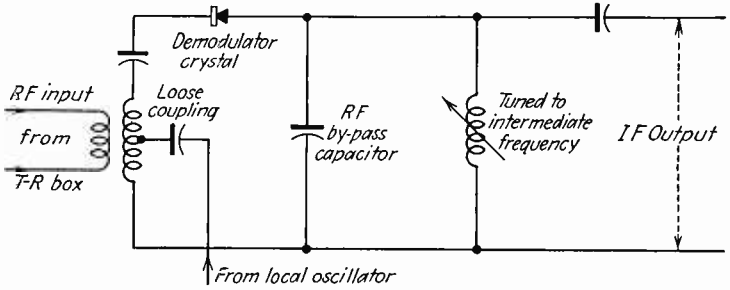

FIG. 8-7. Simplified radar frequency-converter circuit.

Ques. 8.47. What is the purpose of the klystron tube in a radar set?

Ans. The klystron tube in a radar set functions exclusively as local oscillator.

Ques. 8.48. Explain briefly the principle of operation of the reflex klystron.

Ans. In a reflex klystron tube, the electron beam is velocity modulated as it passes between the resonator grids. A retarding electric field beyond these grids causes the electron-beam velocity to decrease to zero and reflects the beam back through the grids. Bunching occurs during the transit interval

between reflections. When the proper negative voltage has been impressed on the repeller plate, the bunched electrons deliver energy to the resonator grids on the return trip.

Ques. 8.49. What care should be taken when handling silicon crystal rectifier cartridges for replacement in radar superheterodyne receivers?

Ans. The care that should be exercised when handling silicon crystal rectifier cartridges for replacement in radar superheterodyne receivers is the avoidance of mechanical shock, the accidental discharge of static charge through the crystal during insertion in the crystal holder, and exposure to strong electric fields.

Ques. 8.50. What nominal intermediate frequencies are commonly found in radar receivers?

Ans. Intermediate frequencies of from 15 to 60 megacycles are used in radar receivers. The intermediate and video frequencies are more readily separated when the higher frequencies are used. On the other hand, the tube capacitance will have minor effect on the alignment when the lower frequencies are used.

Ques. 8.51. Describe briefly the construction and operation of radar T-R and anti T-R boxes. What is the purpose of a "keep alive" voltage?

Ans. The T-R and anti T-R boxes are cavity resonators with a spark gap located one-quarter wavelength from the end. The T-R box functions as a double-pole double-throw switch. It connects the receiver to the common antenna during the resting period of the transmitter and disconnects it during the transmission period. The anti T-R box is located an odd number of quarter wavelengths from the T-R box and is shunted across the main transmission line. It works in conjunction with the T-R box to see that all the

available echo energy is absorbed by the receiver and that none of it reaches the transmitter during its resting period.

The purpose of the "keep alive" voltage is to ionize the spark gap so that it breaks down quickly under initial pulsing conditions. This increases the protection to the receiver's crystal.

Ques. 8.52. What is the purpose of the discriminator stage in a radar superheterodyne?

Ans. The purpose of the discriminator stage in a radar superheterodyne receiver is to provide an automatic frequency control voltage for the repeller electrode of the radar beating oscillator.

Ques. 8.53. What type of detector is used frequently in radar receivers?

Ans. One of the most frequently used types of demodulators used in radar receivers is the semiconductor diode detector.

Ques. 8.54. What is "sea return" on a radar scope?

Ans. The sea return is the reflection of the radar signal from the sea. These echoes are amplified and presented on the scope in the same manner as the target return.

Ques. 8.55. Explain briefly the purpose of the sensitivity-time-control circuit in a radar set.

Ans. The purpose of the sensitivity-time-control circuit in a radar set is to control the receiver gain so that the gain increases with range to offset the decrease of echo amplitudes, and so that nearby targets will not be obscured by sea return or blocking by the transmitted signal.

Ques. 8.56. What is the distance in nautical miles to a target if it takes 123 microseconds for a radar pulse to travel from the radar antenna to the target, back to the antenna, and be displayed on the PPI scope?

Ans. Reflection interval for 1 nautical mile = 12.361 microseconds.

$$\frac{123}{12.3} = \text{approximately 10 nautical miles}$$

(See also Fig. 8-8 for information on time constant and range.)

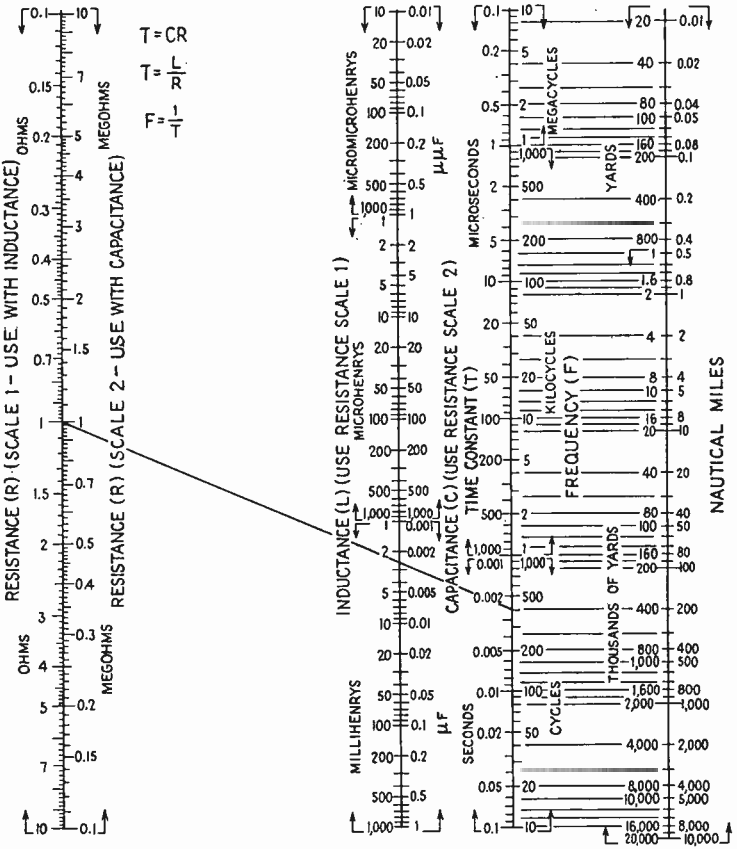

FIG. 8-8. Time constants for series circuits and radar ranges.
Example: Given a resistance of 1 megohm in series with a capacitance 0.0025 microfarad, find the time constant of the network. Placing a straight edge through these respective values (using resistance scale 2 and capacitance scale 2), the time constant scale is intersected at 0.0025 second, a frequency of 400 cycles and a maximum possible range of 200 miles.

Ques. 8.57. What is the purpose of an artificial transmission line in a radar set?

Ans. Artificial transmission lines are employed for pulse formation in driver stages of modulators. The lines consist of a number of capacitors and inductors in certain combinations. The artificial line will deliver a voltage for a definite period of time to a load, in a similar way to the action of a battery rapidly switched on and off. Its advantage lies in the accuracy with which the magnitude and duration of pulses of energy can be delivered and in the extreme rapidity of the action.

Ques. 8.58. Draw a simple diagram of an artificial transmission line showing inductance and capacitance, source of power, the load, and the electronic switch.

Ans. See Fig. 8-9.

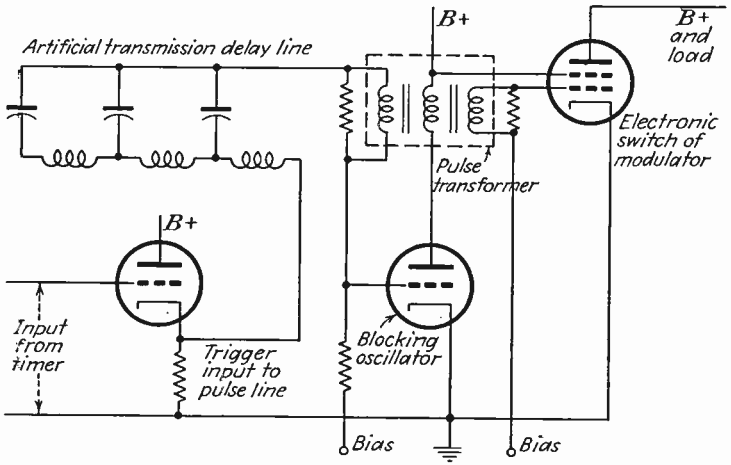

FIG. 8-9. Simplified artificial transmission-line radar pulser.

Ques. 8.59. What component in a radar set determines the pulse repetition rate?

Ans. The timer or synchronizer unit in a radar set determines the pulse repetition rate.

Ques. 8.60. What circuit element determines the operating frequency of the self-blocking oscillator?

Ans. An oscillator in which the plate and grid circuits are closely coupled through an iron-core transformer is called a "blocking oscillator" or "transformer-coupled multivibrator." The operating frequency depends principally upon the R-C time constant of the grid resistor and grid capacitor.

Ques. 8.61. What is the purpose of the rotary spark gap used in some radar sets?

Ans. The rotary spark gap is used in some radar sets (such as some Navy types) to function as a short-circuit switch for pulse-forming networks. One side of the gap is rotated on a wheel in such a way that it passes a fixed electrode at regular intervals. When the rotating electrode is directly under the fixed one, an arc is formed that discharges the pulse-forming network through its useful load. After the rotating electrode has passed the stationary one, the arc is extinguished. This action allows the storage elements of the network to be recharged. The process is then repeated.

Ques. 8.62. What is meant by "bearing resolution" of a radar set?

Ans. Bearing, or azimuth, resolution refers to the ability of a radar set to distinguish between two targets close together at the same range distance. This ability depends upon a number of factors, such as radio frequency of operation (being generally improved at higher frequencies), pulse width, antenna characteristics, and receiver adjustments.

Ques. 8.63. Explain how heading flash and range-marker circles are produced on a radar PPI scope.

Ans. Heading flashes can be reproduced on a radar PPI scope in the following manner: A snap-action switch is mechanically connected to the antenna so as to be closed by a cam. The switch closes on the dead-ahead position of the antenna (coinciding with the longitudinal axis of the mobile unit). When it is closed, a different bias is applied to the indicator sweep; as a result, the sweep coinciding with the mobile unit's heading is exceptionally bright.

Range markers can be produced in the following manner: A series of differentiating circuits produces a series of pips evenly spaced at intervals corresponding to the ranges desired. When these pips are injected into the video amplifier and appear on the indicator screen, the azimuth sweep forms them into circles of illumination that can be used for calculation of distance from the target.

Ques. 8.64. Draw a diagram of a cathode-ray tube as used in radar, showing the principal electrodes in the tube and the path of the electron beam.

Ans. See the labeled diagram in Fig. 8-10.

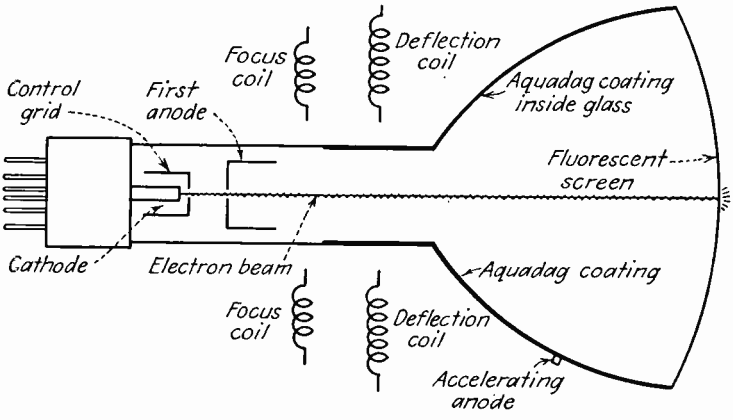

FIG. 8-10. Cross section of magnetic-deflection cathode-ray tube.

Ques. 8.65. What is the purpose of Aquadag coatings on radar cathode-ray tubes?

Ans. Aquadag is the trade name of a colloidal graphite conducting coating painted upon the inside of cathode-ray tubes in order to form an accelerating or second anode. This conducting coating also acts to some extent as an electrostatic shield to prevent external voltage gradients from deflecting the electron beam.

Ques. 8.66. Explain the principle of operation of the cathode-ray PPI tube, and explain the function of each electrode.

Ans. A simplified cross-sectional view of a typical electromagnetic-deflection cathode-ray tube is shown in Fig. 8-10. Within the electron-gun assembly at the left is a heater surrounded by a nickel cathode tube. This nickel tube is coated with oxides of various metals that give off electrons when heated. They are effectively shot out of the electron-gun assembly by the influence of the highly positive first anode through which they pass. A suitable negative voltage on the grid controls this electron flow. A still higher positive voltage on the second or accelerating anode speeds up the electron stream so that it strikes the fluorescent screen, causing light to appear wherever the screen is hit.

A movable permanent magnet or coil through which the current can be varied is used to focus the electron beam to make it hit the fluorescent screen in a small spot. Another electromagnetic-deflection coil causes the beam to move in response to signal currents.

In a set employing PPI, the antenna is rotated uniformly about a vertical axis so that the main axis of the radiated beam sweeps all angles in the horizontal plane. This gives a map-like representation of the area scanned on the screen. The range of the objects reflected back is determined by their calibrated distance from the center of the screen. Direction

is determined by the azimuth angle of the radial line from a predetermined reference point. One means of generating the sweep for the PPI is by means of a rotating yoke system, utilizing the deflection coil.

Ques. 8.67. What is the peak power of a radar pulse if the pulse width is 1.0 microsecond, pulse repetition rate is 900, and the average power is 18 watts? What is the duty cycle?

Ans. The peak power is 20 kilowatts, and the duty cycle is 0.0009.

$$\frac{\text{Average power}}{\text{Peak power}} = \frac{\text{Pulse width}}{\text{Pulse repetition time}} = \text{Duty cycle}$$

$$\text{Peak power} = \frac{(18) \times 10^6}{900} = 20{,}000 \text{ watts}$$

$$\text{Duty cycle} = \frac{\text{Average power}}{\text{Peak power}} = \frac{18}{20{,}000} = 0.0009$$

Ques. 8.68. What precautions should the service and maintenance operator observe when replacing the cathode-ray tube in a radar set?

Ans. (*a*) Be sure the main switch is off and all high-voltage capacitors are discharged.

(*b*) Wear safety goggles and gloves in case the tube should implode.

(*c*) When inserting horizontally into a socket, grip the neck for guidance only; support most of the weight at the screen end.

(*d*) If a tube does break and you get a small cut, wash all dirt away and remove the small particles. Fluorescent materials may prevent a wound from healing.

(*e*) Never place the tube face down unless it is protected by felt or similar soft material.

Ques. 8.69. Draw a simple diagram, showing how a synchro generator located in the radar antenna assembly

is connected to a synchro motor located in the indicator to drive the deflection coils. Show proper designation of all leads, designating where a-c voltages (if needed) are applied.

Ans. See the drawing in Fig. 8-11.

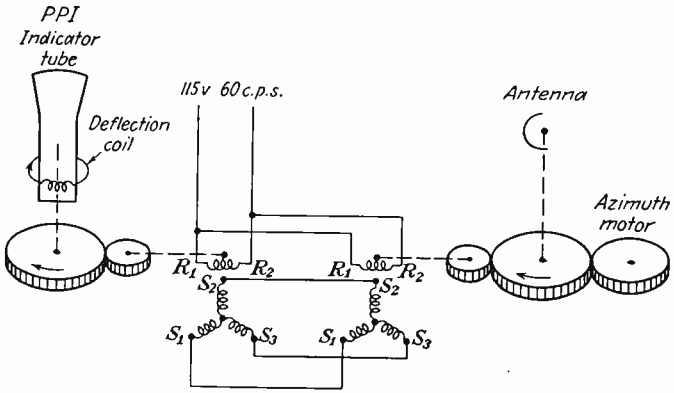

FIG. 8-11. Synchro-motor coupling between radar antenna and PPI scope

This is the end of Element VIII.

APPENDIX

Because of expansion of the standard miscellaneous abbreviations, official changes in the phraseology employed in the Q code, and some change in the use of punctuation and other signs in radiotelegraph procedure, it has been thought advisable to supplement the material appearing on pages 541 to 552 of the Tenth Edition of "Radio Operating Questions and Answers." This revision is based upon U. S. Department of State Publication 3509, being a literal print of the "Telecommunication Convention Final Protocol, and Radio Regulations, Atlantic City, October 2, 1947," and upon "Telegraph Regulation (Paris Revision) Annexed to International Telecommunication Convention, Atlantic City, 1947."

It is recommended that the student purchase the latest copy of "FCC Rules and Regulations, Part 13—Rules Governing Commercial Radio Operators," in order to supplement the material in the Tenth Edition, pages 553 to 562. Since these rules are still in revision, it is not practical to reproduce the current version here.

International Morse Code

With extracts from the list of punctuations and other signs contained in the Telegraph Regulations of the Atlantic City, 1947, Convention

Letters

a ·—	i ··	r ·—·
b —···	j ·———	s ···
c —·—·	k —·—	t —
d —··	l ·—··	u ··—
e ·	m ——	v ···—
f ··—·	n —·	w ·——
g ——·	o ———	x —··—
h ····	p ·——·	y —·——
	q ——·—	z ——··

INTERNATIONAL MORSE CODE (*Continued*)

Figures

1 ·— — — —	6 —····
2 ··— — —	7 — —···
3 ···— —	8 — — —··
4 ····—	9 — — — —·
5 ·····	0 — — — — —

Punctuation and Other Signs

Period	.	·—·—·—
Comma	,	— —··— —
Colon	:	— — —···
Question mark, or request for repetition of a transmission not understood	?	··— —··
Apostrophe	'	·— — — —·
Dash or hyphen	—	—····—
Fraction bar	/	—··—·
Parenthesis (before and after words)	( )	—·— —·—
Inverted commas (quotation marks) (before and after words)	" "	·—··—
Equal sign	=	—···—
Understood		···—·
Error		·····
Cross or end of telegram or end of transmission		·—·—·
Invitation to transmit		—·—
Wait		·—···
End of work		···—·—
Starting signal (beginning every transmission)		—·—·—

The following optional letters and signals may be used exceptionally on connections between countries allowing them:

ä ·—·—	ñ — —·— —
á or å ·— —·—	ö — — —·
ch — — — —	ü ··— —
é ··—··	

Figures and letters are sent without intervening spaces. In transmitting numbers involving a fraction, a hyphen is transmitted before or after the fraction, as the case may be. For example, 44½ is sent as 44-½ (44 —····— ½).

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE

Abbreviation	Question	Answer or Advice
QRA	What is the name of your station?	The name of my station is ____.
QRB	How far approximately are you from my station?	The approximate distance between our stations is ____ nautical miles (*or* kilometres).
QRC	By what private enterprise (*or* State Administration) are the accounts for charges for your station settled?	The accounts for charges of my station are settled by the private enterprise ____ (*or* State Administration).
QRD	Where are you bound and where are you from?	I am bound for ____ from ____.
QRE	What is your estimated time of arrival at ____ (*place*)?	My estimated time of arrival at ____ (*place*) is ____ hours.
QRF	Are you returning to ____ (*place*)?	I am returning to ____ (*place*) *or* Return to ____ (*place*).
QRG	Will you tell me my exact frequency (*or* that of ____)?	Your exact frequency (*or* that of ____) is ____ kc/s (*or* Mc/s).
QRH	Does my frequency vary?	Your frequency varies.
QRI	How is the tone of my transmission?	The tone of your transmission is ____. 1. Good 2. Variable 3. Bad
QRK	What is the readability of my signals (*or* those of ____)?	The readability of your signals (*or* those of ____) is ____. 1. Unreadable 2. Readable now and then 3. Readable, but with difficulty 4. Readable 5. Perfectly readable
QRL	Are you busy?	I am busy (*or* I am busy with ____). Please do not interfere.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Are you troubled by static?	I am troubled by static.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QRQ	Shall I send faster?	Send faster (____ words per minute).
QRR	Are you ready for automatic operation?	I am ready for automatic operation. Send at ____ words per minute.
QRS	Shall I send more slowly?	Send more slowly (____words per minute).
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready.
QRW	Shall I inform ____ that you are calling him on ____ kc/s (*or* Mc/s)?	Please inform ____ that I am calling him on ____ kc/s (*or* Mc/s).
QRX	When will you call me again?	I will call you again at ____ hours [on ____ kc/s (*or* Mc/s)].
QRY	What is my turn? (*Relates to communication*)	Your turn is Number ____ (*or according to any other indication.*) (*Relates to communication.*)
QRZ	Who is calling me?	You are being called by ____ [on ____ kc/s (*or* Mc/s)].
QSA	What is the strength of my signals (*or* those of ____)?	The strength of your signals (*or* those of ____) is ____. 1. Scarcely perceptible 2. Weak 3. Fairly good 4. Good 5. Very good
QSB	Are my signals fading?	Your signals are fading.
QSC	Are you a cargo vessel?	I am a cargo vessel.
QSD	Is my keying defective?	Your keying is defective.
QSG	Shall I send ____ telegrams at a time?	Send ____ telegrams at a time.
QSI		I have been unable to break in on your transmission. *or* Will you inform ____ (*call sign*) that I have been unable to break in on his transmission [on ____ kc/s (or Mc/s)].

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QSJ	What is the charge to be collected per word to ____ including your internal telegraph charge?	The charge to be collected per word to ____ including my internal telegraph charge is ____ francs.
QSK	Can you hear me between your signals?	I can hear you between my signals.
QSL	Can you acknowledge receipt?	I am acknowledging receipt.
QSM	Shall I repeat the last telegram which I sent you, *or* some previous telegram?	Repeat the last telegram which you sent me [*or* telegram(s) number(s) ____].
QSN	Did you hear me [*or* ____ (call sign)] on ____ kc/s (*or* Mc/s)?	I did hear you [*or* ____ (call sign)] on ____ kc/s (*or* Mc/s).
QSO	Can you communicate with ____ direct or by relay?	I can communicate with ____ direct (or by relay through ____).
QSP	Will you relay to ____ free of charge?	I will relay to ____ free of charge.
QSQ	Have you a doctor on board [*or* is ____ (name of person) on board]?	I have a doctor on board [*or* ____ (name of person) is on board].
QSU	Shall I send or reply on this frequency [*or* on ____ kc/s (*or* Mc/s)] (with emissions of class ____)?	Send or reply on this frequency [*or* on ____ kc/s (*or* Mc/s)] (with emissions of class ____).
QSV	Shall I send a series of V's on this frequency [*or* ____ kc/s (*or* Mc/s)]?	Send a series of V's on this frequency [or ____ kc/s (*or* Mc/s)].
QSW	Will you send on this frequency [or on ____ kc/s (*or* Mc/s)] (with emissions of class ____)?	I am going to send on this frequency [*or* on ____ kc/s (*or* Mc/s)] (with emissions of class ____).
QSX	Will you listen to ____ [*call sign(s)*] on ____ kc/s (*or* Mc/s)?	I am listening to ____ [*call sign(s)*] on ____ kc/s (*or* Mc/s).
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency [*or* on ____ kc/s (*or* Mc/s)].
QSZ	Shall I send each word or group more than once?	Send each word or group twice (*or* ____ times).

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QTA	Shall I cancel telegram number ____ as if it had not been sent?	Cancel telegram number ____ as if it had not been sent.
QTB	Do you agree with my counting of words?	I do not agree with your counting of words; I will repeat the first letter or digit of each word or group.
QTC	How many telegrams have you to send?	I have ____ telegrams for you (*or* for ____).
QTE	What is my TRUE bearing from you? *or* What is my TRUE bearing from ____ (*call sign*)? *or* What is the TRUE bearing of ____ (*call sign*) from ____ (*call sign*)?	Your TRUE bearing from me is ____ degrees (at ____ hours) *or* Your TRUE bearing from ____ (*call sign*) was ____ degrees (at ____ hours) *or* The TRUE bearing of ____ (*call sign*) from ____ (*call sign*) was ____ degrees at ____ hours.
QTF	Will you give me the position of my station according to the bearings taken by the direction-finding stations which you control?	The position of your station according to the bearings taken by the direction-finding stations which I control was ____ latitude, ____ longitude, class ____ at ____ hours.
QTG	Will you send two dashes of ten seconds each followed by your call sign (repeated ____ times) [on ____ kc/s (*or* Mc/s)? *or* Will you request ____ to send two dashes of ten seconds followed by his call sign (repeated ____ times) on ____ kc/s (*or* Mc/s)?	I am going to send two dashes of ten seconds each followed by my call sign (repeated ____ times) [on ____ kc/s (*or* Mc/s)] *or* I have requested ____ to send two dashes of ten seconds followed by his call sign (repeated ____ times) on ____ kc/s (*or* Mc/s).

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QTH	What is your position in latitude and longitude (*or according to any other indication*)?	My position is ____ latitude ____ longitude (*or according to any other indication*).
QTI	What is your TRUE track?	My TRUE track is ____ degrees.
QTJ	What is your speed? (*Requests the speed of a ship or aircraft through the water or air respectively.*)	My speed is ____ knots (*or* kilometres per hour). (*Indicates the speed of a ship or aircraft through the water or air respectively.*)
QTK	What is the speed of your aircraft in relation to the surface of the earth?	The speed of my aircraft in relation to the surface of the earth is ____ knots (*or* kilometres per hour).
QTL	What is your TRUE heading (TRUE course with no wind)?	My TRUE heading is ____ degrees.
QTN	At what time did you depart from ____ (*place*)?	I departed from ____ (*place*) at ____ hours.
QTO	Have you left dock (*or* port)? *or* Are you airborne?	I have left dock (*or* port) *or* I am airborne.
QTP	Are you going to enter dock (*or* port)? *or* Are you going to alight (*or* land)?	I am going to enter dock (*or* port) *or* I am going to alight (*or* land).
QTQ	Can you communicate with my station by means of the International Code of Signals?	I am going to communicate with your station by means of the International Code of Signals.
QTR	What is the correct time?	The correct time is ____ hours.
QTS	Will you send your call sign for ____ minute(s) now (*or* at ____ hours) [on ____ kc/s (*or* Mc/s)] so that your frequency may be measured?	I will send my call sign for ____ minute(s) now (*or* at ____ hours) [on ____ kc/s (*or* Mc/s)] so that my frequency may be measured.
QTU	What are the hours during which your station is open?	My station is open from ____ to ____ hours.

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QTV	Shall I stand guard for you on the frequency of ____ kc/s (*or* Mc/s) (from ____ to ____ hours)?	Stand guard for me on the frequency of ____ kc/s (*or* Mc/s) (from ____ to ____ hours).
QTX	Will you keep your station open for further communication with me until further notice (*or* until ____ hours)?	I will keep my station open for further communication with you until further notice (*or* until ____ hours).
QUA	Have you news of ____ (*call sign*)?	Here is news of ____ (*call sign*).
QUB	Can you give me, in the following order, information concerning: visibility, height of clouds, direction and velocity of ground wind at ____ (*place of observation*)?	Here is the information requested.
QUC	What is the number (*or other indication*) of the last message you received from me [or from ____ (*call sign*)]?	The number (*or other indication* of the last message I received from you [or from ____ (*call sign*)] is ____.
QUD	Have you received the urgency signal sent by ____ (*call sign of mobile station*)?	I have received the urgency signal sent by ____ (*call sign of mobile station*) at ____ hours.
QUF	Have you received the distress signal sent by ____ (*call sign of mobile station*)?	I have received the distress signal sent by ____ (*call sign of mobile station*) at ____ hours.
QUG	Will you be forced to alight (*or* land)?	I am forced to alight (*or* land) immediately. *or* I shall be forced to alight (*or* land) at ____ (*position or place*).
QUH	Will you give me the present barometric pressure at sea level?	The present barometric pressure at sea level is ____ (*units*).
QUI	Are your navigation lights working?	My navigation lights are working.

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QUJ	Will you indicate the TRUE course for me to steer toward you (*or* ____) with no wind?	The TRUE course for you to steer toward me (*or* ____) with no wind is ____ degrees at ____ hours.
QUK	Can you tell me the condition of the sea observed at ____ (*place or coordinates*)?	The sea at ____ (*place or coordinates*) is ____.
QUL	Can you tell me the swell observed at ____ (*place or coordinates*)?	The swell at ____ (*place or coordinates*) is ____.
QUM	Is the distress traffic ended?	The distress traffic is ended.
QUN	Will vessels in my immediate vicinity [(*or* in the vicinity of ____ latitude ____ longitude) (or of ____)] please indicate their position, TRUE course, and speed?	My position, TRUE course, and speed are ____.
QUO	Shall I search for ____ 1. Aircraft 2. Ship 3. Survival craft in the vicinity of ____ latitude ____ longitude (*or according to any other indication*)?	Please search for ____ 1. Aircraft 2. Ship 3. Survival craft in the vicinity of ____ latitude ____ longitude (*or according to any other indication*).
QUP	Will you indicate your position by ____? 1. Searchlight 2. Black smoke trail 3. Pyrotechnic lights	My position is indicated by ____. 1. Searchlight 2. Black smoke trail 3. Pyrotechnic lights
QUQ	Shall I train my searchlight nearly vertical on a cloud, occulting if possible, and if your aircraft is seen, deflect the beam up wind and on the water (*or* land) to facilitate your landing?	Please train your searchlight on a cloud, occulting if possible, and, if my aircraft is seen or heard, deflect the beam up wind and on the water (*or* land) to facilitate my landing.

ABBREVIATIONS AVAILABLE FOR ALL SERVICES—Q CODE (*Continued*)

Abbreviation	Question	Answer or Advice
QUR	Have survivors ____? 1. Received survival equipment 2. Been picked up by rescue vessel 3. Been reached by ground rescue party	Survivors ____. 1. Are in possession of survival equipment dropped by ____ 2. Have been picked up by rescue vessel 3. Have been reached by ground rescue party
QUS	Have you sighted survivors or wreckage? If so, in what position?	Have sighted ____ 1. Survivors in water 2. Survivors on rafts 3. Wreckage in position ____ latitude ____ longitude (*or according to any other indication*).
QUT	Is position of incident marked?	Position of incident is marked (by ____).
QUU	Shall I home ship or aircraft to my position?	Home ship or aircraft 1. ____ (*call sign*) to your position by transmitting your call sign and long dashes on ____ kc/s (*or* Mc/s) 2. ____ (*call sign*) by transmitting on ____ kc/s (*or* Mc/s) courses to steer to reach you
QUV	What is my MAGNETIC bearing from you (*or* from ____)? (*This signal, in general, will not be used in the Maritime Mobile Service.*)	Your MAGNETIC bearing from me (*or* from ____) was ____ degrees at ____ hours. (*This signal, in general, will not be used in the Maritime Mobile Service.*)
QUX	Will you indicate the MAGNETIC course for me to steer toward you (*or* ____) with no wind? (*This signal, in general, will not be used in the Maritime Mobile Service.*)	The MAGNETIC course for you to steer to reach me (*or* ____) with no wind was ____ degrees at ____ hours. (*This signal, in general, will not be used in the Maritime Mobile Service.*)

MISCELLANEOUS ABBREVIATIONS AND SIGNALS

Abbreviation or Signal	Definition
AA	All after ____ (*used after a question mark to request a repetition*).
AB	All before ____ (*used after a question mark to request a repetition*).
ABV	Repeat (*or* I repeat) the figures in abbreviated form.
ADS	Address (*used after a question mark to request a repetition*).
$\overline{AR}$	End of transmission (· — · — · *to be sent as one signal*).
$\overline{AS}$	Waiting period (· — · · · *to be sent as one signal*).
BK	Signal used to interrupt a transmission in progress.
BN	All between ____ and ____ (*used after a question mark to request a repetition*).
BQ	A reply to an RQ.
C	Yes.
CFM	Confirm (*or* I confirm).
CL	I am closing my station.
COL	Collate (*or* I collate).
CP	General call to two or more specified stations.
CQ	General call to all stations.
CS	Call sign (*used to request a call sign*).
DB	I cannot give you a bearing; you are not in the calibrated sector of this station.
DC	The minimum of your signal is suitable for the bearing.
DF	Your bearing at ____ (*time*) was ____ degrees, in the doubtful sector of this station, with a possible error of ____ degrees.
DG	Please advise me if you note an error in the bearing given.
DI	Bearing doubtful in consequence of the bad quality of your signal.
DJ	Bearing doubtful because of interference.
DO	Bearing doubtful. Ask for another bearing later [*or at* ____ (*time*)].
DP	Possible error of bearing may amount to ____ degrees.
DS	Adjust your transmitter; the minimum of your signal is too broad.
DT	I cannot furnish you with a bearing; the minimum of your signal is too broad.
DY	This station is not able to determine the sense of the bearing. What is your approximate direction relative to this station?

MISCELLANEOUS ABBREVIATIONS AND SIGNALS (*Continued*)

Abbreviation or Signal	Definition
DZ	Your bearing is reciprocal. (*To be used only by the control station of a group of direction-finding stations when it is addressing stations of the same group.*)
DE	Used to separate the call sign of the station called from the call sign of the calling station.
ER	Here ——.
ETA	Estimated time of arrival.
ITP	The punctuation counts.
JM	Make a series of dashes if I may transmit. Make a series of dots to stop my transmission (*not to be used on 500 kc/s except in cases of distress*).
K	Invitation to transmit.
MN	Minute (*or* Minutes).
MSG	Prefix indicating a message to or from the master of a ship concerning its operation or navigation.
N	No.
NIL	I have nothing to send to you.
NW	Now.
OK	We agree (*or* It is correct).
P	Prefix indicating a private radiotelegram.
PBL	Preamble (*used after a question mark to request a repetition*).
PTR	Used by a coast station to request the position and next port of call of a mobile station.
R	Received.
REF	Reference to —— (*or* Refer to ——).
RPT	Repeat (*or* I repeat) (*or* Repeat ——).
RQ	Indication of a request.
SIG	Signature (*used after a question mark to request a repetition*).
$\overline{\text{SOS}}$	Distress Signal (· · · — — — · · · *to be sent as one signal*).
SS	Indicator preceding the name of a ship station.
SVC	Prefix indicating a service telegram.
SYS	Refer to your service telegram.
TFC	Traffic.
TR	Used as a prefix to indicate reply to PTR.
TTT	This group when sent three times constitutes the safety signal.
TU	Thank you.
TXT	Text (*used after a question mark to request a repetition*).

MISCELLANEOUS ABBREVIATIONS AND SIGNALS (*Continued*)

Abbreviation or Signal	Definition
$\overline{\text{VA}}$	End of work (· · · — · — *to be sent as one signal*).
W	Word(s) *or* [Group(s)].
WA	Word after ____ (*used after a question mark to request a repetition*).
WB	Word before ____ (*used after a question mark to request a repetition*).
XXX	This group when sent three times constitutes the urgency signal.

RADIOTELEPHONE WORD LIST

International procedure in the Mobile Radiotelephone Service requires that when it is necessary to spell out call signs, service abbreviations, and words, the following table is used. However, stations of the same country may use, when communicating between themselves, any other list of words recognized by their administration.

A	Amsterdam	N	New York
B	Baltimore	O	Oslo
C	Casablanca	P	Paris
D	Danemark	Q	Quebec
E	Edison	R	Roma
F	Florida	S	Santiago
G	Gallipoli	T	Tripoli
H	Havana	U	Upsala
I	Italia	V	Valencia
J	Jerusalem	W	Washington
K	Kilogramme	X	Xantippe
L	Liverpool	Y	Yokohama
M	Madagascar	Z	Zurich

Figures and punctuation to be transmitted by radiotelephone. Each transmission of figures is preceded and followed by the words "as a number" spoken twice.

1	6	Comma
2	7	Fraction bar
3	8	Break signal
4	9	Full stop (period)
5	0	

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