

FEDERAL COMMUNICATIONS COMMISSION

STUDY GUIDE

AND

REFERENCE MATERIAL

FOR

**COMMERCIAL RADIO OPERATOR
EXAMINATIONS**

REVISED MAY 15, 1955

N O T I C E

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COMMISSION**

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and Reference Material**

**FOR
COMMERCIAL RADIO OPERATOR
EXAMINATIONS**



REVISED MAY 15, 1955

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GENERAL INFORMATION

The questions printed herein are representative of the scope of the questions contained in the various elements of the commercial radio operator examination.

Element 1 of the examination consists of 20 questions and 5 percent credit will be allowed for each question answered correctly. Elements 2, 4, 5 and 8 of the examination contain 50 questions each. Two percent credit will be allowed for each correct solution. Elements 3, 6 and 7 consist of 100 questions each and 1 percent credit will be allowed for each correct solution to these questions.

The 50 questions of Element 2 are subdivided so that a candidate who wishes to do so may, for 10 of the questions, select the subject to be dealt with from one of three fields, namely ship, coastal, or aircraft radiotelephony.

None of the questions in the commercial radio operator license examination requires an essay or explanatory type of answer. In answering the type of question in which several choices are given, the applicant *must* choose *one* (and only *one*) of the answers shown. The numeral preceding the answer which is selected as correct must be inserted in the space which is provided at the right-hand side of the question. Two examples of this type of question are given below:

965.07 Seattle is located in:

1. Nebraska.
2. New York.
3. Oregon.
4. Washington.
5. Texas.

4

965.08 Seattle is *not* located in:

1. The Western Hemisphere.
2. The United States.
3. North America.
4. Washington.
5. Canada.

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(II)

The other types of questions which may be found in the examination are to be answered by the solution of a simple mathematical problem, the drawing of a diagram, the completion of an incomplete diagram, or the correction of an incorrect diagram, as required. In the correction of an incorrect diagram, any connection or symbol which is to be eliminated shall be crossed out by means of a wavy line or by short diagonal cross lines.

The applicant must sign his name in the space which is provided on each sheet of the examination. Before beginning the examination, the applicant should read carefully the instructions printed on the element envelope.

All paper for writing examinations will be furnished. Books or papers may not be taken into the examining room.

Additional information pertaining to the commercial radio operator examinations may be found in part 13 of the Commission's rules, published as a separate document and normally obtainable from the Superintendent of Documents, U. S. Printing Office, Washington 25, D. C.

Regulatory information commonly used in preparing for commercial radio operator examinations is to be found in appendix I, which contains extracts from the following:

Communications Act of 1934, as amended.

International Radio Regulations, Atlantic City, 1947.

International Telecommunication Convention, Atlantic City, 1947.

Telegraph Regulations (Paris Revision, 1949).

Civil Air Regulations.

International Civil Aviation Organization Publications.

Agreement Between the United States of America and Canada for Promotion of Safety on the Great Lakes by Means of Radio.

Rules and Regulations of the Federal Communications Commission.

Appendix II contains tables of abbreviations used in radio communications and the International Telegraph Code with punctuation symbols.

Appendix III contains material for use in preparing for Elements 2 and 5.

KEY TO ABBREVIATIONS

Sec. -----Refers to a section of the Communications Act of 1934.

Art. -----Refers to an article of the International Radio Regulations (Atlantic City 1947).

R. & R. -----Refers to a provision of the Rules and Regulations of the Federal Communications Commission.

(III)

GLR -----Refers to regulations annexed to Agreement between the United States and Canada for Promotion of Safety on the Great Lakes by Means of Radio.

CAR -----Refers to Civil Air Regulations.

ICAO -----Refers to International Civil Aviation Organization Publications.

S. G. E. P. ---Standards of Good Engineering Practice.

T. R. -----Refers to the International Telegraph Regulations (Paris Revision, 1949).

Caveat: The revision of the Study Guide in which this caveat appears is based upon the Communications Act of 1934, as amended to May 15, 1955, and Commission Rules and Regulations and all treaty and convention provisions in force on that date.

ELEMENT I

QUESTIONS ON BASIC LAW

1. Where and how is an operator license or permit obtained? (R. & R. Part 13.11.)
2. Must a person designated to operate a radiotelephone station post his operator license or permit and, if so, where? (R. & R. 13.6.)
3. How must a person who receives a Notice of Violation from the FCC reply? (R. & R. 1.401.)
4. How soon does the FCC require a response to a Notice of Violation? (R. & R. 1.401.)
5. If a person cannot respond to a Notice of Violation in the time prescribed by the FCC is it necessary to explain the reason for any delay? (R. & R. 1.401.)
6. Should the answer to each Notice of Violation be complete and should reference be made to remedial action, if any specific remedial steps are necessary? (R. & R. 1.401.)
7. To whom is a response to a Notice of Violation addressed? (R. & R. 1.401.)
8. May the FCC suspend an operator license or permit for due cause? (Sec. 303 (m).)
9. Can suspension of an operator license or permit take effect prior to notification? (Sec. 303 (m).)
10. How soon after receiving notification of suspension of an operator license or permit does a suspension order become effective? (Sec. 303 (m).)
11. May a person who has received an order of suspension of operator license or permit request a hearing? (Sec. 303 (m).)
12. Is it prohibited by law to transmit unnecessary and superfluous signals? (Art. 13-1.) Is profane and obscene language prohibited? (Criminal Code 18, U. S. C. 1464.)
13. Does the Government have authority to impose fines for failure to comply with the rules and regulations governing the use of radio on compulsorily equipped ships? (Sec. 502.)
14. What must a person do whose operator license or permit has been lost, mutilated or destroyed? (R. & R. 13.71.)
15. In applying for a duplicate operator license or permit, what documentary evidence must be submitted along with an application? (R. & R. 13.71.)

16. Is it permissible to operate pending receipt of a duplicate operator license or permit after application has been made for reissue? (R. & R. 13.72.)

17. What provision is made for operation without an actual operator license or permit pending receipt of a duplicate? (R. & R. 13.71.)

18. Is the holder of a radiotelephone third-class operator permit authorized to make technical adjustments to the transmitter he operates? (R. & R. 13.61.)

19. Should a radio station that is required to be operated by a licensed radio operator be a licensed radio station? (Sec. 318.)

20. Are communications bearing upon distress situations subject to the secrecy provisions of law? (Sec. 605.)

21. What penalty is provided by law for willful and knowing violation of regulations imposed by the Federal Communications Commission and of radio treaties? (Sec. 502.)

22. What penalty is provided by law for willful and knowing violation of the radio laws? (Sec. 501.)

23. Are radio stations subject to inspection by the Federal Communications Commission? (Sec. 303 (n).)

24. In radiotelephony, what are the distress, urgency, and safety signals? (Art. 37.)

25. In radio communication, what does the transmission of the "distress", "urgency" and "safety" signals signify, respectively? (Art. 37.)

26. What information must be contained in a distress message? (Art. 37-14.)

27. Under what conditions may a mobile radio station send a distress message for another mobile station in distress? (Art. 37-18.)

28. In the case of a mobile radio station in distress what station is responsible for the control of distress message traffic? (Art. 37-22.)

29. What does the distress call consist of when sent by radiotelephony? (Art. 37-12.)

30. How many necessary corrections to the log record be made? (R. & R. 7.192, 8.184, 9.156.)

31. How soon before expiration of an operator license or permit should application be made for renewal? (R. & R. 13.11.)

32. Is it prohibited by law to transmit false or fraudulent signals of distress? (Sec. 325.)

33. What is the priority of the urgency signal? (R. & R. 8.177.)

ELEMENT II

BASIC OPERATING PRACTICE

GENERAL

1. 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?
2. Why is it important to avoid unnecessary calls by radio-communication?
3. Is it required that a person listen on a channel before transmitting?
4. Why is it advisable to listen on a channel before transmitting?
5. Why should a trial of the radiotelephone installation be made every day?
6. How can the radiotelephone installation be tested?
7. Before placing the transmitting apparatus of a radio station in operation for a test what precautions must be taken?
8. What is the correct form for transmitting a distress call by radiotelephony? (Art. 37-12.)
9. Why is it a good policy to be brief in radiotelephone conversations?
10. What is the significance of the word "clear" when transmitted at the end of a radiotelephone communication?
11. Are there any ill effects to radio communication if the operator shouts into the microphone?
12. Is it a good practice to shield the microphone with the hands when speaking into a microphone in a noisy location?
13. In radiotelephone communications why should the operator use well-known words and phrases and simple language as much as possible?
14. What is the operator's responsibility upon hearing the word "security" repeated three times? (Art. 37-43.)
15. What must the operator do if he is told that he is interfering with a distress call? (Art. 37-13.)
16. What is the significance of the word "over" when transmitted at the end of a radiotelephone communication?

17. What is indicated by the word "out" when transmitted at the end of a radiotelephone communication?

18. Can a radio operator always consider his radiotelephone conversation completely confidential and not heard by other persons?

19. In calling a station by radiotelephony how many times does the calling station generally repeat the call sign or name of the calling station in each calling transmission?

20. Would you listen on a shared channel before transmitting? Why?

21. Under normal conditions would a transmission on a calling frequency be proper if the receiver for that frequency was inoperative?

22. What is the difference between calling and working frequencies?

23. Why is it important to clearly give the station call sign?

24. Should a test of the radiotelephone equipment be made each day?

25. Should messages bearing upon safety, including weather information, be given priority over business messages? (R. & R. 8.177.)

26. If a station is required by law to listen on a calling and distress frequency, when may the listening be discontinued?

27. Why should a radiotelephone transmitter be kept off-the-air when voice transmissions are not in progress?

28. Why is it beneficial for the transmitter of a radio station to be in constant readiness for making a call?

29. If a station is required to maintain effective listening on a distress frequency why is it desirable for the equipment to return automatically to reception on the distress frequency immediately after completing use of the equipment on another frequency?

30. Why is rapid frequency change of the transmitter and receiver desirable?

31. What would you do as radiotelephone operator if you were told that your voice was distorting?

32. What is the correct form for transmitting a distress call by radiotelephone?

33. Under what conditions may a radiotelephone station employ a calling frequency as contrasted to a working frequency? (Art. 34-9.)

34. In calling a station by radiotelephony should the calling station repeat the call sign or name of the called station in each calling transmission more than three times?

35. Why should stations using a shared frequency leave an interval between calls?

36. Under what conditions may it be desirable to repeat important words by radiotelephony?

37. What is the operator's responsibility upon hearing a distress call in the mobile services?

38. Is it good practice to listen on the working frequency to be later used before making an initial call on the calling frequency?

39. Why is it important to avoid unnecessary calls by radio-communication?

40. State why station identification should be clearly made by a radio transmitting station.

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

42. What is the order of priority for radiotelephone communications?

SPECIAL

1. In making a ship-to-ship contact, except in an emergency involving safety, how long may a ship radiotelephone station continue calling in each instance? (R. & R. 8.366.)

2. Except in an emergency involving safety, if a ship radiotelephone station does not receive a reply after calling, how long must it wait before calling again? (R. & R. 8.366.)

3. What types of communications may be transmitted by ship stations on the ship-to-ship frequencies between 2000 and 3000 kc? (R. & R. 8.366.)

4. In regions of heavy traffic how long may the ship-to-ship radiotelephone frequencies between 2000 and 3000 kc. be used for any one exchange of communications? (Other than distress and emergency communications.) (R. & R. 8.366.)

5. How is a ship radiotelephone station required to be identified in connection with its operation? (R. & R. 8.364.)

6. Do public coast stations normally charge for forwarding messages reporting dangers to navigation? (R. & R. 7.179.)

7. How does the licensed operator of ship radiotelephone station exhibit his authority to operate the station? (R. & R. 13.6, 8.156.)

8. If a radiotelephone installation provided on board ship for safety purposes, in accordance with treaty, becomes defective what action must the licensed operator take? (GLR-2.)

9. Who signs the radio log of a ship radiotelephone station certifying to entries made therein? (R. & R. 8.368.)

10. What are the requirements with respect to listening watch in a ship radiotelephone station during its hours of service in the 2000-3000 kc. band? (R. & R. 8.223.)

11. Who may operate the radiotelephone set aboard a vessel? (R. & R. 8.151, 13.61.)

12. Is it necessary for all vessels having knowledge of distress traffic to follow the traffic even if they do not take part in it? (Art. 37-24.)

13. What is the proper form to use in acknowledging a distress message? (Art. 37-27, 34-6.)

14. What information is required to be sent following acknowledgment of a distress message? (Art. 37-28.)

15. Is it necessary that the authority of the master or person responsible for the vessel be obtained prior to sending information required following acknowledgment of a distress call? (Art. 37-28.)

16. Is it desirable that care be taken to ensure an acknowledgment to a distress message will not interfere with other acknowledgments from vessels better able to assist? (Art. 37-19.)

17. Is a vessel which hears a distress message but is not in a position to assist required to take all possible steps to attract the attention of stations which might be in a position to assist? (Art. 37-29.)

18. Is it necessary to make a trial of the ship radiotelephone installation every day? (GLR-2.)

19. How can the radiotelephone installation be tested each day? (GLR-2.)

20. If the radiotelephone ship installation is normally used during the day is it necessary to make any special test communication for the purpose of trying the radio? (GLR-2.)

21. How would you contact another vessel prior to actually communicating with it for routine communication purposes?

22. What radio channel is used for communicating with the United States Coast Guard?

23. What procedure would you use in contacting the United States Coast Guard?

24. Is it permissible to use 2182 kc. for establishing contact prior to communicating on an appropriate public correspondence channel?

25. What procedure would you use in contacting a coast station on 2,182 kc. and what would you say over the air?

26. Is it permissible to communicate with coast stations or

any other station on 2182 kc. except for safety purposes? (R. & R. 8.352, 8.353, 8.366.)

27. Give a typical procedure you might use to call a vessel when its identity is not known.

28. What daily attention should be given to the antenna tower lights at a radio station? (R. & R. 17.37.)

29. What should be done in case of failure of the antenna tower lights at a radio station? (R. & R. 17.37.)

30. How should station identification be made at a coast station using radiotelephony? (R. & R. 7.310.)

31. If a licensed radio operator at the controls of a radio station observes obscene language being spoken by another person and transmitted through the facilities of the station, what action should he take?

32. If a coast station hears a distress call from a mobile station what action, if any, should the operator on duty take? (Art. 37-13.)

33. Under what circumstances should a public coast station employing radiotelephony use a calling frequency in establishing a communication circuit with a ship or aircraft? (R. & R. 7.305.)

34. What type of radiotelephone communications must be handled free by a public coast station which normally charges for its service? (R. & R. 7.179.)

35. When calling a mobile radiotelephone station but receiving no immediate reply, how often may a coast station using radiotelephony repeat the call? (R. & R. 7.312.)

36. What is meant by "safety communication" in the maritime mobile service? (R. & R. 7.7.)

37. What are the requirements with respect to log-keeping at a coast station using radiotelephony? (R. & R. 7.314.)

38. Under what conditions may a coast station intervene in a distress situation? (Art 37-25, 29.)

39. To what extent may a coast station using radiotelephony communicate with stations other than ship stations? (R. & R. 7.302.)

40. What is indicated by the use of the word "break" in a radiotelephone conversation?

41. What is indicated by the use of the word "Roger" as a reply to a radiotelephone communication?

42. What is indicated by the expression "words twice" when transmitted by radiotelephone?

43. What is indicated by the use of the words "read back" in a radiotelephone communication?

44. For what purpose is the frequency 121.5 Mc. authorized to be used by an aircraft radio station? (R. & R. 9.312.)

45. What is the national calling and working frequency for air carrier aircraft? (R. & R. 9.321.)

46. In lieu of using a call sign, how may a private aircraft telephone station be identified in the course of operation? (R. & R. 9.191.)

47. What types of communications or messages is an aircraft radiotelephone station authorized to transmit? (R. & R. 9.311.)

48. When must an aircraft radio station and maintenance records be made available for inspection? (R. & R. 9.192.)

49. How is the communication range of an aircraft radio station on a very high frequency dependent upon the altitude of the aircraft?

50. Why should an aircraft station avoid making unnecessary on-the-air tests?

51. What is the normal calling procedure of a private aircraft for contacting a control tower?

52. How should an air carrier aircraft radiotelephone station normally be identified in operation in lieu of using the call sign? (R. & R. 9.191.)

53. What is meant by a phonetic alphabet in radiotelephone communication?

54. What radio channel or channels are used by ships for communicating by radiotelephone with the U. S. Coast Guard? (R. & R. 8.352.)

55. Is it general practice for a ship to use 2182 kc. for establishing contact prior to communicating with a coast station on an appropriate public correspondence channel? (R. & R. 8.366.)

56. How often should station identification be made at a base or land radiotelephone station? (R. & R. 10.152.)

57. What entries must be made in the logs or records of radio stations required to have antenna tower lights? (R. & R. 17.38.)

58. What attention should be given periodically to the antenna tower lights and associated apparatus at a radio station? (R. & R. 17.37.)

59. What precautions should be taken when a radio station is left unattended in a public place?

ELEMENT III
BASIC RADIOTELEPHONE

1. By what other expression may a "difference of potential" be described?
2. By what other expression may an "electric current flow" be described?
3. Which factors determine the amplitude of the emf induced in a conductor which is cutting magnetic lines of force?
4. Name four methods by which an electrical potential may be generated.
5. If the diameter of a conductor of given length is doubled, how will the resistance be affected?
6. If the value of a resistance, to which a constant emf is applied, is halved, what will be the resultant proportional power dissipation?
7. What method of connection should be used to obtain the maximum no-load output voltage from a group of similar cells in a storage battery?
8. What is the sum of all voltage drops around a simple d. c. series circuit, including the source?
9. What method of connection should be used to obtain the maximum short-circuit current from a group of similar cells in a storage battery?
10. If the value of a resistance, across which a constant emf is applied, is doubled, what will be the resultant proportional power dissipation?
11. Name four materials which are good insulators at radio frequencies. Name four materials which are not good insulators at radio frequencies, but which are satisfactory for use at commercial power frequencies.
12. Explain the factors which influence the resistance of a conductor.
13. What effect does the cross-section area of a conductor have upon its resistance per unit length?
14. Name four conducting materials in the order of their conductivity.
15. What effect does a change in the dielectric constant of a condenser dielectric material have upon the capacitance of a condenser?

16. Explain the effect of increasing the number of plates upon the capacitance of a condenser.

17. If the specific inductive capacity of a condenser dielectric material between the condenser plates were changed from 1 to 2, what would be the resultant change in capacitance?

18. State the formula for determining the quantity or charge of a condenser. The energy stored in a condenser.

19. Neglecting temperature coefficient of resistance and using the same gauge of wire and the same applied voltage in each case, what would be the effect, upon the field strength of a single layer solenoid, of a small increase in the number of turns?

20. How may a magnetic compass be affected when placed within a coil carrying an electric current?

21. Which factors influence the direction of magnetic lines of force generated by an electromagnet?

22. Define the term "permeability."

23. What unit is used in expressing the alternating current impedance of a circuit?

24. What is the unit of resistance?

25. Explain the meaning of the prefix "micromicro".

26. What is the unit of capacitance?

27. What single instrument may be used to measure electrical resistance? Electrical power? Electrical current? Electromotive force?

28. Define the term "residual magnetism."

29. What is the unit of electrical power?

30. What is the unit of conductance?

31. What is the unit of inductance?

32. What is the meaning of the prefix "kilo"?

33. What is the meaning of the prefix "micro"?

34. What is the meaning of "power factor"?

35. What is the meaning of the prefix "meg."?

36. Define the term "conductance."

37. What instrument is used to measure current flow?

38. Define the term "decibel."

39. What is meant by "ampere turns"?

40. Define the term "inductance."

41. Define the term "coulomb."

42. State the three ordinary mathematical forms of Ohm's Law.

43. If a vacuum tube having a filament rated at one-quarter ampere and 5 volts is to be operated from a 6-volt battery, what is the value of the necessary series resistor?

44. If the voltage applied to a circuit is doubled and the re-

sistance of the circuit is increased to three times its former value, what will be the final current value?

45. What should be the minimum power dissipation rating of a resistor of 20,000 ohms to be connected across a potential of 500 volts?

46. If resistors of 5, 3, and 15 ohms are connected in parallel, what is the total resistance?

47. What is the maximum rated current carrying capacity of a resistor marked "5,000 ohms, 200 watts"?

48. A milliammeter with a full-scale deflection of 1 milliampere and having a resistance of 25 ohms, was used to measure an unknown current by shunting the meter with a four (4) ohm resistor. It then read 0.4 milliamperes. What was the unknown current value?

49. What will be the heat dissipation, in watts, of a resistor of 20 ohms having a current of one-quarter ($\frac{1}{4}$) ampere passing through it?

50. If two 10-watt, 500-ohm resistors are connected in parallel, what are the power dissipation capabilities of the combination?

51. What is the formula used to determine the total capacitance of three or more capacitors connected in series?

52. If condensers of 1, 3, and 5 microfarads are connected in parallel, what is the total capacitance?

53. If condensers of 5, 3, and 7 microfarads are connected in series, what is the total capacitance?

54. The charge in a condenser is stored in what portion of the condenser?

55. Having available a number of condensers rated at 400 volts and 2 microfarads each, how many of these condensers would be necessary to obtain a combination rated at 1,600 volts and 1.5 microfarads?

56. The voltage drop across an individual condenser of a group of condensers connected in series across a source of potential is proportional to what factors?

57. What factors determine the charge stored in a condenser?

58. Given two identical mica condensers of 0.1 mfd. capacitance each. One of these is charged to a potential of 125 volts and disconnected from the charging circuit. The charged condenser is then connected in parallel with the uncharged condenser. What voltage will appear across the two condensers connected in parallel?

59. What is the effect of adding an iron core to an air core inductance?

60. What will be the effect of a shorted turn in an inductance?

61. What is the relationship between the number of turns and the inductance of a coil?

62. Define the term "reluctance".

63. State the formula for determining the resonant frequency of a circuit when the inductance and capacitance are known.

64. What is the formula for determining the power in a d. c. circuit when the voltage and resistance are known?

65. What is the formula for determining the power in a d. c. circuit when the current and resistance are known?

66. What is the formula for determining the power in a d. c. circuit when the current and voltage are known?

67. What is the formula for determining the wavelength when the frequency, in kilocycles, is known?

68. State Ohm's Law for a. c. circuits.

69. Draw a simple schematic diagram showing a tuned-plate tuned-grid oscillator with series-fed plate. Indicate polarity of supply voltages.

70. Draw a simple schematic diagram showing a Hartley triode oscillator with shunt-fed plate. Indicate power supply polarity.

71. Draw a simple schematic diagram showing a tuned-grid Armstrong type triode oscillator, with shunt-fed plate. Indicate power supply polarity.

72. Draw a simple schematic diagram showing a tuned-plate tuned-grid triode oscillator with shunt-fed plate. Indicate polarity of supply voltages.

73. Draw a simple schematic diagram of a crystal controlled vacuum tube oscillator. Indicate power supply polarity.

74. Draw a simple schematic diagram showing a Colpitts type triode oscillator, with shunt-fed plate. Indicate power supply polarity.

75. Draw a simple schematic diagram showing a tuned-grid Armstrong type triode oscillator, with series-fed plate. Indicate power supply polarity.

76. Draw a simple schematic diagram of an electron coupled oscillator, indicating power supply polarities where necessary.

77. Draw a simple schematic diagram of a pentode type tube used as a crystal controlled oscillator, indicating power supply polarities.

78. Draw a simple schematic circuit showing a method of coupling a high impedance loudspeaker to an audio-frequency amplifier tube without flow of tube plate current through the speaker windings, and without the use of a transformer.

79. Draw a simple schematic diagram of a triode vacuum tube audio frequency amplifier inductively coupled to a loudspeaker.

80. Draw a simple schematic circuit showing a method of resistance coupling between two triode vacuum tubes in an audio frequency amplifier.

81. Draw a simple schematic diagram showing a method of transformer coupling between two triode vacuum tubes in an audio frequency amplifier.

82. Draw a simple schematic diagram of a method of impedance coupling between two vacuum tubes in an audio frequency amplifier.

83. Draw a simple schematic diagram showing a method of coupling the radio frequency output of the final power amplifier stage of a transmitter to an antenna.

84. Draw a simple schematic diagram showing a method of coupling between two tetrode vacuum tubes in a tuned radio frequency amplifier.

85. Draw a simple schematic diagram showing a method of coupling between two triode vacuum tubes in a tuned radio frequency amplifier, and a method of neutralizing to prevent oscillation.

86. Draw a simple schematic diagram of a diode vacuum tube connected for diode detection, and showing a method of coupling to an audio amplifier.

87. Draw a simple schematic diagram of a triode vacuum tube connected for plate or "power" detection.

88. Draw a simple schematic diagram of a triode vacuum tube connected for grid-leak condenser detection.

89. Draw a simple schematic circuit of a regenerative detector.

90. Draw a simple schematic circuit of a radio frequency doubler stage, indicating any pertinent points which will distinguish this circuit as that of a frequency doubler.

91. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be two-thirds the resistance of one unit.

92. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be one and one-half times the resistance of one unit.

93. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be one-third of one unit.

94. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be three times the resistance of one unit.

95. Draw a diagram of a single-button carbon microphone circuit, including the microphone transformer and source of power.

96. What is meant by a "soft" vacuum tube?

97. Describe the electrical characteristics of the pentode, tetrode, and triode.

98. What are the visible indications of a "soft" tube?

99. Describe the physical structure of a triode vacuum tube.

100. Describe the physical structure of a tetrode vacuum tube.

101. Does a pentode vacuum tube usually require neutralization when used as a radio-frequency amplifier?

102. What is the meaning of "secondary emission"?

103. What is the meaning of "electron emission"?

104. Describe the characteristics of a vacuum tube operating as a class C amplifier.

105. During what approximate portion of the excitation voltage cycle does plate current flow when a tube is used as a class C amplifier?

106. Describe the characteristics of a vacuum tube operating as a class A amplifier.

107. Describe the characteristics of a vacuum tube operating as a class B amplifier.

108. During what portion of the excitation voltage cycle does plate current flow when a tube is used as a class B amplifier?

109. Does a properly operated class A audio amplifier produce serious modification of the input wave form?

110. What is the meaning of the term "maximum plate dissipation"?

111. What is meant by a "blocked grid"?

112. What is meant by the "load" on a vacuum tube?

113. What circuit and vacuum tube factors influence the voltage gain of a triode audio frequency amplifier stage?

114. What is the purpose of a bias voltage on the grid of an audio frequency amplifier tube?

115. What is the primary purpose of a screen grid in a vacuum tube?

116. What is the primary purpose of a suppressor grid in a multi-element vacuum tube?

117. What is the meaning of the term "plate saturation"?

118. What is the most desirable factor in the choice of a vacuum tube to be used as a voltage amplifier?

119. What is the principal advantage of a tetrode over a triode as a radio-frequency amplifier?

120. What is the principal advantage of the tetrode as compared to the triode, when used in a radio receiver?

121. What is the principal advantage in the use of a diode detector instead of a grid-leak type triode detector?

122. Draw a grid voltage-plate current characteristic curve of a vacuum tube and indicate the operating points for class A, class B, and class C amplifier operation.

123. What operating conditions determine that a tube is being used as a "power detector"?

124. Why is it desirable to use an alternating current filament supply for vacuum tubes?

125. Why is it advisable to reverse periodically the polarity of the filament potential of high power vacuum tubes when a d. c. filament supply is used?

126. Why is it important to maintain transmitting tube filaments at recommended voltages?

127. When an alternating current filament supply is used, why is a filament center-tap usually provided for the vacuum tube plate and grid return circuits?

128. Explain the operation of a "grid leak" type detector.

129. List and explain the characteristics of a "square law" type of vacuum tube detector.

130. Explain the operation of a diode type of detector.

131. Explain the operation of a "power" or "plate rectification" type of vacuum tube detector.

132. Is a "grid leak" type of detector more or less sensitive than a "power" detector (plate rectification)? Why?

133. Describe what is meant by a "class A amplifier."

134. What are the characteristics of a class A audio amplifier?

135. What will be the effect of incorrect grid bias in a class A audio amplifier?

136. What are the factors which determine the bias voltage for the grid of a vacuum tube?

137. Why are tubes, operated as class C amplifiers, not suited for audio frequency amplification?

138. Draw a circuit of a "frequency doubler" and explain its operation.

139. For what purpose is a "doubler" amplifier stage used?

140. Describe what is meant by "link coupling" and for what purpose(s) is it used?

141. What factors may cause low plate current in a vacuum tube amplifier?

142. Given the following vacuum tube constants $E_p=1,000$ volts, $I_p=150$ ma., $I_g=10$ ma., and grid leak = 5,000 ohms, what would be the value of d. c. grid bias voltage?

143. Explain how you would determine the value of cathode

bias resistance necessary to provide correct grid bias for any particular amplifier.

144. What is the chemical composition of the active material composing the negative plate of a lead-acid type storage cell?

145. What is the chemical composition of the active material composing the negative plate of an Edison type storage cell?

146. What is the chemical composition of the active material composing the positive plate of a lead-acid type storage cell?

147. How does a primary cell differ from a secondary cell?

148. What is the chemical composition of the active material composing the positive plate of an Edison type storage cell?

149. What is the chemical composition of the electrolyte used in an Edison type storage cell?

150. What is the chemical composition of the electrolyte of a lead-acid storage cell?

151. What is "polarization" as applied to a primary cell and how may its effect be counteracted?

152. Describe three causes of a decrease in capacity of an Edison type storage cell.

153. What is the cause of the heat developed within a storage cell under charge or discharge condition?

154. How may a dry cell be tested to determine its condition?

155. What will be the result of discharging a lead-acid storage cell at an excessively high current rate?

156. What is the approximate fully charged voltage of an Edison storage cell?

157. A six volt storage battery has an internal resistance of 0.01 ohm. What current will flow when a 3 watt, 6 volt lamp is connected?

158. What is the approximate fully charged voltage of a lead-acid cell?

159. Why is low internal resistance desirable in a storage cell?

160. How may the condition of charge of an Edison cell best be determined?

161. If the charging current through a storage battery is maintained at the normal rate, but its polarity is reversed, what will result?

162. What are the effects of sulphation?

163. How may the state of charge of a lead-acid storage cell be determined?

164. Why is laminated iron or steel generally used in the construction of the field and armature cores of motors and generators instead of solid metal?

165. What is the purpose of "commutating poles" or "interpoles" in a d. c. motor?

166. How may the output voltage of a separately excited a. c. generator, at constant output frequency, be varied?

167. If the field of a shunt wound d. c. motor were opened while the machine was running under no load, what would be the probable result(s)?

168. Name four causes of excessive sparking at the brushes of a d. c. motor or generator.

169. What is the purpose of a commutator on a d. c. motor? On a d. c. generator?

170. What is meant by "counter emf" in a d. c. motor?

171. What determines the speed of a synchronous motor?

172. Describe the action and list the main characteristics of a shunt wound d. c. motor.

173. Describe the action and list the main characteristics of a series d. c. motor.

174. Describe the action and list the main characteristics of a series d. c. generator.

175. List the main advantages of a full wave rectifier as compared to a half wave rectifier.

176. Why may a transformer not be used with direct current?

177. What are the primary advantages of a high vacuum rectifier as compared to the hot cathode mercury vapor rectifier?

178. What are the primary characteristics of a gas filled rectifier tube?

179. What are the primary advantages of a mercury vapor rectifier as compared to the thermionic high vacuum rectifier?

180. Why is it desirable to have low resistance filter chokes?

181. When filter condensers are connected in series, resistors of high value are often connected across the terminals of the individual condensers. What is the purpose of this arrangement?

182. What is the primary purpose of a "bleeder" as used in a filter system?

183. Describe the construction and characteristics of a thermocouple type of meter; of a wattmeter.

184. Describe the construction and characteristics of a "D'Arsonval" type meter.

185. Describe the construction and characteristics of a repulsion type ammeter.

186. Describe the construction and characteristics of a dynamometer type indicating instrument.

187. If two voltmeters are connected in series, how would you be able to determine the total drop across both instruments?

188. What type of meters may be used to measure radio frequency currents?

189. Why are copper-oxide rectifiers, associated with d. c. voltmeters for the purpose of measuring a. c., not suitable for the measurement of voltages at radio frequencies?

190. If two ammeters are connected in parallel, how may the total current through the two meters be determined?

191. Is the angular scale deflection of a repulsion iron vane ammeter proportional to the square or square root of the current, or merely directly proportional to the current?

192. Does an a. c. ammeter indicate peak, average or effective values of current?

193. If two ammeters are connected in series, how may the total current through the two meters be determined?

194. How may a d. c. milliammeter, in an emergency, be used to indicate voltage?

195. What is the purpose of a multiplier resistance used with a voltmeter?

196. What type of indicating instrument is best suited for use in measuring radio frequency currents?

197. What is the purpose of a "shunt" as used with an ammeter?

198. What effects might be caused by a shorted grid condenser in a three-circuit regenerative receiver?

199. What would be the effect of a short-circuited coupling condenser in a conventional resistance coupled audio amplifier?

200. What might be the cause of low sensitivity of a three-circuit regenerative receiver?

201. What is the effect of local action in a lead-acid storage cell and how may it be compensated?

202. Why should adequate ventilation be provided in the room housing a large group of storage cells?

203. When should distilled water be added to a lead-acid storage cell and for what purpose?

204. How may the polarity of the charging source to be used with a storage battery be determined?

205. Describe the care which should be given a group of storage cells to maintain them in good operating condition.

206. What may cause the plates of a lead-acid storage cell to buckle?

207. What may cause "sulphation" of a lead-acid storage cell?

208. What chemical may be used to neutralize a storage cell acid electrolyte?

209. What steps may be taken to prevent corrosion of lead-acid storage cell terminals?

210. Why are bypass condensers often connected across the brushes of a high voltage d. c. generator?

211. What may cause a motor-generator bearing to overheat?

212. How may the radiofrequency interference, often caused by sparking at the brushes of a high-voltage generator, be minimized?

213. Why are high reactance head telephones generally more satisfactory for use with radio receivers than low reactance types?

214. What may cause packing of the carbon granules in a carbon button microphone?

215. Why should polarity be observed in connecting head telephones directly in the plate circuit of a vacuum tube?

216. What precautions should be observed in the use of a double-button carbon microphone?

217. If low impedance head telephones of the order of 75 ohms are to be connected to the output of a vacuum tube amplifier, how may this be done to permit most satisfactory operation?

218. What is the effect on the resonant frequency of connecting an inductor in series with an antenna?

219. What is the effect on the resonant frequency of adding a capacitor in series with an antenna?

220. What is the velocity of propagation of radio frequency waves in space?

221. What is the relationship between the electrical and physical length of a Hertzian antenna?

222. If you desire to operate on a frequency lower than the resonant frequency of an available Marconi antenna, how may this be accomplished?

223. What will be the effect upon the resonant frequency if the physical length of a Hertzian antenna is reduced?

224. Which type of antenna has a minimum of directional characteristics in the horizontal plane?

225. What factors determine the resonant frequency of any particular antenna?

226. If the resistance and the current at the base of a Marconi antenna are known, what formula could be used to determine the power in the antenna?

227. Does the resistance of a copper conductor vary with variations in temperature and if so, in what manner?

228. What material is best suited for use as an antenna strain insulator which is exposed to the elements?

229. What material is frequently used for relay contacts? Why?

230. Describe the operation of a crystal detector (rectifier).

231. Why is rosin used as soldering flux in radio construction work?

232. What is meant by a "harmonic"?

233. Why should all exposed metal parts of a transmitter be grounded?

234. What is the difference between electrical power and electrical energy?

235. How can the direction of flow of d. c. electricity in a conductor be determined?

236. What instrument measures electric power?

237. What instrument measures electrical energy?

238. What is an electron? An ion?

239. With respect to electrons, what is the difference between conductors and non-conductors?

240. Describe an electrolyte.

241. What is an "A" battery? A "B" battery? A "C" battery?

242. What are the lowest radio frequencies useful in radio communication?

243. What radio frequencies are useful for long distance communications requiring continuous operation?

244. What frequencies have substantially straight-line propagation characteristics analogous to that of light waves and unaffected by the ionosphere?

245. What effect do sun spots and aurora borealis have on radio communications?

246. What type of modulation is largely contained in "static" and "lightning" radio waves?

247. What types of radio receivers do not respond to static interference?

248. What crystalline substance is widely used in crystal oscillators?

249. Why is the crystal in some oscillators operated at constant temperature?

250. What is meant by "negative temperature coefficient" of a quartz crystal when used in an oscillator?

251. What is the seventh harmonic of 360 kilocycles?

252. Describe the directional characteristics of the following types of antennas:

- (a) Horizontal Hertz Antenna.
- (b) Vertical Hertz Antenna.
- (c) Vertical Loop Antenna.

(d) Horizontal Loop Antenna.

(e) Vertical Marconi Antenna.

253. What is meant by the efficiency of a radio device?

254. What form of energy is contained in a sound wave?

255. What characteristic determines the pitch of a sound?

256. How many micromicrofarads are there in one microfarad?

257. What is the difference between a milliwatt and a kilowatt?

258. What precaution should be observed when connecting electrolytic condensers in a circuit?

259. Show by a diagram how to connect battery cells in series.

260. Show by a diagram how to connect battery cells in parallel.

261. What material is used in the electrodes of a common dry cell?

262. If the period of one complete cycle of a radio wave is 0.000001 second, what is the wave length?

263. Compare the selectivity and sensitivity of the following types of receivers:

(a) Tuned radio frequency receiver.

(b) Superregenerative receiver.

(c) Superheterodyne receiver.

264. What type of radio receivers contain intermediate frequency transformers?

265. What type of radio receiver is subject to image interference?

266. What type of radiotelephone receiver using vacuum tubes does not require an oscillator?

267. Describe the operation of a regenerative type receiver.

268. How may a regenerative type receiver be adjusted for maximum sensitivity?

269. What effect does the reception of modulated signals have on the plate current of a grid leak-grid condenser type of detector? On a grid bias type of detector?

270. What is meant by double detection in a receiver?

271. What is the purpose of a wave trap in a radio receiver?

272. What is the purpose of an oscillator in a receiver operating on a frequency near the intermediate frequency of the receiver?

273. Explain the purpose and operation of the first detector in a superheterodyne receiver.

274. What is a "getter" in a vacuum tube?

275. What is "space charge" in a vacuum tube?

276. Explain the operation of a triode vacuum tube as an amplifier.

277. What is the approximate efficiency of a class A vacuum tube amplifier? Class B? Class C?

278. Does d. c. grid current normally flow in a class A amplifier employing one tube?

279. Why must some radio frequency amplifiers be neutralized?

280. Describe how a vacuum tube oscillates in a circuit?

281. Is the d. c. bias normally positive or negative in a class A amplifier?

282. What is the composition of filaments, heaters and cathodes in vacuum tubes?

283. What is the direction of electronic flow in the plate and grid circuits of vacuum tube amplifiers?

284. Draw a diagram showing a method of obtaining grid bias to an indirectly heated cathode type vacuum tube by use of a resistance in the cathode circuit of the tube.

285. Draw a diagram showing a method of obtaining grid bias to a filament type vacuum tube by use of a resistance in the plate circuit of the tube.

286. What is the impedance of a solenoid if its resistance is 5 ohms and 0.3 amperes flow through the winding when 110 volts at 60 cycles is applied to the solenoid?

287. What is the conductance of a circuit if 6 amperes flow when 12 volts d. c. is applied to the circuit?

288. What is the relationship between the effective value of a radio frequency current and the heating value of the current?

289. What safety precautions should a person observe when making internal adjustments to a television receiver to avoid personal injury?

290. With measuring equipment that is widely available, is it possible to measure a frequency of 10,000,000 cycles to within one cycle of the exact frequency?

291. Do oscillators operating on adjacent frequencies have a tendency to synchronize oscillation or drift apart in frequency?

292. What form of energy is stored in lead type storage batteries?

293. What precaution should be observed when using and storing crystal microphones?

294. If a 1,500 kilocycle radio wave is modulated by a 2,000 cycle sine wave tone, what frequencies are contained in the modulated wave?

295. Why are laminated iron cores used in audio and power transformers?

296. What are cathode rays?
297. Why is a high ratio of capacity to inductance employed in the grid circuit of some oscillators?
298. What is the purpose of a buffer amplifier stage in a transmitter?
299. What determines the speed of a synchronous motor? An induction motor? A d. c. series motor?
300. What is the total resistance of a parallel circuit consisting of one branch of 10 ohms resistance and one branch of 25 ohms resistance?
301. Draw a diagram of a resistance load connected in the plate circuit of a vacuum tube and indicate the direction of electronic flow in this load.
302. Indicate by a drawing a sine wave of voltage displaced 180 degrees from a sine wave of current.
303. Show by a diagram how a voltmeter and ammeter should be connected to measure power in a d. c. circuit.
304. Indicate by a diagram how the total current in three branches of a parallel circuit can be measured by one ammeter.
305. Draw a graph indicating how the plate current in a vacuum tube varies with plate voltage, grid bias remaining constant.
306. Indicate by a drawing two cycles of a radio frequency wave and indicate one wave length thereof.
307. Explain the purposes and methods of neutralization in radio-frequency amplifiers.
308. In a circuit consisting of an inductance having a reactance value of 100 ohms and a resistance of 100 ohms, what will be the phase angle of the current with reference to the voltage?
309. What is the effective value of a sine wave in relation to its peak value?
310. What is the meaning of "phase difference"?
311. What factors must be known in order to determine the power factor of an alternating current circuit?
312. What are the properties of a series condenser, acting alone in an a. c. circuit?
313. What is the reactance value of a condenser of 0.005 microfarad at a frequency of 1000 kilocycles?
314. State the mathematical formula for the energy stored in the magnetic field surrounding an inductance carrying an electric current.
315. What is the current and voltage relationship when inductive reactance predominates in an a. c. circuit?
316. Given a series circuit consisting of a resistance of 4 ohms,

an inductive reactance of 4 ohms and a capacitive reactance of 1 ohm; the applied circuit alternating e. m. f. is 50 volts. What is the voltage drop across the inductance?

317. What would be the effect if d. c. were applied to the primary of an a. c. transformer?

318. If a power transformer having a voltage step-up ratio of one to five is placed under load, what will be the approximate ratio primary to secondary current?

319. What is the meaning of "skin effect" in conductors of radio frequency energy?

320. Neglecting distributed capacitance, what is the reactance of a 5 millihenry choke coil at a frequency of 1000 kilocycles?

321. What is meant by the term "radiation resistance"?

322. What is the value of total reactance in a series resonant circuit at the resonant frequency?

323. What is the value of reactance across the terminals of the capacitor of a parallel resonant circuit, at the resonant frequency, and assuming zero resistance in both legs of the circuit?

324. Given a series resonant circuit consisting of a resistance of 6.5 ohms, and equal inductive and capacitive reactances of 175 ohms what is the voltage drop across the resistance, assuming the applied circuit potential is 260 volts?

325. Given a series resonant circuit consisting of a resistance of 6.5 ohms, and equal inductive and capacitive reactances of 175 ohms, what is the voltage drop across the inductance when the applied circuit potential is 260 volts?

326. Under what conditions will the voltage drop across a parallel tuned circuit be a maximum?

327. Draw a simple schematic diagram showing a method of coupling a modulator tube to a radio frequency power amplifier tube to produce plate modulation of the amplified radio frequency energy.

328. Draw a diagram of a carrier wave envelope when modulated 50 percent by a sinusoidal wave. Indicate on the diagram the dimensions from which the percentage of modulation is determined.

329. Draw a diagram of a microphone circuit complete with two stages of audio amplification.

330. Draw a simple schematic diagram showing a Heising modulation system capable of producing 100-percent modulation. Indicate power-supply polarity where necessary.

331. Draw a simple schematic diagram showing a method of suppressor grid modulation of a pentode type vacuum tube.

332. Draw a simple schematic diagram showing a method of

coupling a modulator tube to a radio frequency power amplifier tube to produce grid modulation of the amplified radio frequency energy.

333. What is meant by "frequency shift" or "dynamic instability" with reference to a modulated radio frequency emission?

334. What is meant by "high level" modulation?

335. What is meant by "grid modulation"? By "plate modulation"?

336. What is meant by "low-level" modulation?

337. Describe the construction and characteristics of a "crystal" type microphone.

338. Describe the construction and characteristics of a "carbon button" type microphone.

339. What might be the cause of variations in plate current of a "class B" type of modulator?

340. What is the relationship between the average power output of the modulator and the modulator amplifier plate circuit input, under 100 percent, sinusoidal plate modulation?

341. What would be the effect of a shorted turn in a class B modulation transformer? In a class A modulation transformer?

342. Why is a high percentage of modulation desirable?

343. What are some of the possible results of overmodulation?

344. What might cause frequency modulation in an amplitude modulated radio telephone transmitter?

345. What percentage of antenna current increase should be expected between unmodulated conditions and 100 percent sinusoidal modulation?

346. What might be the cause of a decrease in antenna current of a high level amplitude modulated radiotelephone transmitter, when modulation is applied?

347. Why is it necessary to use an oscillating detector for reception of an unmodulated carrier?

348. What is the purpose of shielding in a multistage radio receiver?

349. Explain what circuit conditions are necessary in a regenerative receiver for maximum response to a modulated signal.

350. What feedback conditions must be satisfied in a regenerative detector for most stable operation of the detector circuit in an oscillating condition?

351. What are the advantages to be obtained from adding a tuned radio frequency amplifier stage ahead of the first detector (converter) stage of a superheterodyne receiver?

352. What feedback conditions must be satisfied in a regenerative detector in order to obtain sustained oscillations?

353. How is "automatic volume control" accomplished in a radio receiver?

354. If a superheterodyne receiver is tuned to a desired signal at 1000 kilocycles, and its conversion oscillator is operating at 1300 kilocycles, what would be the frequency of an incoming signal which would possibly cause "image" reception?

355. If a tube in the only radio frequency stage of your receiver burned out, how could temporary repairs or modifications be made to permit operation of the receiver if no spare tube is available?

356. What are the characteristics of "plate detection"?

357. What is the purpose of a "radio frequency" choke?

358. What would be the effect upon a radio receiver if the vacuum tube plate potential were reversed in polarity?

359. Draw a simple schematic diagram of a system of coupling a single electron tube employed as a radio-frequency amplifier to a Hertz type antenna.

360. Draw a simple schematic diagram indicating a link coupling system between a tuned grid-tuned plate oscillator stage and a single electron tube, neutralized amplifier.

361. Draw a simple schematic diagram of a push-pull, neutralized radio frequency amplifier stage, coupled to a Marconi-type antenna system.

362. Draw a simple schematic diagram of a system of neutralizing the grid-plate capacitance of a single electron tube employed as a radio-frequency amplifier.

363. Draw a simple schematic diagram showing the proper method of obtaining d. c. screen-grid voltage from the plate supply in the case of a modulated pentode, class C amplifier.

364. What is the purpose of a "buffer" amplifier?

365. What are the characteristics of a "frequency doubler" stage?

366. What are the advantages of a master oscillator-power amplifier type of transmitter as compared to a simple oscillator transmitter?

367. What are the differences between Colpitts and Hartley oscillators?

368. What is the primary purpose of a grid-leak in a vacuum tube transmitter?

369. By what means is feedback coupling obtained in a tuned-grid, tuned-plate type of oscillator?

370. What may be the result of parasitic oscillations?

371. How may the production of harmonic energy by a vacuum tube radio frequency amplifier be minimized?

372. What is a definition of "parasitic oscillations"?
373. What is the purpose of a "Faraday" screen between the final tank inductance of a transmitter and the antenna inductance?
374. How may the distortion effects caused by class B operation of a radio frequency amplifier be minimized?
375. What is the effect of carrier shift in a plate modulated class C amplifier?
376. What are some possible indications of a defective transmitting vacuum tube?
377. What would be the possible indications that a vacuum tube in a transmitter has subnormal filament emission?
378. What are possible causes of negative carrier shift in a linear radio-frequency amplifier?
379. In a modulated class C radio-frequency amplifier, what is the effect of insufficient excitation?
380. What is the purpose of a "dummy antenna"?
381. In a class C radio-frequency amplifier stage of a transmitter, if plate current continues to flow and radio-frequency energy is still present in the antenna circuit after grid excitation is removed, what defect would be indicated?
382. If the transmitter filament voltmeter should cease to operate, how may the approximately correct filament rheostat adjustment be found?
383. What are some possible causes of overheating vacuum tube plates?
384. Should the plate current of a modulated class C amplifier stage vary or remain constant under modulation conditions? Why?
385. What is the effect of a swinging antenna upon the output of a simple oscillator?
386. What factors permit high conduction currents in a hot cathode type of mercury vapor rectifier tube?
387. List the principal advantages of a mercury vapor rectifier over a high vacuum tube type of rectifier.
388. What effect does the resistance of filter chokes have on the regulation of a power supply in which they are used?
389. Describe the theory of current conduction and rectification by means of cold cathode, gassy diode vacuum tube.
390. Describe the principle of operation of a synchronous type of mechanical rectifier.
391. What might be the result of starting a motor too slowly, using a hand starter?
392. State the principal advantage of a "third brush" generator for radio power supply in automobiles.

393. What materials should be used to clean the commutator of a motor or generator?
394. List three causes of sparking at the commutator of a d. c. motor.
395. Why is it sometimes necessary to use a starting resistance when starting a d. c. motor?
396. List the comparative advantages and disadvantages of motor generator and transformer-rectifier power supplies.
397. If the reluctance of an iron-cored choke is increased by increasing the air gap of the magnetic path, in what other way does this affect the properties of the choke?
398. What is the effect upon a filter choke of a large value of direct current flow?
399. What are the characteristics of a condenser-input filter system as compared to a choke-input system?
400. What is the principal function of the filter in a power supply?
401. What are the characteristics of a choke-input filter system as compared to a condenser-input system?
402. What is the percentage regulation of a power supply with a no-load voltage output of 126.5 volts and a full-load voltage output of 115 volts?
403. What is the definition of "voltage regulation" as applied to power supplies?
404. May two condensers of 500 volts, operating voltage, one an electrolytic and the other a paper condenser, be used successfully in series across a potential of 1,000 volts? Explain your answer.
405. What is the principal function of a "swinging choke" in a filter system?
406. What is the purpose(s) of a "bleeder" resistor as used in connection with power supplies?
407. What does a blue haze in the space between the filament and plate of a high vacuum rectifier tube indicate?
408. When condensers are connected in series in order that the total operating voltage of the series connection is adequate for the output voltage of a filter system, what is the purpose of placing resistors of high value in shunt with each individual condenser?
409. If a high vacuum type, high voltage rectifier tube should suddenly show severe internal sparking and then fail to operate, what elements of the rectifier-filter system should be checked for possible failure before installing a new rectifier tube?
410. If the plate, or plates, of a rectifier tube suddenly be-

came red hot, what might be the cause, and how could remedies be effected?

411. Draw a simple schematic diagram of a quartz crystal controlled oscillator, indicating the circuit elements necessary to identify this form of oscillatory circuit.

412. Draw a simple schematic diagram of a dynatron type of oscillator, indicating the circuit elements necessary to identify this form of oscillatory circuit.

413. Draw a simple schematic diagram of an electron coupled oscillator, indicating the circuit elements necessary to identify this form of oscillatory circuit.

414. What does the expression "positive temperature coefficient" mean, as applied to a quartz crystal?

415. Draw a simple schematic diagram of a crystal controlled vacuum tube oscillator using a pentode type tube. Indicate power supply polarity where necessary.

416. What will result if a d. c. potential is applied between the two parallel surfaces of a quartz crystal?

417. What does the expression "negative temperature coefficient" mean, as applied to a quartz crystal?

418. What does the expression "low temperature coefficient" mean, as applied to a quartz crystal?

419. What is the function of a quartz crystal in a radio transmitter?

420. What may result if a high degree of coupling exists between the plate and grid circuits of a crystal controlled oscillator?

421. What is the purpose in maintaining the temperature of a quartz crystal as constant as possible?

422. Why is a separate source of plate power desirable for a crystal oscillator stage in a radio transmitter?

423. What are the principal advantages of crystal control over tuned circuit oscillators?

424. What is the approximate range of temperature coefficients to be encountered with X-cut quartz crystals?

425. Is it necessary or desirable that the surfaces of a quartz crystal be clean? If so, what cleaning agents may be used which will not adversely affect the operation of the crystal?

426. List the characteristics of a dynatron type of oscillator.

427. List the characteristics of an electron-coupled type of oscillator.

428. Upon what characteristic of an electron tube does a dynatron type of oscillator depend?

429. What is a multivibrator and what are its uses?

430. If a frequency meter having an over-all error propor-

tional to the frequency, is accurate to 10 cycles when set at 600 kilocycles, what is its error in cycles when set at 1110 kilocycles?

431. What precautions should be taken before using a heterodyne type of frequency meter?

432. What is the meaning of "zero beat" as used in connection with frequency measuring equipment?

433. What precautions should be observed in using an absorption type frequency meter to measure the frequency of a self-excited oscillator? Explain your reasons.

434. If the first speech amplifier tube of a radiotelephone transmitter were over-excited, but the percentage modulation capabilities of the transmitter were not exceeded, what would be the effect upon the output of the transmitter?

435. What is the purpose of a "preamplifier"?

436. What are the advantages of using two tubes in push-pull as compared to the use of the same tubes in parallel in an audio frequency amplifier?

437. List four causes of distortion in a class A audio frequency amplifier.

438. What is the purpose of bypass condensers connected across an audio frequency amplifier cathode bias resistor?

439. What are the advantages of using a resistor in series with the cathode of a class C radio frequency amplifier tube to provide bias?

440. How may the generation of even harmonic energy in a radio frequency amplifier stage be minimized?

441. What tests will determine if a radio frequency power amplifier stage is properly neutralized?

442. Why is the plate circuit efficiency of a radio frequency amplifier tube operating as class C higher than that of the same tube operated as class B? If the statement above is false, explain your reasons for such a conclusion.

443. Why does a class B audio frequency amplifier stage require considerably greater driving power than a class A amplifier?

444. Discuss the input circuit requirements for a class B audio frequency amplifier grid circuit.

445. When a signal is impressed on the grid of a properly adjusted and operated class A audio frequency amplifier, what change in average value of plate current will take place?

446. If the value of capacitance of a coupling condenser in a resistance coupled audio amplifier is increased, what effect may be noted?

447. Why does a screen grid tube normally require no neutralization when used as a radio frequency amplifier?

448. What instruments or devices may be used to adjust and determine that an amplifier stage is properly neutralized?

449. What is meant by the term "unity coupling"?

450. Draw a diagram illustrating capacitive coupling between two tuned radio frequency circuits.

451. Draw a diagram illustrating "inductive" coupling between two tuned radio frequency circuits.

452. Draw a diagram illustrating "direct" or "Loftin-White" coupling between two stages of audio frequency amplification.

453. List four classes of stations which may be operated by a person holding a radiotelephone second-class license.

454. May the holder of a radiotelephone second-class operator license adjust and service or supervise the adjustment and servicing of any class of police radio station?

455. List four classes of stations, the equipment of which may be adjusted and serviced by the holder of a radiotelephone second-class operator license.

456. List three classes of stations which may not be serviced or adjusted by the holder of a radiotelephone second-class operator license.

457. Is it necessary that the original operator license be posted at an aeronautical station? An aircraft station? An airport station? A broadcast station? A ship station?

458. What is a "verification card" and under what circumstances may it be used?

459. If a ship-telephone station is assigned the frequency of 2738 kilocycles, and the maximum frequency tolerance is 0.02 percent, what are the highest and lowest frequencies within the tolerance limits?

460. If an aircraft station is assigned the frequency of 3117.5 kilocycles, and the maximum tolerance is 0.01 percent, what are the highest and lowest frequencies within the tolerance limits?

461. If a heterodyne frequency meter, having a calibrated range of 1000 to 5000 kilocycles, is used to measure the frequency of a transmitter operating on approximately 500 kilocycles by measurement of the second harmonic of this transmitter, and the indicated measurement was 1008 kilocycles, what is the actual frequency of the transmitter output?

462. Define the following types of emission: A0, A1, A2, A3, A4, A5.

463. In the adjustment of a radiotelephone transmitter, what precautions should be observed?

464. Explain the relation between the signal frequency, the oscillator frequency and the image frequency in a superheterodyne receiver.

465. What means are used to prevent interaction between the stages of a multistage audio-frequency amplifier?

466. For what period of time must a log containing distress entries be retained?

467. What effect, if any, does modulation have on the amplitude of the antenna current of a frequency modulated transmitter?

468. Why is a high percentage of modulation desirable in amplitude modulated transmitters?

469. How would loss of radio-frequency excitation affect a class C modulated amplifier when using a grid leak bias only?

470. What is the purpose of a center-tap connection on a filament transformer?

471. What would be the result of a short circuit of the plate radio-frequency choke coil in a radio-frequency amplifier?

472. What are the advantages of push pull operation compared to single tube operation in amplifiers?

473. What class of amplifiers is appropriate to use in a radio-frequency doubler stage?

474. What is the ratio of modulator power output to modulated amplifier plate power input for 100 percent amplitude modulation?

475. Draw a diagram of a Hartley oscillator. A Colpitts oscillator.

476. Describe the construction and characteristics of (a) a beam power tube, (b) a thyratron tube, and (c) a battery charging rectifier tube.

477. What kind of vacuum tube responds to filament reactivation and how is reactivation accomplished?

478. What is the purpose of a bleeder resistor in the filter of a high voltage d. c. power supply?

479. How much energy is consumed in 20 hours by a radio receiver rated at 60 watts?

480. How does the value of resistance in the grid leak of a regenerative type detector affect the sensitivity of the detector?

481. Compare the design and operating characteristics of class A, class B, and class C amplifiers.

482. What are causes of downward fluctuation of the antenna current of an amplitude modulated transmitter when the transmitter is modulated?

483. What may cause upward fluctuation of the antenna cur-

rent of an amplitude modulated transmitter when the transmitter is modulated?

484. Explain how grid bias voltage is developed by the grid leak in an oscillator.

485. Explain why radio-frequency chokes are sometimes placed in the power leads between a motor-generator power supply and a high powered radio transmitter.

486. What effect does inductive reactance in an a. c. circuit have on the power factor of the circuit?

487. In what circuits of a radio station are three-phase circuits sometimes employed?

488. Explain the operation of a vacuum tube rectifier power supply and filter.

489. What are the merits of a frequency modulation communication system compared to an amplitude modulation communication system?

490. What is meant by horizontal and vertical polarization of a radio wave?

491. How should a transmitting antenna be designed if a vertically polarized wave is to be radiated and how should the receiving antenna be designed for best performance in receiving the ground wave from this transmitting antenna?

492. Draw a block diagram of a frequency modulation receiver and explain its principle of operation.

493. Draw a block diagram of a frequency modulated transmitter and indicate the center frequency of the master oscillator and the center frequency radiated by the antenna.

494. In a frequency modulation radio communication system what is the meaning of modulation index? Of deviation ratio? What values of deviation ratio are used in a frequency modulation radio communication system?

495. Why is narrow band frequency modulation rather than wide band frequency modulation used in radio communication systems?

496. What is the purpose of a squelch circuit in a radio communication receiver?

497. Discuss methods whereby interference to radio reception can be reduced.

498. Draw a diagram of an absorption type wavemeter and explain its principle of operation.

499. Draw a diagram of an ohmmeter and explain its principle of operation.

500. Discuss Lecher wires; their properties and use.

501. If a 0-1 d. c. milliammeter is to be converted into a volt-

meter with full scale calibration 100 volts, what value of series resistance should be connected in series with the milliammeter?

502. What are wave guides? Cavity resonators?

503. What is the purpose of a diversity antenna receiving system?

504. Why are insulators sometimes placed in antenna guy wires?

505. Discuss the construction and operation of dynamotors.

506. Discuss the cause and prevention of interference to radio receivers installed in motor vehicles.

507. Explain the process of neutralizing a triode radio-frequency amplifier.

508. A relay with a coil resistance of 500 ohms is designed to operate when 0.2 ampere flows through the coil. What value of resistance must be connected in series with the coil if operation is to be made from a 110 volt d. c. line?

509. What value of resistance should be connected in series with a 6 volt battery that is to be charged at a 3 ampere rate from a 115 volt d. c. line?

510. What may cause self-oscillation in an audio amplifier?

511. Why are pairs of wires carrying a. c. heater currents in audio amplifiers twisted together?

512. Draw a block diagram of a superheterodyne receiver capable of receiving amplitude modulated signals and indicate the frequencies present in the various stages when the receiver is tuned to 2450 kilocycles. What is the frequency of a station that might cause image interference to the receiver when tuned to 2450 kilocycles?

513. Show by a diagram how to connect a wave trap in the antenna circuit of a radio receiver to attenuate an interfering signal.

514. Draw a diagram of a tuned radio-frequency type radio receiver.

515. What would be the effects of connecting 110 volts at 25 cycles to the primary of a transformer rated at 110 volts and 60 cycles?

516. Draw a diagram of a one-tube audio oscillator using an iron core choke.

517. Show by a diagram how a two-wire radio-frequency transmission line may be connected to feed a Hertz antenna.

518. Draw a diagram of a synchronous vibrator power supply. A nonsynchronous vibrator power supply.

519. In accordance with the Commission's Rules and Regula-

tions what is the primary standard for radio-frequency measurements of radio stations in the various services? (R. & R. 2.1.)

520. What is meant by carrier frequency? (Carrier wave? (R. & R. 2.1.)

521. 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. (R. & R. 2.1.)

522. What are the frequency ranges included in the following frequency subdivisions: MF (medium frequency), HF (high frequency), VHF (very high frequency), UHF (ultra high frequency) and SHF (super high frequency)? (R. & R. 2.102.)

523. Explain what is meant by the following types of emission: FO, F1, F2, F3, F4, and PO emission? (R. & R. 2.201.)

524. 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? (R. & R. 13.74.)

525. If service or maintenance logs are required to be kept at a radio station, what entries are required to be entered in the log? (R. & R. 13.75.)

526. 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? (R. & R. 10.105.)

527. 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? (R. & R. 10.108.)

528. Describe the physical structure of two types of transistor and explain how they operate as an amplifier.

529. Draw a simple schematic circuit diagram of a two stage audio amplifier using transistors.

530. Describe briefly the construction and purpose of a wave guide. What precautions should be taken in the installation and maintenance of a wave guide to insure proper operation?

531. Describe the physical structure of a multianode magnetron and explain how it operates.

532. Describe the physical structure of a klystron tube and explain how it operates as an oscillator.

533. Describe three methods for reducing the radio frequency harmonic emission of a radiotelephone transmitter.

534. A ship radiotelephone transmitter operates on 2738 kc. At a certain point distant from the transmitter the 2738 kc. signal has a measured field of 147 millivolts per meter. The second-harmonic field at the same point is measured as 405 microvolts per meter. To the nearest whole unit in decibels, how much has the harmonic emission been attenuated below the 2738 kc. fundamental?

ELEMENT IV

ADVANCED RADIOTELEPHONE

1. A parallel circuit is made up of five branches; three of the branches being pure resistances of 7, 11 and 14 ohms, respectively. The fourth branch has an inductive reactance value of 500 ohms. The fifth branch has a capacitive reactance of 900 ohms. What is the total impedance of this network? If a voltage is impressed across this parallel network, which branch will dissipate the greatest amount of heat?

2. What is the reactance of a condenser at the frequency of 1200 kilocycles if its reactance is 300 ohms at 680 kilocycles?

3. If the mutual inductance between two coils is 0.1 henry, and the coils have inductances of 0.2 and 0.8 henry, respectively, what is the coefficient of coupling?

4. If, in a given a. c. series circuit, the resistance, inductive reactance and capacitive reactance are of equal magnitude of 11 ohms, and the frequency is reduced to 0.411 of its value at resonance, what is the resultant impedance of the circuit at the new frequency?

5. If an alternating current of 5 amperes flows in a series circuit composed of 12 ohms resistance, 15 ohms inductive reactance and 40 ohms capacitive reactance. what is the voltage across the circuit?

6. A series circuit contains resistance, inductive reactance, and capacitive reactance. The resistance is 7 ohms, the inductive reactance is 8 ohms and the capacitive reactance is unknown. What value must this condenser have in order that the total circuit impedance be 13 ohms?

7. What is the total reactance of two inductances connected in series with zero mutual inductance?

8. If an alternating voltage of 115 volts is connected across a parallel circuit made up of a resistance of 30 ohms, an inductive reactance of 17 ohms and a capacitive reactance of 19 ohms, what is the total circuit current drain from the source?

9. When two coils, of equal inductance, are connected in series, with unity coefficient of coupling and their fields in phase, what is the total inductance of the two coils?

10. If a power transformer has a primary voltage of 4,400

volts and a secondary voltage of 220 volts, and the transformer has an efficiency of 98 percent, when delivering 23 amperes of secondary current, what is the value of primary current?

11. Three single-phase transformers, each with a ratio of 220 to 2,200 volts, are connected across a 220 volt three-phase line, primaries in delta. If the secondaries are connected in Υ , what is the secondary line voltage?

12. What factors determine the core losses in a transformer?

13. What circuit constants determine the "copper" losses of a transformer?

14. Draw a schematic wiring diagram of a three-phase transformer with delta connected primary and Υ connected secondary.

15. What factor(s) determine the ratio of impedances which a given transformer can match?

16. If a transformer, having a turns ratio of 10 to 1, working into a load impedance of 2,000 ohms and out of a circuit having an impedance of 15 ohms, what value of resistance may be connected across the load to effect an impedance match?

17. In a class C radio frequency amplifier, what ratio of load impedance to dynamic plate impedance will give the greatest plate efficiency?

18. If a lamp, rated at 100 watts and 115 volts, is connected in series with an inductive reactance of 355 ohms and a capacitive reactance of 130 ohms across a voltage of 220 volts, what is the current value through the lamp?

19. If an a. c. series circuit has a resistance of 12 ohms, an inductive reactance of 7 ohms and capacitive reactance of 7 ohms, at the resonant frequency, what will be the total impedance at twice the resonant frequency?

20. In a parallel circuit composed of an inductance of 150 microhenrys and a capacitance of 160 micromicrofarads, what is the resonant frequency?

21. What value of capacitance must be shunted across a coil having an inductance of 56 microhenrys in order that the circuit resonate at 5,000 kilocycles?

22. Why should impedances be matched in speech-input equipment?

23. What are the purposes of H or T pad attenuators?

24. Why are grounded center-tap transformers frequently used to terminate program wire lines?

25. What is the purpose of a "line pad"?

26. Why are electrostatic shields used between windings in coupling transformers?

27. Why is it preferable to isolate the direct current from the

primary winding of an audio transformer working out of a single vacuum tube?

28. Why are preamplifiers sometimes used ahead of mixing systems?

29. What is the purpose of a variable attenuator in a speech input system?

30. In a low-level amplifier using degenerative feedback, at a nominal mid-frequency, what is the phase relationship between the feedback voltage and the input voltage?

31. Under what circumstances will the gain-per-stage be equal to the voltage amplification factor of the vacuum tube employed?

32. Why is a high-level amplifier, feeding a program transmission line, generally isolated from the line by means of a pad?

33. What is the purpose of deliberately introduced degenerative feedback in audio amplifiers?

34. What unit has been adopted by leading program transmission organizations as a volume unit and to what power is this unit equivalent?

35. What is the purpose of a line equalizer?

36. Draw a diagram of an equalizer circuit most commonly used for equalizing wire-line circuits.

37. What type of microphone employs a coil of wire, attached to a diaphragm, which moves in a magnetic field as the result of the impinging of sound waves?

38. What is the most serious disadvantage of using carbon microphones with high fidelity amplifiers?

39. Why are the diaphragms of certain types of microphones stretched?

40. Draw a simple schematic diagram of a grid bias modulation system, including the modulated radio frequency stage.

41. Draw a simple schematic diagram of a class B audio high level modulation system, including the modulated radio frequency stage.

42. Draw a sample sketch of the trapezoidal pattern on a cathode ray oscilloscope screen indicating low percent modulation without distortion.

43. During 100-percent modulation, what percentage of the average output power is in the side-bands?

44. Draw a schematic diagram of test equipment which may be used to detect carrier shift of a radio telephone transmitter output.

45. What are the advantages and disadvantages of class B modulators?

46. Why is frequency modulation undesirable in the standard broadcast band?

47. What is meant by "low level" modulation?

48. If a preamplifier, having a 600-ohm output, is connected to a microphone so that the power output is minus 40 db., and assuming the mixer system to have a loss of 10 db., what must be the voltage amplification necessary in the line amplifier in order to feed plus 10 db. into the transmitter line?

49. If the power output of a modulator is decreased from 1,000 watts to 10 watts, how is the power reduction expressed in decibels?

50. In a modulated amplifier, under what circumstances will the plate current vary as read on a d. c. meter?

51. What could cause downward deflection of the antenna current ammeter of a transmitter when modulation is applied?

52. If tests indicate that the positive modulation peaks are greater than the negative peaks in a transmitter employing a class B audio modulator, what steps should be taken to determine the cause?

53. In a properly adjusted grid bias modulated radio frequency amplifier, under what circumstances will the plate current vary as read on a d. c. meter?

54. What percentage increase in average output power is obtained under 100 percent sinusoidal modulation as compared with average unmodulated carrier power?

55. In a class C radio frequency amplifier stage feeding an antenna system, if there is a positive shift in carrier amplitude under modulation conditions, what may be the trouble?

56. Name four causes of distortion in a modulated amplifier stage output.

57. If you decrease the percentage of modulation from 100 to 50 percent, by what percentage have you decreased the power in the side bands?

58. If a certain audio frequency amplifier has an over-all gain of 40 db. and the output is 6 watts, what is the input?

59. If the field intensity of 25 millivolts per meter develops 2.7 volts in a certain antenna, what is its effective height?

60. Draw a schematic diagram of a final amplifier with capacity coupling to the antenna which will discriminate against the transfer of harmonics.

61. In what units is the field intensity of a broadcast station normally measured?

62. Draw a simple schematic diagram showing a method of coupling the radio frequency output of the final power amplifier

stage of a transmitter to a two-wire transmission line, with a method of suppression of second and third harmonic energy.

63. An antenna is being fed by a properly terminated two-wire transmission line. The current in the line at the input end is 3 amperes. The surge impedance of the line is 500 ohms. How much power is being supplied to the line?

64. If the daytime transmission line current of a 10-kilowatt transmitter is 12 amperes, and the transmitter is required to reduce to 5 kilowatts at sunset, what is the new value of transmission line current?

65. If the antenna current of a station is 9.7 amperes for 5 kilowatts, what is the current necessary for a power of 1 kilowatt?

66. What is the antenna current when a transmitter is delivering 900 watts into an antenna having a resistance of 16 ohms?

67. If the day input power to a certain broadcast station antenna having a resistance of 20 ohms is 2,000 watts, what would be the night input power if the antenna current were cut in half?

68. The d. c. input power to the final amplifier stage is exactly 1,500 volts and 700 milliamperes. The antenna resistance is 8.2 ohms and the antenna current is 9 amperes. What is the plate efficiency of the final amplifier?

69. If the power output of a broadcast station is quadrupled, what effect will this have upon the field intensity at a given point?

70. The ammeter connected at the base of a Marconi antenna has a certain reading. If this reading is increased 2.77 times, what is the increase in output power?

71. If the power output of a broadcast station has been increased so that the field intensity at a given point is doubled, what increase has taken place in antenna current?

72. If a transmitter is modulated 100 percent by a sinusoidal tone, what percentage increase in antenna current will occur?

73. What is the ratio between the currents at the opposite ends of a transmission line, $\frac{1}{4}$ wave length long, and terminated in an impedance equal to its surge impedance?

74. The power input to a 72-ohm concentric transmission line is 5,000 watts. What is the r. m. s. voltage between the inner conductor and sheath?

75. A long transmission line delivers 10 kilowatts into an antenna; at the transmitter end the line current is 5 amperes and at the coupling house it is 4.8 amperes. Assuming the line to be properly terminated and the losses in the coupling system negligible, what is the power lost in the line?

76. The power input to a 72-ohm concentric line is 5,000 watts. What is the current flowing in it?

77. What is the primary reason for terminating a transmission line in an impedance equal to the characteristic impedance of the line?

78. If a vertical antenna is 405 feet high and is operated at 1250 kilocycles, what is its physical height, expressed in wave lengths? (One meter equals 3.28 feet.)

79. What must be the height of a vertical radiator one-half wave length high if the operating frequency is 1100 kilocycles?

80. Draw a diagram of a crystal oscillator.

81. Draw a diagram of a class B push-pull linear amplifier using triode tubes. Include a complete antenna coupling circuit and antenna circuit. Indicate points at which the various voltages will be connected.

82. Draw a diagram of a complete class B modulation system, including the modulated radio frequency amplifier stage. Indicate points where the various voltages will be connected.

83. A certain transmitter has an output of 100 watts. The efficiency of the final, modulated amplifier stage is 50 percent. Assuming that the modulator has an efficiency of 66 percent, what plate input to the modulator is necessary for 100 percent modulation of this transmitter? Assuming that the modulator output is sinusoidal.

84. If an oscillatory circuit consists of two identical tubes, the grids connected in push-pull and the plates in parallel, what relationship will hold between the input and output frequencies?

85. What undesirable effects result from overmodulation of a broadcast transmitter?

86. What do variations in the final amplifier plate current of a transmitter employing low-level modulation usually indicate?

87. If, upon tuning the plate circuit of a triode r. f. amplifier, the grid current undergoes variations, what defect is indicated?

88. A 50-kilowatt transmitter employs 6 tubes in push-pull parallel in the final class B linear stage, operating with a 50-kilowatt output and an efficiency of 33 percent. Assuming that all of the heat radiation is transferred to the water cooling system, what amount of power must be dissipated from each tube?

89. What is the value of voltage drop across the elements of a mercury-vapor rectifier tube under normal conducting conditions?

90. Draw a diagram of a bridge rectifier giving full-wave rectification without a center-tapped transformer. Indicate polarity of output terminals.

91. Draw a diagram of a rectifier system supplying two plate

voltages, one approximately twice the other and using one high-voltage transformer with a single center-tapped secondary, and such filament supplies as may be necessary.

92. What is meant by "arc back" or "flash back" in a rectifier tube?

93. What is meant by the "inverse peak voltage" rating of a rectifier tube?

94. How may a condenser be added to a choke input filter system to increase the full load voltage?

95. Why is it not advisable to operate a filter reactance in excess of its rated current value?

96. What is a "low pass" filter? A "high pass" filter?

97. Draw a diagram of a simple low pass filter.

98. If a power supply has a regulation of 11 percent when the output voltage at full load is 240 volts, what is the output voltage at no load?

99. How is the inverse peak voltage to which the tubes of a full-wave rectifier will be subject, determined from the known secondary voltages of the power transformer? Explain.

100. If a power supply has an output voltage of 140 volts at no load and the regulation at full load is 15 percent, what is the output voltage at full load?

101. Why is a time delay relay arranged to apply the high voltage to the anodes of mercury vapor rectifier tubes some time after the application of filament voltage?

102. Why is it important to maintain the operating temperature of mercury-vapor tubes within specified limits?

103. If a frequency doubler stage has an input frequency of 1000 kilocycles, and the plate inductance is 60 microhenries, what value of plate capacitance is necessary for resonance, neglecting stray capacitances?

104. Draw a simple schematic diagram of a multivibrator oscillatory circuit.

105. What precautions should be taken to insure that a crystal oscillator will function at one frequency only?

106. What are the advantages of mercury thermostats as compared to bimetallic thermostats?

107. A 600-kilocycle X-cut crystal, calibrated at 50 degrees Centigrade, and having a temperature coefficient of -20 parts per million per degree, will oscillate at what frequency when its temperature is 60 degrees Centigrade?

108. Why are quartz crystals in some cases operated in temperature-controlled ovens?

109. What is the device called which is used to derive a

standard frequency of 10 kilocycles from a standard-frequency oscillator operating on 100 kilocycles?

110. What procedure should be adopted if it is found necessary to replace a tube in a heterodyne frequency meter?

111. If a frequency of 500 cycles is beat with a frequency of 550 kilocycles, what will be the resultant frequencies?

112. In what part of a broadcast station system is a "phase monitor" sometimes found? What is the function of this instrument?

113. If a broadcast station receives a frequency measurement report indicating that the station frequency was 45 cycles low at a certain time, and the transmitter log for the same time shows the measured frequency to be 5 cycles high, what is the error in the station frequency monitor?

114. If a heterodyne frequency meter, having a straight-line relation between frequency and dial reading, has a dial reading of 31.7 for a frequency of 1390 kilocycles, and a dial reading of 44.5 for a frequency of 1400 kilocycles, what is the frequency of the ninth harmonic of the frequency corresponding to a scale reading of 41.2?

115. What is the reason why certain broadcast station frequency monitors must receive their energy from an unmodulated stage of the transmitter?

116. In what part of a broadcast station system are "limiting" devices usually employed? What are their functions?

117. What are the results of using an audio peak limiter?

118. How is the load on a modulator, which modulates the plate circuit of a class C radio frequency stage, determined?

119. Given a class C amplifier with a plate voltage of 1,000 volts and a plate current of 150 milliamperes which is to be modulated by a class A amplifier with a plate voltage of 2,000 volts, plate current of 200 milliamperes and a plate impedance of 15,000 ohms. What is the proper turns ratio for the coupling transformer?

120. Indicate, by a simple diagram, the shunt-fed plate circuit of a radio frequency amplifier.

121. Indicate, by a simple diagram, the series-fed plate circuit of a radio frequency amplifier.

122. With respect to the unmodulated values, doubling the excitation voltage of a class B "linear" radio frequency amplifier will result in what increase in r. f. power output?

123. What may be the cause of a decrease in antenna current during modulation of a class B linear r. f. amplifier?

124. In adjusting the plate tank circuit of a radio frequency

amplifier, should minimum or maximum plate current indicate resonance?

125. What is the formula for determining the db loss or gain in a circuit?

126. What will occur if one tube is removed from a push-pull class A audio frequency amplifier stage?

127. What is the stage amplification obtained with a single triode operating with the following constants: Plate voltage 250, Plate current 20 ma, Plate impedance 5,000 ohms, Load impedance 10,000 ohms, grid bias 4.5 volts, amplification factor 24?

128. Under what circumstances is neutralization of a triode radio frequency amplifier not required?

129. Why is it necessary or advisable to remove the plate voltage from the tube being neutralized?

130. Under what conditions may a standard broadcast station be operated at a power lower than specified in the station license? (R. & R. 3.57.)

131. When the transmitter of a standard broadcast station is operated at 85 percent modulation, what is the maximum permissible combined audio harmonic output? (S.G.E.P.-A.M. 12.)

132. How frequently must the auxiliary transmitter of a standard broadcast station be tested? (R. & R. 3.63.)

133. For what purpose is an auxiliary transmitter maintained?

134. If the plate ammeter in the last stage of a broadcast transmitter burned out, what should be done? (R. & R. 3.58.)

135. The currents in the elements of a directive broadcast antenna must be held to what percentage of their licensed value? (R. & R. 3.57.)

136. What are the permissible tolerances of power of a standard broadcast station? (R. & R. 3.57.)

137. What are meant by "equipment", "program" and "service" tests where these are mentioned in the Rules and Regulations of the Commission? (R. & R. 3.167, 3.168, 7.64.)

138. At broadcast stations using the direct method of computing output power, at what point in the antenna system must the antenna current be measured? (R. & R. 3.14, 3.54.)

139. For what purpose may a standard broadcast station, licensed to operate daytime or specified hours, operate during the experimental period without specific authorization? (R. & R. 3.73.)

140. What is the last audio frequency amplifier stage which modulates the radio frequency stage termed? (R. & R. 3.14.)

141. How frequently must a remote reading ammeter be

checked against a regular antenna ammeter? (S.G.E.P.-A.M. 13.)

142. What factors enter into the determination of power of a broadcast station which employs the indirect method of measurement? (R. & R. 3.52, 3.267.)

143. What is the power that is actually transmitted by a standard broadcast station termed?

144. Are the "antenna current," "plate current," etc., as used in the Rules and Regulations of the Commission with reference to radio telephone transmitters, modulated or unmodulated values? (R. & R. 3.14.)

145. With reference to broadcast stations, what is meant by the "experimental period"? (R. & R. 3.10.)

146. What percentage of modulation capability is required of a standard broadcast station? (S.G.E.P.-A.M. 12.)

147. Define the maximum rated carrier power of a broadcast station transmitter. (R. & R. 3.14.)

148. Define the plate input power of a broadcast station transmitter. (R. & R. 3.14.)

149. Define high level and low level modulation. (R. & R. 3.14.)

150. What is the frequency tolerance for a standard broadcast station? (R. & R. 3.59.)

151. What is the frequency tolerance allowed an International Broadcast station? (R. & R. 3.767.)

152. What is the required full scale accuracy of the ammeters and voltmeters associated with the final radio stage of a broadcast transmitter? (S.G.E.P.-A.M. 13.)

153. If a broadcast transmitter employs seven tubes of a particular type, how many spare tubes of the same type are required to be kept on hand in accordance with F.C.C. regulations? (S.G.E.P.-A.M. 12.)

154. Describe the various methods by which a standard broadcast station may compute its operating power, and state the conditions under which each method may be employed. (R. & R. 3.51.)

155. What portion of the scale of an antenna ammeter having a square law scale is considered as having acceptable accuracy for use at a broadcast station? (S.G.E.P.-A.M. 13.)

156. Define: Amplifier gain, percentage deviation, stage amplification, and percentage of modulation. Explain how each is determined.

157. Define an auxiliary broadcast transmitter and state the conditions under which it may be used. (R. & R. 3.13, 3.63.)

158. What is the purpose of using a frequency standard or service independent of the transmitter frequency monitor or control?

159. Discuss the characteristics of a modulated class C amplifier.

160. What is the purpose of neutralizing a radio-frequency amplifier stage?

161. When the authorized nighttime power of a standard broadcast station is different from the daytime power and the operating power is determined by the "indirect" method, which of the efficiency factors established by F.C.C. rules is used? (R. & R. 3.52, 3.53.)

162. Describe the technique used in frequency measurements employing a 100-kilocycle oscillator, a 10-kilocycle multivibrator, a heterodyne frequency meter of known accuracy, a suitable receiver, and standard frequency transmission.

163. What is the power specified in the instrument of authorization for a standard broadcast station called?

164. What is the effect of 10,000 cycle modulation of a standard broadcast station on adjacent channel reception?

165. What system of connections for a three-phase, three-transformer bank will provide maximum secondary voltage?

166. Draw a diagram and describe the electrical characteristics of an electron-coupled oscillator circuit.

167. In frequency measurements using the heterodyne "zero beat" method, what is the best ratio of signal e. m. f. to calibrated heterodyne oscillator e. m. f.?

168. What is meant by the "Q" of a radio-frequency inductance coil?

169. What effect does a loading resistance have on a tuned radio-frequency circuit?

170. What is meant by the "time constant" of a resistance-capacitance circuit?

171. A potential of 110 volts is applied to a series circuit containing an inductive reactance of 25 ohms, a capacitive reactance of 10 ohms and a resistance of 15 ohms. What is the phase relationship between the applied voltage and the current flowing in this circuit?

172. What does the term "power factor" mean in reference to electric power circuits?

173. What is the predominant ripple frequency in the output of a single-phase full-wave rectifier when the primary source of power is 110 volts at 60 cycles?

174. When mercury-vapor tubes are connected in parallel in a

rectifier system, why are small resistors sometimes placed in series with the plate leads of the tubes?

175. A rectifier-filter power supply is designed to furnish 500 volts at 60 milliamperes to one circuit and 400 volts at 40 milliamperes to another circuit. The bleeder current in the voltage divider is to be 15 milliamperes. What value of resistance should be placed between the 500- and 400-volt taps of the voltage divider?

176. What is the approximate speed of a 220-volt, 60-cycle, 4-pole, 3-phase induction motor?

177. Draw a diagram of a shunt wound d. c. motor.

178. Draw a diagram of a voltage doubling power supply using two half wave rectifiers.

179. Why is degenerative feedback sometimes used in an audio amplifier?

180. What determines the fundamental operating frequency range of a multivibrator oscillator?

181. Draw a diagram of an audio amplifier with inverse feedback.

182. What is the meaning of "mutual conductance," and "amplification factor" in reference to vacuum tubes?

183. What is the purpose of a screen grid in a vacuum tube?

184. What is meant by secondary emission in a vacuum tube?

185. Why are grounded grid amplifiers sometimes used at very high frequencies?

186. What material is used in shields to prevent stray magnetic fields in the vicinity of radio-frequency circuits?

187. For maximum stability, should the tuned circuit of a crystal oscillator be tuned to exact crystal frequency?

188. What is the principal advantage of a class C amplifier?

189. Draw a diagram of a grounded grid amplifier.

190. A current-squared meter has a scale divided into 50 equal divisions. When 45 milliamperes flow through the meter the deflection is 45 divisions. What is the current flowing through the meter when the scale deflection is 25 divisions?

191. What is the ohms per volt of a voltmeter constructed of a 0-1 d. c. milliammeter and a suitable resistor which makes the full scale reading of the meter 500 volts?

192. What is the power output of an audio amplifier if the voltage across the load resistance of 500 ohms is 40 volts?

193. What type of meter is suitable for measuring peak a. c. voltage?

194. What type of meter is suitable for measuring the A. V. C. voltage in a standard broadcast receiver?

195. What type of meter is suitable for measuring radio-frequency currents?

196. What type of voltmeter absorbs no power from the circuit under test?

197. What type of voltmeter is appropriate to measure peak a. c. voltages?

198. If the spacing of the conductors in a two-wire radio-frequency transmission line is doubled, what change takes place in the surge impedance of the line?

199. If the conductors in a two-wire radio-frequency transmission line are replaced by larger conductors, how is the surge impedance affected, assuming no change in the center-to-center spacing of the conductor?

200. Why is an inert gas sometimes placed within concentric radio-frequency transmission cables?

201. What is the direction of maximum radiation from two vertical antennas spaced 180 degrees and having equal currents in phase?

202. Explain the properties of a quarter-wave section of a radio-frequency transmission line.

203. How does the field strength of a standard broadcast station vary with distance from the antenna?

204. What pattern on a cathode-ray oscilloscope indicates overmodulation of a standard broadcast station?

205. What is a Doherty amplifier?

206. Why do some standard broadcast stations use top-loaded antennas?

207. How may a standard broadcast antenna ammeter be protected from lightning?

208. What is the ratio of unmodulated carrier power to instantaneous peak power, at 100 percent modulation at a standard broadcast station?

209. What effect do broken ground conductors have on a standard broadcast antenna?

210. What may cause unsymmetrical modulation of a standard broadcast transmitter?

211. If the two towers of a 950-kilocycle directional antenna are separated by 120 electrical degrees, what is the tower separation in feet?

212. Draw a diagram showing how automatic volume control is accomplished in a standard broadcast receiver.

213. What is the required full scale accuracy of the plate ammeter and plate voltmeter of the final radio stage of a standard broadcast transmitter?

214. What is the maximum carrier shift permissible at a standard broadcast station?

215. In accordance with the Commission's Standards of Good Engineering Practice, what determines the maximum permissible full scale reading of indicating instruments required in the last radio stage of a standard broadcast transmitter?

216. When an X- or a Y-cut crystal is employed in the automatic frequency control equipment at a standard broadcast station, what is the maximum permitted temperature variation at the crystal from the normal operating temperature? (S.G.E.P.-A.M. 12.)

217. What is the purpose of a discriminator in an FM broadcast receiver?

218. Explain why high gain antennas are used at FM broadcast stations.

219. What is the frequency swing of an FM broadcast transmitter when modulated 60 percent?

220. An FM broadcast transmitter is modulated 50 percent by a 7,000-cycle test tone. When the frequency of the test tone is changed to 5,000 cycles and the percentage of modulation is unchanged, what is the transmitter frequency swing?

221. What is a common method of obtaining frequency modulation in an FM broadcast transmitter?

222. What is meant by pre-emphasis in an FM broadcast transmitter?

223. What is the purpose of a de-emphasis circuit in an FM broadcast receiver?

224. An FM broadcast transmitter operating on 98.1 megacycles has a reactance tube-modulated oscillator operating on a frequency of 4905 kilocycles. What is the oscillator frequency swing when the transmitter is modulated 100 percent by a 2,500-cycle tone?

225. What characteristic of an audio tone determines the percentage of modulation of an FM broadcast transmitter?

226. What determines the rate of frequency swing of an FM broadcast transmitter?

227. How wide a frequency band must the intermediate frequency amplifier of an FM broadcast receiver pass?

228. An FM broadcast transmitter is modulated 40 percent by a 5,000-cycle test tone. When the percentage of modulation is doubled, what is the frequency swing of the transmitter?

229. If an FM transmitter employs one doubler, one tripler and one quadrupler, what is the carrier frequency swing when the oscillator frequency swing is 2 kilocycles?

230. What is the purpose of a "reactance tube" in an FM broadcast transmitter?

231. What is a ratio detector?

232. How does the amount of audio power required to modulate a 1,000-watt FM broadcast transmitter compare with the amount of audio power required to modulate a 1,000-watt standard broadcast transmitter to the same percentage of modulation?

233. What is the purpose of a limiter stage in an FM broadcast receiver?

234. If the transmission line current of an FM broadcast transmitter is 8.5 amperes without modulation, what is the transmission line current when the percentage of modulation is 90 percent?

235. An FM broadcast transmitter has 370 watts plate power input to the last radio-frequency stage and an antenna field gain of 1.3. The efficiency of the last radio-frequency stage is 65 percent and the efficiency of the antenna transmission line is 75 percent. What is the effective radiated power?

236. Draw a diagram of an FM broadcast receiver detector circuit.

237. Draw a diagram of a means of modulation of an FM broadcast station.

238. Draw a diagram of a limiter stage in an FM broadcast receiver.

239. How is the operating power of an FM broadcast station determined?

240. If an FM broadcast station uses a total of 5 tubes of a given type at the transmitter, what is the minimum number of spare tubes of this type required at the transmitter?

241. What is the required frequency range of the indicating device on the frequency monitor at an FM broadcast station?

242. What is the audio frequency range that an FM broadcast station is required to be capable of transmitting? (R. & R. 3.254.)

243. How wide is an FM broadcast channel? (S.G.E.P.—F.M. 1.)

244. What frequency swing is defined as 100 percent modulation for an FM broadcast station? (S.G.E.P.—F.M. 1.)

245. What is the tolerance in operating power of FM broadcast stations? (R. & R. 3.267.)

246. What is the meaning of the term "Center Frequency" in reference to FM broadcasting? (S.G.E.P.—F.M. 1.)

247. Exclusive of monitors, what indicating instruments are

required in the transmitting system at an FM broadcast station? (R & R. 3.258.)

248. What is the required accuracy of instruments indicating the plate current and the plate voltage of the last radio stage or the transmission line current or voltage at an FM broadcast station? (S.G.E.P.—F.M. 9.)

249. What is the frequency tolerance of an FM broadcast station? (R. & R. 3.269.)

250. What is the meaning of the term "frequency swing" in reference to FM broadcast stations? (S.G.E.P.—F.M. 1.)

251. Why is a scanning technique known as "interlacing" used in television broadcasting?

252. Does the video transmitter at a television broadcast station employ frequency or amplitude modulation?

253. Does the sound transmitter at a television broadcast station employ frequency or amplitude modulation?

254. What is a monitor picture tube at a television broadcast station?

255. Describe scanning as used by television broadcast stations. Describe the manner in which the scanning beam moves across the picture in the receiver.

256. What is a mosaic plate in a television camera?

257. What is the purpose of synchronizing pulses in a television broadcast signal?

258. What is the effective radiated power of a television broadcast station if the output of the transmitter is 1,000 watts, antenna transmission line loss is 50 watts and the antenna power gain is 3? (R. & R. 3.681.)

259. Besides the camera signal, what other signals and pulses are included in a complete television broadcast signal?

260. What are synchronizing pulses in a television broadcasting and receiving system?

261. What are blanking pulses in a television broadcasting and receiving system?

262. For what purpose is a voltage of sawtooth wave form used in a television broadcast receiver.

263. In television broadcasting, what is the meaning of the term "aspect ratio"? (R. & R. 3.681.)

264. How many frames per second do television broadcast stations transmit?

265. In television broadcasting, why is the field frequency made equal to the frequency of the commercial power supply?

266. If the cathode ray tube in a television receiver is replaced by a larger tube such that the size of the picture is

changed from 8 by 6 inches to 16 by 12 inches, what change if any is made in the number of scanning lines per frame?

267. If a television broadcast station transmits the video signals in channel No. 6 (82 to 88 Mc), what is the center frequency of the aural transmitter? (R. & R. 3.682.)

268. What is the field frequency of a television broadcast transmitter?

269. How is the operating power of the aural transmitter of a television broadcast station determined? (R. & R. 3.689.)

270. Numerically, what is the aspect ratio of a picture as transmitted by a television broadcast station? (R. & R. 3.681.)

271. What is meant by vestigial side band transmission of a television broadcast station? (R. & R. 3.681.)

272. What is the frequency tolerance for television broadcast transmitters? (R. & R. 3.687.)

273. What is meant by antenna field gain of a television broadcast antenna?

274. How wide is a television broadcast channel? (R. & R. 3.682.)

275. If standard broadcast emissions are classified as A3 emission, what is the classification of television broadcast video emissions? (R. & R. 2.201.)

276. What is the range of audio frequencies that the aural transmitter of a television broadcast station is required to be capable of transmitting? (R. & R. 3.687.)

277. What is meant by one hundred percent modulation of the aural transmitter at a television broadcast station? (R. & R. 3.687.)

278. What is the frequency tolerance for a broadcast STL station? (R. & R. 4.561.)

279. What are the radio operator license requirements for the person on duty at an experimental television broadcast station? (R. & R. 4.166.)

280. What type of antenna is required at a broadcast STL station? (R. & R. 4.536.)

281. What is the frequency tolerance for a noncommercial educational FM broadcast station? (R. & R. 3.569.)

282. What are the licensed operator requirements for a TV broadcast station? An FM broadcast station? A 5-kw. nighttime directional standard broadcast station? (R. & R. 3.165, 3.265, 3.661.)

283. Under what conditions may a standard broadcast station be operated by remote control? (R. & R. 3.66.)

284. Within what limits is the operating power of a TV aural

or visual transmitter required to be maintained? (R. & R. 3.689.)

285. Describe the composition of the Chrominance subcarrier used in the authorized system of color television.

286. Describe the procedure and adjustments necessary to couple properly a typical VHF visual transmitter to its load circuits.

287. Draw a block diagram of a typical monochrome television transmitter indicating the function of each part.

288. Describe the scanning process employed in connection with color TV broadcast transmission.

289. Under what conditions should the indicating instruments of a TV visual transmitter be read in order to determine operating power?

290. In a transmitted monochrome television signal what is the relationship between peak carrier level and the blanking level? (R. & R. 3.682.)

291. Draw a simple schematic diagram of a T-type coupling network suitable for coupling a coaxial line to a standard broadcast antenna. Include means for harmonic attenuation.

ELEMENT V

RADIOTELEGRAPH OPERATING PRACTICE

1. List three classes of stations which may not be operated by the holder of a radiotelegraph third class operator permit. (R. & R. 13.61.)

2. Is the holder of a radiotelegraph third class operator permit authorized to make technical adjustments to a radiotelephone transmitter? To a radiotelegraph transmitter? (R. & R. 13.61.)

3. Where should the operator on duty at a manually operated radiotelegraph station normally post his operator license or permit? (R. & R. 13.6.)

4. What are the requirements for station identification at radiotelegraph stations in the Public Safety Radio Services? (R. & R. 10.152.)

5. What is the radiotelegraph distress signal? Urgency signal? Safety signal? (Art. 37-6, 35, 40.)

6. The speed of radiotelegraph code transmission in cases of distress, urgency or safety must not in general exceed what speed? (Art. 37-3.)

7. What radiotelegraph signal is generally used in a call "to all stations"? (Art. 31.)

8. What is meant by the following radiotelegraph operating signals:

R, AS, IMI, C, BT, K, AR, VA, DE?

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

10. When testing a radiotelegraph transmitter what signals are generally transmitted?

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.

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

13. In addition to the preamble what parts does a radiotelegraph message contain?

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

15. What does "word count" or "Check" mean in a radiotelegraph message?

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

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

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

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

20. In general what is the purpose of a service message in radiotelegraph communication?

21. Why are Q-signals or other arbitrarily selected procedure signals used in radiotelegraph communications?

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

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?

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?

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

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

27. What is meant by the statement "A station is open to public correspondence"?

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

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?

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

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?

32. Explain the use of the crystal filter switch on a communications receiver.

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

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

35. How should a radiotelegraph receiver be adjusted for the reception of type A-2 emissions?

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?

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?

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

ELEMENT VI

ADVANCED RADIOTELEGRAPH

1. By what other expression may a "difference of potential" be described?
2. By what other expression may an "electric current flow" be described?
3. Which factors determine the amplitude of the emf induced in a conductor which is cutting magnetic lines of force?
4. Name four methods by which an electrical potential may be generated.
5. State the three ordinary mathematical forms of Ohm's Law.
6. What is the unit of electrical power?
7. What is the unit of conductance?
8. What is the unit of inductance?
9. Define the term "conductance".
10. What is meant by "ampere turns"?
11. Define the term "inductance".
12. Define the term "coulomb".
13. State the formula for determining the quantity or charge of a condenser. The energy stored in a condenser.
14. What is the unit of resistance?
15. What unit is used in expressing the alternating current impedance of a circuit?
16. What is the unit of capacitance?
17. Define the term "decibel".
18. What factors determine the charge stored in a condenser?
19. State Ohm's Law for a. c. circuits.
20. What is the formula for determining the power in a d. c. circuit when the voltage and resistance are known?
21. What is the formula for determining the power in a d. c. circuit when the current and resistance are known?
22. What is the formula for determining the power in a d. c. circuit when the current and voltage are known?
23. What is the meaning of the prefix "kilo"?
24. What is the meaning of the prefix "micro"? "Micromicro"?
25. What is the meaning of "power factor"?
26. What is the meaning of the prefix "meg."?

27. Explain the factors which influence the resistance of a conductor.

28. What effect does the cross-section area of a conductor have upon its resistance per unit length?

29. Name four conducting materials in the order of their conductivity.

30. Name four materials which are good insulators at radio frequencies. Name four materials which are not good insulators at radio frequencies, but which are satisfactory for use at commercial power frequencies.

31. If the value of a resistance, across which a constant emf is applied, is doubled, what will be the resultant proportional power dissipation?

32. How may a magnetic compass be affected when placed within a coil carrying an electric current?

33. What single instrument may be used to measure electrical resistance? Electrical power? Electrical current? Electromotive force?

34. What is the sum of all voltage drops around a simple d. c. series circuit, including the source?

35. If the value of a resistance, to which a constant emf is applied, is halved, what will be the resultant proportional power dissipation?

36. If the diameter of a conductor of given length is doubled, how will the resistance be affected?

37. What is an electron? An ion?

38. With respect to electrons, what is the difference between conductors and non-conductors?

39. How can the direction of flow of d. c. electricity in a conductor be determined?

40. What is the difference between electrical power and electrical energy?

41. Does the resistance of a copper conductor vary with variations in temperature and if so, in what manner?

42. Describe an electrolyte.

43. What is the relationship between the effective value of a radio frequency current and the heating value of the current?

44. How many watts equal one horsepower?

45. What factors determine the heat generated in a conductor carrying an electric current?

46. What is the ratio of peak to average value of a sine wave?

47. What is the meaning of the term "leading power factor"?

48. What is meant by a "harmonic"?

49. What load conditions must be satisfied in order to obtain the maximum possible output from any power source?

50. What is the meaning of the term "phase difference"?

51. What method is used to obtain more than one value of voltage from a fixed voltage d. c. source?

52. What is the conductance of a circuit if 6 amperes flow when 12 volts d. c. is applied to the circuit?

53. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be one and one-half times the resistance of one unit.

54. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be one-third of one unit.

55. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be two-thirds the resistance of one unit.

56. Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be three times the resistance of one unit.

57. If two 10-watt, 500-ohm resistors are connected in parallel, what are the power dissipation capabilities of the combination?

58. What is the maximum rated current carrying capacity of a resistor marked "5,000 ohms, 200 watts"?

59. What will be the heat dissipation, in watts, of a resistor of 20 ohms having a current of one-quarter ($\frac{1}{4}$) ampere passing through it?

60. If the voltage applied to a circuit is doubled and the resistance of the circuit is increased to three times its former value, what will be the final current value?

61. If a vacuum tube having a filament rated at one-quarter ampere and 5 volts is to be operated from a 6-volt battery, what is the value of the necessary series resistor?

62. What should be the minimum power dissipation rating of a resistor of 20,000 ohms to be connected across a potential of 500 volts?

63. If two 10 watt, 500 ohm resistors are connected in series, what is the total power dissipation capability?

64. If two 10 watt, 500 ohm resistors are connected in parallel, what is the total power dissipation capability?

65. What is the maximum current carrying capacity of a resistor marked "5,000 ohms, 200 watts"?

66. What is the total resistance of a parallel circuit consisting

of one branch of 10 ohms resistance and one branch of 25 ohms resistance?

67. Two resistors are connected in series. The current through these resistors is 3 amperes. Resistor No. 1 has a value of 50 ohms; resistor No. 2 has a voltage drop of 50 volts across its terminals. What is the total impressed e.m.f.?

68. Two resistors of 18 and 15 ohms are connected in parallel; in series with this combination is connected a 36-ohm resistor; in parallel with this total combination is connected a 22-ohm resistor. The total current flowing through the combination is 5 amperes. What is the current value in the 15 ohm resistor?

69. A circuit is passing a current of 3 amperes. The internal resistance of the source is 2 ohms. The total external resistance is 50 ohms. What is the terminal voltage of the source?

70. A 10,000-ohm 100-watt resistor, a 40,000-ohm 50-watt resistor and a 5,000-ohm 10-watts resistor are connected in parallel. What is the maximum value of total current through this parallel combination which will not exceed the wattage rating of any of the resistors?

71. A certain keying relay coil has a resistance of 500 ohms and is designed to operate on 125 milliamperes. If the relay is to operate from a 110-volt d. c. source, what value of resistance should be connected in series with the relay coil?

72. If the power input to a radio receiver is 75 watts how many kilowatt hours does the receiver consume in 24 hours of continuous operation?

73. What is the total reactance when two capacitances of equal value are connected in series?

74. The charge in a condenser is stored in what portion of the condenser?

75. The voltage drop across an individual condenser of a group of condensers connected in series across a source of potential is proportional to what factors?

76. What is the formula used to determine the total capacitance of three or more capacitors connected in series?

77. If condensers of 5, 3, and 7 microfarads are connected in series, what is the total capacitance?

78. If condensers of 1, 3, and 5 microfarads are connected in parallel, what is the total capacitance?

79. Having available a number of condensers rated at 400 volts and 2 microfarads each, how many of these condensers would be necessary to obtain a combination rated at 1,600 volts and 1.5 microfarads?

80. Given two identical mica condensers of 0.1 mfd ca-

capacitance each. One of these is charged to a potential of 125 volts and disconnected from the charging circuit. The charged condenser is then connected in parallel with the uncharged condenser. What voltage will appear across the two condensers connected in parallel?

81. What will be the effect of a shorted turn in an inductance?

82. What is the relationship between the number of turns and the inductance of a coil?

83. State the formula for determining the resonant frequency of a circuit when the inductance and capacitance are known.

84. What is the formula for determining the wavelength when the frequency, in kilocycles, is known?

85. If the period of one complete cycle of a radio wave is 0.000001 second, what is the wave length?

86. What is meant by the efficiency of a radio device?

87. Indicate by a drawing a sine wave of voltage displaced 180° from a sine wave of current.

88. Draw a graph indicating how the plate current in a vacuum tube varies with plate voltage, grid bias remaining constant.

89. What is the total impedance of a capacitor and inductor having equal values of reactance, when connected in parallel?

90. What is the total inductance of two coils, connected in parallel but without any mutual coupling?

91. What is the total reactance of a series a. c. circuit containing no resistance, and equal values of inductive and capacitive reactance?

92. What is the total inductance of two coils, connected in series, but without any mutual coupling?

93. Indicate by a drawing two cycles of a radio frequency wave and indicate one wave length thereof.

94. A series inductance, acting alone in an alternating current circuit, has what properties?

95. What is meant by "shock" excitation of a circuit?

96. What are cathode rays?

97. What may be the effects of shielding applied to radio frequency inductances?

98. What is meant by the "fly-wheel" effect of a tank circuit?

99. Define "power factor".

100. Define "parasitic oscillations".

101. What is the effect of parasitic oscillations?

102. What is the velocity of propagation of radio frequency waves in space?

103. What changes in circuit constants will double the resonant frequency of a resonant circuit?

104. How may the "Q" of a parallel resonant circuit be increased?

105. If a parallel circuit, resonant at 1000 kilocycles, has its values of inductance halved and capacitance doubled, what will be the resultant resonant frequency?

106. What is the resonant frequency of a tuned circuit consisting of a condenser of 500 micromicrofarads, a tuning coil of 150 microhenrys and a resistance of 10 ohms?

107. Draw a diagram of a resistance load connected in the plate circuit of a vacuum tube and indicate the direction of electronic flow in this load.

108. Define "voltage regulation".

109. List four principles by which an e. m. f. may be generated by sound waves.

110. How can low power factor in an electrical power circuit be corrected?

111. Define the following terms: hysteresis, permeability, eddy currents.

112. What is meant by the "time constant" of certain electrical circuits containing resistance and capacitance?

113. What is the reactance of a 0.01 microfarad condenser at a frequency of 3000 cycles? What is the reactance of a 2 henry choke coil at the same frequency?

114. Assume an inductance of 5 henrys in parallel with a capacitance of one microfarad. If there is no resistance in either leg of this circuit, what is the equivalent impedance of the parallel network at resonance?

115. What is the total impedance of a series a. c. circuit having a resistance of 3 ohms, an inductive reactance of 7 ohms and zero capacitive reactance?

116. What is the total impedance of a series a. c. circuit having an inductive reactance of 14 ohms, a resistance of 6 ohms and a capacitive reactance of 6 ohms?

117. If a 220-volt, 60-cycle, single-phase line delivers 100 watts at 80 percent power factor to a load, what is the phase angle between the line current and the line voltage? How much current flows in the line?

118. List at least two essentials for making a good soldered connection.

119. Why should all exposed metal parts of a transmitter be grounded?

120. What is the ratio of peak to average values of a sine wave? Peak to effective voltage values of a sine wave?
121. Draw diagrams showing various ways by which three power transformers can be connected for operation on a three-phase circuit. Show how only two transformers can be connected for full operation on a three-phase circuit.
122. Define the term "reluctance".
123. Define the term "permeability".
124. What is the meaning of "residual magnetism"?
125. Which factors influence the direction of magnetic lines of force generated by an electromagnet?
126. What is the effect of adding an iron core to an air core inductance?
127. Name at least five pieces of radio equipment which make use of electromagnets.
128. Neglecting temperature coefficient of resistance and using the same gauge of wire and the same applied voltage in each case, what would be the effect upon the field strength of a single layer solenoid of a small increase in the number of turns?
129. Why may a transformer not be used with direct current?
130. Describe the physical structure of a triode vacuum tube.
131. Describe the physical structure of a tetrode vacuum tube.
132. Describe the physical structure of the triode, tetrode, and pentode vacuum tubes on a comparative basis.
133. Describe the electrical characteristics of the pentode, tetrode and triode vacuum tubes on a comparative basis.
134. Define the following terms in reference to vacuum tubes: Amplification factor, plate resistance, mutual conductance, and maximum inverse plate voltage.
135. What is the primary purpose of the control grid of a triode?
136. What is the primary purpose of the screen grid of a tetrode?
137. What is the primary purpose of the suppressor grid of a pentode tube?
138. What is the composition of filaments, heaters and cathodes in vacuum tubes?
139. Describe the construction of a "beam power" vacuum tube. In what types of circuits do these tubes find application?
140. What is the meaning of "electron emission"?
141. What is the meaning of "secondary emission"?
142. Describe the characteristics of a vacuum tube operating as a class A amplifier.

143. Describe the characteristics of a vacuum tube operating as a class B amplifier.

144. What are the factors which determine the bias voltage for the grid of a vacuum tube?

145. Draw a grid voltage-plate current characteristic curve of a vacuum tube and indicate the operating points for class A, class B, and class C amplifier operation.

146. Explain the operation of a triode vacuum tube as an amplifier.

147. Does d. c. grid current normally flow in a class A amplifier employing one tube?

148. Is the d. c. bias normally positive or negative in a class A amplifier?

149. What will be the effect of incorrect grid bias in a class A audio amplifier?

150. What is the approximate efficiency of a class A vacuum tube amplifier? Class B? Class C?

151. What is "space charge" in a vacuum tube?

152. What is a "getter" in a vacuum tube?

153. What types of vacuum tube emitting surfaces respond to reactivation?

154. Describe how reactivation may be accomplished.

155. Is a tungsten filament operated at higher or lower temperatures than a thoriated filament? Why?

156. What is indicated when a blue glow is noticed within a vacuum tube envelope?

157. Why should the cathode of an indirectly heated type of vacuum tube be maintained at nearly the same potential as the heater circuit?

158. Why is it important to maintain transmitting tube filaments at recommended voltages?

159. Why is it desirable to use an alternating current filament supply for vacuum tubes?

160. Why is it advisable to periodically reverse the polarity of the filament potential of high power vacuum tubes when a d. c. filament supply is used?

161. What is the purpose of a bias voltage on the grid of an audio frequency amplifier tube?

162. What is the primary purpose of a screen grid in a vacuum tube?

163. What is the primary purpose of a suppressor grid in a multi-element vacuum tube?

164. What circuit and vacuum tube factors influence the voltage gain of a triode audio frequency amplifier stage?

165. What is meant by the "load" on a vacuum tube?
166. What is meant by a "blocked grid"?
167. What is the meaning of the term "maximum plate dissipation"?
168. What is the meaning of the term "plate saturation"?
169. What is the most desirable factor in the choice of a vacuum tube to be used as a voltage amplifier?
170. What is the principal advantage of a tetrode over a triode as a radio-frequency amplifier?
171. Describe the characteristics of a vacuum tube operating as a class C amplifier.
172. During what approximate portion of the excitation voltage cycle does plate current flow when a tube is used as a class C amplifier?
173. What is meant by a "soft" vacuum tube?
174. Why are tubes, operated as class C amplifiers, not suited for audio frequency amplification?
175. What factors may cause low plate current in a vacuum tube amplifier?
176. Describe how a vacuum tube oscillates in a circuit?
177. Why must some radio frequency amplifiers be neutralized?
178. What are cavity resonators and in what type of radio circuits do they find application?
179. What determines the operating frequency of a magnetron oscillator? A klystron oscillator?
180. In what radio circuits do klystron and magnetron oscillators find application?
181. Explain the operation of a diode type of detector.
182. Explain the operation of a "grid leak" type detector.
183. What effect does an incoming signal have upon the plate current of a triode detector of the grid-leak type?
184. List and explain the characteristics of a "square law" type of vacuum tube detector.
185. Is a "grid leak" type of detector more or less sensitive than a "power" detector (plate rectification)? Why?
186. What is the principal advantage in the use of a diode detector instead of a grid-leak type triode detector?
187. What operating conditions determine that a tube is being used as a "power detector"?
188. When an alternating current filament supply is used, why is a filament center-tap usually provided for the vacuum tube plate and grid return circuits?
189. Explain how you would determine the value of cathode

bias resistance necessary to provide correct grid bias for any particular amplifier.

190. Given the following vacuum tube constants. $E_p=1,000$ volts, $I_p=150$ ma., $I_g=10$ ma., and grid leak=5,000 ohms, what would be the value of d. c. grid bias voltage?

191. A triode transmitting tube, operating with plate voltage of 1,250 volts, has filament voltage of 10, filament current of 3.25 amperes and plate current of 150 milliamperes. The amplification factor is 25. What value of control grid bias must be used for operation as a class C stage?

192. What currents will be indicated by a milliammeter connected between the center tap of the filament transformer of a tetrode, and negative high voltage (ground)?

193. What is a dynatron oscillator? Explain its principle of operation.

194. What is an electron-coupled oscillator? Explain its principle of operation.

195. Name four materials which can be used as "crystal" detectors.

196. Explain the operation of a "power" or "plate rectification" type of vacuum tube detector.

197. For what purpose is a "doubler" amplifier stage used? Draw the circuit and explain its operation.

198. Does a pentode vacuum tube usually require neutralization when used as a radio-frequency amplifier?

199. What is the function of a quartz crystal in a radio transmitter?

200. Name four advantages of crystal control over tuned circuit oscillators.

201. Why is the temperature of a quartz crystal usually maintained constant? What does the expression "a low temperature coefficient crystal" mean?

202. Why is a separate source of power sometimes desirable for the crystal oscillator unit of a transmitter?

203. What does the statement "the temperature coefficient of an X-cut crystal is negative" mean?

204. What will be the effect of applying a d. c. potential to the opposite plane surfaces of a quartz crystal?

205. What does the statement "the temperature coefficient of a Y-cut crystal is positive" mean?

206. What is a thermocouple?

207. What are wave guides and in what type of radio circuits do they find application?

208. Describe the physical structure of two types of transistor and explain how they operate as an amplifier.

209. What precaution should be observed when using and storing crystal microphones?

210. Draw a diagram of a single-button carbon microphone circuit, including the microphone transformer and source of power.

211. What effect does a change in the dielectric constant of a condenser dielectric material have upon the capacitance of a condenser?

212. Explain the effect of increasing the number of plates upon the capacitance of a condenser.

213. If the specific inductive capacity of a condenser dielectric material between the condenser plates were changed from 1 to 2, what would be the resultant change in capacitance?

214. Draw a circuit diagram showing the principle of operation of a telegraph keying relay.

215. What is meant by "self-wiping" contacts as used in connection with relays?

216. Why are permanent magnets used in head telephones? In d. c. meters?

217. What emergency repairs may be made to an inductance coil having burned or charred insulation?

218. Name four indications of a defective vacuum tube in a transmitter.

219. What factors determine the breakdown voltage rating of a condenser?

220. What cleaning agents may be used to clean the surfaces of a quartz crystal? Is such cleaning ever necessary? Explain.

221. What are the visible indications of a "soft" tube?

222. What is the impedance of a solenoid if its resistance is 5 ohms and 0.3 amperes flow through the winding when 110 volts at 60 cycles is applied to the solenoid?

223. What are some uses of a "low-pass" filter network?

224. What is a "swinging" choke?

225. What material is best suited for use as an antenna strain insulator which is exposed to the elements?

226. What material is frequently used for relay contacts? Why?

227. Why is rosin used as soldering flux in radio construction work?

228. What crystalline substance is widely used in crystal oscillators?

229. Why is the crystal in some oscillators operated at constant temperature?

230. What are the advantages of the single-button carbon microphone?

231. What precautions should be observed in the use of a double-button carbon microphone?

232. Draw a circuit diagram showing how a microphone can be connected to an audio amplifier.

233. Why should polarity be observed in connecting head telephones directly in the plate circuit of a vacuum tube?

234. In the operation of a class B audio amplifier stage, should the plate current fluctuate or should it remain at a steady value?

235. What turns ratio should a transformer have which is to be used to match a source impedance of 500 ohms to a load of 10 ohms?

236. What types of microphones have a high impedance output?

237. If low impedance head telephones of the order of 75 ohms are to be connected to the output of a vacuum tube amplifier, how may this be done to permit most satisfactory operation?

238. Why do headphone receivers used in radio communication usually have high impedance windings?

239. What is the purpose of a "choke" coil?

240. Draw a simple schematic diagram of a triode vacuum tube audio frequency amplifier inductively coupled to a loudspeaker.

241. Draw a simple schematic circuit showing a method of resistance coupling between two triode vacuum tubes in an audio frequency amplifier.

242. Draw a simple schematic diagram showing a method of transformer coupling between two triode vacuum tubes in an audio frequency amplifier.

243. Draw a simple schematic diagram of a method of impedance coupling between two vacuum tubes in an audio frequency amplifier.

244. Draw a simple schematic circuit showing a method of coupling a high impedance loudspeaker to an audio-frequency amplifier tube without flow of tube plate current through the speaker windings, and without the use of a transformer.

245. Draw a simple schematic diagram of a diode vacuum tube connected for diode detection, and showing a method of coupling to an audio amplifier.

246. Why is correct grid bias important in an audio frequency amplifier?

247. During what portion of the excitation voltage cycle does plate current flow when a tube is used as a class B amplifier?

248. Does a properly operated class A audio amplifier produce serious modification of the input wave form?

249. In a class A audio-frequency amplifier, what is the main advantage obtained through the use of two triodes in push-pull as compared to parallel operation?

250. What is the maximum permissible r.m.s. value of audio voltage which can be applied to the grid of a class A audio amplifier which has a grid bias value of 10 volts?

251. List four causes of distortion in a class A audio amplifier.

252. Name four applications for vacuum tubes operation as class A audio amplifiers.

253. Why is a push-pull audio frequency amplifier preferable to a single tube stage?

254. Draw a simple schematic diagram showing a method of "direct" coupling between two stages of an audio frequency amplifier.

255. What is the d. c. plate voltage of a resistance coupled amplifier stage which has a plate supply voltage of 260 volts, a plate current of one milliampere, and a plate load resistance of 100,000 ohms?

256. Why is it necessary to use two tubes in a class B audio amplifier?

257. What would be the effect of leakage in the coupling condenser in a conventional resistance coupled audio-frequency amplifier?

258. Why is it not feasible to employ a vacuum tube operated class C as an audio amplifier, either singly or in push-pull?

259. How may even-harmonic energy be reduced in the output of an audio-frequency amplifier?

260. What is the main advantage of a tuned audio-frequency amplifier in a receiver used for the reception of radiotelegraph signals?

261. What is the purpose of decoupling networks in the plate circuits of a multi-stage audio amplifier?

262. Why is an audio transformer seldom employed as the output device to be used in the plate circuit of a tetrode audio amplifier stage?

263. What is the chief advantage of class A audio operation as compared to other classes of audio-frequency amplifiers?

264. What is the principal advantage of transformer coupling compared to resistance coupling, as used in audio-frequency amplifiers?

265. What factors determine the efficiency of a power transformer?

266. What factors determine the ratios of primary and secondary currents in a power transformer?

267. What is the secondary voltage of a transformer which has a primary voltage of 100, primary turns 200, and secondary turns 40?

268. What factors determine the no-load voltage ratio of a power transformer?

269. What is the relationship between the turns ratio and the impedance ratio of the windings of a transformer?

270. Draw a simple schematic circuit diagram of a triode vacuum tube connected for plate or "power" detection.

271. Draw a simple schematic circuit diagram of a triode vacuum tube connected for grid-leak condenser detection.

272. How does a primary cell differ from a secondary cell?

273. What is "polarization" as applied to a primary cell and how may its effect be counteracted?

274. How may a dry cell be tested to determine its condition?

275. What material is used in the electrodes of a common dry cell?

276. What is an "A" battery? A "B" battery? A "C" battery?

277. How can the condition of charge of dry "B" batteries be determined?

278. What precaution should be observed in storing spare "B" batteries?

279. Draw a sketch showing the construction of a storage cell.

280. Define "specific gravity" as used in reference to storage batteries.

281. What are the main differences between Edison and lead-acid types of storage batteries?

282. What is the chemical composition of the electrolyte of a lead-acid storage cell?

283. What is the chemical composition of the active material composing the negative plate of a lead-acid type storage cell? The positive plate?

284. What is the chemical composition of the electrolyte used in an Edison type storage cell?

285. What is the chemical composition of the active material composing the negative plate of an Edison type storage cell? The positive plate?

286. What is the approximate fully charged voltage of an Edison storage cell?

287. Describe three causes of a decrease in capacity of an Edison type storage cell.

288. What is the approximate fully charged voltage of a lead-acid cell?

289. Why is low internal resistance desirable in a storage cell?

290. How may the condition of charge of an Edison cell best be determined?

291. How may the state of charge of a lead-acid storage cell be determined?

292. What are the effects of sulphation?

293. If the charging current through a storage battery is maintained at the normal rate, but its polarity is reversed, what will result?

294. If a hydrometer is not available how can the condition of charge of a storage battery be determined?

295. What is indicated if, in testing a storage battery, the voltage polarity of some of the cells in the battery is found reversed?

296. When should distilled water be added to a lead-acid storage cell and for what purpose?

297. What is the effect of local action in a lead-acid storage cell and how may it be compensated?

298. Describe the care which should be given a group of storage cells to maintain them in good operating condition.

299. What may cause the plates of a lead-acid storage cell to buckle?

300. What may cause "sulphation" of a lead-acid storage cell?

301. What chemical may be used to neutralize a storage cell acid electrolyte?

302. What steps may be taken to prevent corrosion of lead-acid storage cell terminals?

303. Why should adequate ventilation be provided in the room housing a large group of storage cells?

304. Show by a diagram how to connect battery cells in series.

305. Show by a diagram how to connect battery cells in parallel.

306. What is the meaning of "electrolyte"? List two types of radio equipment in which it may be used.

307. What is the effect of low temperatures upon the operation of a lead-acid storage battery?

308. What form of energy is stored in lead type storage batteries?

309. Draw a diagram of the charging circuits of two batteries using a four-pole double-throw switch such that while one battery

is on charge the other is on discharge. Indicate the d. c. power source, voltage dropping resistors and connections to the battery load.

310. How may the polarity of the charging source to be used with a storage battery be determined?

311. A storage battery with a terminal voltage of 12.5 is to be trickle charged at a 0.5 ampere rate. What value of resistance should be connected in series with the battery if the trickle charge is to be made from a 110-volt d. c. line?

312. A discharged storage battery of three cells has an open circuit voltage of 1.8 volts per cell and an internal resistance of 0.1 ohms per cell. What potential is necessary to produce an initial charging rate of 10 amperes?

313. What capacity storage battery is required to operate a 50-watt emergency radiotelegraph transmitter for 6 hours, assuming a continuous transmitter load of 70 percent of the key-locked demand of 40 amperes? The emergency light load is 1.5 amperes.

314. If you found that it was impossible to keep the receiver storage "A" battery charged, and at the same time maintain the required watch period, what remedy may be found?

315. What could cause abnormally low voltage at the input power terminals of a lifeboat radiotelegraph transmitter while it is in operation?

316. If an auxiliary storage battery has a voltage of 12.4 volts on open circuit and 12.2 volts when the charging switch is closed, what is the difficulty?

317. Why should the tops of lead-acid storage batteries be kept clean and free from moisture?

318. How may the condition of charge of an Edison cell be determined?

319. What special precautions should be taken when lead-acid storage cells are subject to low temperatures?

320. What should be done if the electrolyte in a lead-acid storage cell becomes low due to evaporation?

321. Why should an Edison storage battery not be charged at less than normal rate specified by the manufacturer? Explain.

322. Lacking an hydrometer, how may the state of charge of a storage battery be determined?

323. Your emergency lead-acid storage battery has a specific gravity of 1.120. What should be done?

324. Why should care be taken in the selection of water to be added to a storage cell to replace that lost by evaporation?

325. If you place the emergency batteries on charge and the

overload circuit breakers refuse to stay closed, what is the trouble?

326. What is the cause of the heat developed within a storage cell under charge or discharge condition?

327. What method of connection should be used to obtain the maximum short-circuit current from a group of similar cells in a storage battery?

328. What method of connection should be used to obtain the maximum no-load output voltage from a group of similar cells in a storage battery?

329. A 6-volt storage battery has an internal resistance of 0.01 ohm. What current will flow when a 3-watt, 6-volt lamp is connected?

330. Why does the charging rate to a storage cell, being charged from a fixed voltage source, decrease as charging progresses?

331. Draw a simple schematic circuit diagram of a rectifier and filter for supplying plate voltage to a radio receiver.

332. Explain the principle of operation of the cold cathode, gaseous rectifying diodes.

333. Discuss the uses of copper oxide rectifiers.

334. What are the primary advantages of a high-vacuum rectifier as compared to the hot-cathode mercury-vapor rectifier?

335. Compare the advantages and disadvantages of high-vacuum and hot-cathode mercury-vapor rectifier tubes.

336. Describe the construction and the operation of rectifier tubes that are used for charging batteries. Draw a diagram of a battery-charging circuit employing such a tube.

337. Draw a simple schematic diagram of a cold cathode electron tube connected as a voltage regulator. As a rectifier.

338. Why should the temperature of the filament or heater in a mercury-vapor rectifier tube reach normal operating temperature before the plate voltage is applied?

339. What are the advantages of the high-vacuum rectifier tube as compared to the hot cathode, gas-filled tube?

340. What action permits the high conduction currents of a hot cathode gas-filled rectifier tube?

341. Draw a simple circuit diagram of a voltage doubling power supply using two $\frac{1}{2}$ wave rectifiers.

342. What are the principal characteristics of a gas-filled rectifier tube?

343. What is the principal function of the filter in a power supply?

344. What are the relative advantages of the condenser-input and choke-input filters when used with rectifiers?

345. What is the primary advantage to be obtained by shunting a high-resistance fixed resistor across each unit of a high-voltage series condenser bank in the power supply filter circuit of a transmitter?

346. If part of the secondary winding of the power supply transformer of a transmitter were accidentally shorted, what would be the immediate effect?

347. Why are "bleeder" resistors used in power supplies?

348. What is the ratio of the frequencies of the output and input circuits of a single-phase full-wave rectifier?

349. Why is a condenser sometimes placed in series with the primary of a power transformer?

350. Why are small resistors sometimes placed in series with each plate lead of mercury-vapor rectifier tubes connected in parallel?

351. What is the maximum allowable total secondary voltage of a transformer to be used as a center-tapped full-wave rectifier in connection with rectifier tubes having a peak inverse voltage rating of 10,000 volts?

352. What would happen if a transformer, designed for operation on 60-cycle voltage were connected to a 120-cycle source of the same voltage?

353. What would happen if a transformer, designed for operation on 500 cycles, were connected to a 60-cycle source of the same voltage?

354. A marine transmitter uses 500-cycle alternating current for plate supply. It is rectified by a full wave rectifier circuit but is not filtered. How would the emission be classified?

355. What is the purpose of an air gap in the core of a filter choke coil?

356. What is the effect of loose laminations in a filter choke?

357. What is meant by "regulation" of a power supply? What causes poor regulation?

358. Why should the metallic case of a high-voltage transformer be "grounded"?

359. How may a filter condenser be checked for leakage?

360. Explain the principle of operation of an electrolytic condenser. What precaution should be observed when connecting electrolytic condensers in series?

361. List the main advantages of a full-wave rectifier as compared to a half-wave rectifier.

362. Why is it desirable to have low-resistance filter chokes?

363. When filter condensers are connected in series, resistors of high value are often connected across the terminals of the individual condensers. What is the purpose of this arrangement?

364. What is a desirable feature of an electrolytic condenser as compared to other types?

365. Indicate the approximate values of power supply filter inductances encountered in practice.

366. A radio receiver has a power transformer and rectifier designed to supply plate voltage to the vacuum tubes at 250 volts when operating from a 110-volt 60-cycle supply. What will be the effect if this transformer primary is connected to a 110-volt d. c. source?

367. Describe the action and list the main characteristics of a shunt wound d. c. motor.

368. Describe the action and list the main characteristics of a series wound d. c. motor.

369. What is meant by "counter emf" in a d. c. motor?

370. Explain the principle of operation and list the main characteristics of a compound wound d. c. motor and explain how the speed is regulated.

371. Why is laminated iron or steel generally used in the construction of the field and armature cores of motors and generators instead of solid metal?

372. What is the purpose of a commutator on a d. c. motor? On a d. c. generator?

373. Why is a series motor not used in radio power supply motor-generators?

374. What is the danger of operating a d. c. series motor without a load?

375. If the field of a shunt-wound d. c. motor were opened while the machine was running under no load, what would be the probable result(s)?

376. What is the purpose of "commutating poles" or "interpoles" in a d. c. motor?

377. What will be the effect(s) of a short circuit in an armature coil of a d. c. motor?

378. When starting a large d. c. motor-generator set what adjustment should be made to the motor field rheostat?

379. What may be the trouble if a motor generator fails to start when the start button is depressed?

380. Explain the principle of operation and list the main operating characteristics of a d. c. shunt generator and a d. c. compound generator. Explain how the voltage of a d. c. gen-

erator can be controlled. Draw a simple schematic circuit diagram of each of these types of generators.

381. Describe the action and list the main characteristics of a series wound d. c. generator.

382. When increased output voltage is desired from a motor-generator set, what is the usual procedure?

383. Describe the construction of a dynamotor. What are its operating characteristics?

384. How may the output voltage of a dynamotor be regulated?

385. What is the principal advantage in the use of a dynamotor, rather than a motor generator, to furnish plate power to a small mobile transmitter? Principal disadvantage?

386. Name four causes of excessive sparking at the brushes of a d. c. motor or generator.

387. Why are bypass condensers often connected across the brushes of a high voltage d. c. generator?

388. What may cause a motor-generator bearing to overheat?

389. How may the radio-frequency interference, often caused by sparking at the brushes of a high-voltage generator, be minimized?

390. Why should emery cloth never be used to clean the commutator of a motor or generator?

391. If a 3-horsepower, 110-volt d. c. motor is 85 percent efficient when developing its rated output, what will be the line current?

392. Explain the principle of operation of an induction motor and how such motors are started.

393. What determines the speed of a synchronous motor? An induction motor? A d. c. series motor?

394. What is the line current of a single-phase, 7-horsepower a. c. motor when operating from a 120-volt line at full rated load and at a power factor of 0.8 and 95 percent efficiency.

395. In what units is an alternator output ordinarily rated?

396. What conditions must be met before two a. c. generators can be operated in parallel?

397. What is the effect of an inductive load on the output voltage of an alternator?

398. Draw a simple schematic circuit diagram of three kinds of d. c. motors, including a starting device.

399. Draw a simple schematic diagram showing a Colpitts-type triode oscillator, with shunt-fed plate. Indicate power supply polarity.

400. Draw a simple schematic diagram of an electron coupled oscillator, indicating power supply polarities where necessary.

401. Draw a simple schematic diagram showing a Hartley triode oscillator with shunt-fed plate. Indicate power supply polarity.

402. Draw a simple schematic diagram showing a tuned-grid Armstrong-type triode oscillator with shunt-fed plate. Indicate power supply polarity.

403. Draw a simple schematic diagram showing a tuned-plate tuned-grid triode oscillator with shunt-fed plate. Indicate polarity of supply voltages.

404. Draw a simple schematic diagram of a crystal-controlled triode vacuum tube oscillator. Indicate power supply polarity.

405. Draw a simple schematic diagram of a pentode-type tube used as a crystal-controlled oscillator, indicating power supply polarities.

406. Draw a simple schematic diagram showing a tuned-plate tuned-grid oscillator with series-fed plate. Indicate polarity of supply voltages.

407. Draw a simple schematic diagram of a crystal-controlled vacuum tube oscillator using a tetrode-type tube. Indicate power supply polarity where necessary.

408. What will be the effect of a high degree of coupling between the plate and grid circuits of a quartz crystal oscillator?

409. Draw a simple schematic diagram of a crystal-controlled oscillator and means of coupling to the following radio-frequency amplifier stage, showing power supply polarities.

410. What type of oscillator depends upon secondary emission from the anode for its operation?

411. Draw a simple schematic diagram of a dynatron oscillator using a tetrode, indicating polarity of power supply voltages.

412. Why is an additional plate-grid feedback condenser sometimes necessary in a crystal oscillator?

413. Draw a simple schematic diagram of a Pierce oscillator.

414. What is the principal advantage to be gained by the use of a crystal-controlled oscillator in a marine radiotelegraph transmitter?

415. Discuss the advantages and disadvantages of self-excited oscillator and master oscillator-power amplifier transmitters.

416. What is the primary function of the power amplifier stage of a marine radiotelegraph transmitter?

417. What is the purpose of a buffer amplifier stage in a transmitter?

418. Draw a simple schematic diagram showing a method of coupling the radio frequency output of the final power amplifier stage of a transmitter to an antenna.

419. What class of amplifier should be employed in the final amplifier stage of a radiotelegraph transmitter for maximum plate efficiency?

420. Under what "class" of amplification are the vacuum tubes in a linear radio-frequency amplifier stage, following a modulated stage, operated?

421. If a final radio-frequency amplifier, operated as class B linear, were excited to saturation with no modulation, what would be the effects when undergoing modulation?

422. Define a class C amplifier.

423. Discuss the effects of insufficient radio-frequency excitation on a class C modulated radio-frequency amplifier insofar as the output signal wave form is concerned.

424. What is the second harmonic of 380 kilocycles?

425. What are the effects of overexcitation of a class B amplifier grid circuit?

426. What is the function of a grid leak in a class C amplifier?

427. Describe how a radio-frequency amplifier stage may be neutralized. What precautions must be observed.

428. Why is a "speech amplifier" used in connection with the modulator of a radiotelephone transmitter?

429. If the first speech amplifier tube of a radiotelephone transmitter were overexcited, but the percentage modulation capabilities of the transmitter were not exceeded, what would be the effect upon the output?

430. How should the bias of a grid modulated radio frequency stage be adjusted?

431. Compare the characteristics of plate and grid bias modulation.

432. What is meant by "low level" modulation?

433. Should the efficiency of a grid bias modulated stage be maximum at complete modulation or zero modulation? Explain.

434. Does grid current flow in the conventional grid bias modulated stage of a radiotelephone transmitter, under modulated conditions?

435. What might be the causes of a positive shift in carrier amplitude during modulation?

436. What is the ratio between the d. c. power input of the plate circuit of the stage being plate modulated, and the output audio power of the modulator for 100-percent sinusoidal modulation?

437. What increase in antenna current will be observed when a radiotelephone transmitter is modulated 100 percent by a sinusoidal wave form?

438. Why is a series resistor used in the d. c. plate supply of a modulated radio-frequency amplifier, between the amplifier and the modulator, in a Heising modulation system?

439. What is the purpose of the plate choke used in Heising modulation?

440. The d. c. plate input to a modulated class C amplifier, with an efficiency of 60 percent, is 200 watts. What value of sinusoidal audio power is required in order to insure 100-percent modulation? 50-percent modulation?

441. A ship's transmitter has an antenna current of 8 amperes using A-1 emission. What would the antenna current be when this transmitter is 100-percent modulated by sinusoidal modulation?

442. If a transmitter is adjusted for maximum power output for telegraph operation, why must the plate voltage be reduced if the transmitter is to be amplitude modulated?

443. In a series-fed plate circuit of a vacuum tube amplifier, what would be the result of a short circuit of the plate bypass condenser?

444. In a shunt-fed plate circuit of a vacuum tube amplifier, what would be the result of a short circuit of the plate RF choke coil?

445. What is the total band width of a transmitter using A-2 emission with a modulating frequency of 800 cycles and a carrier frequency of 500 kilocycles?

446. What is the correct value of negative grid bias, for operation as a class B amplifier, for a vacuum tube of the following characteristics: Plate voltage 1,000, plate current 127 milliamperes, filament voltage 4 volts, filament current 5.4 amperes, mutual conductance 8,000 micromhos, and amplification factor 25?

447. What is the meaning of "carrier shift"? What may cause a positive carrier shift in a linear radio-frequency amplifier output?

448. Name three instruments which may be used as indicating devices in neutralizing a radio frequency amplifier stage of a transmitter.

449. Draw a simple schematic circuit of a radio-frequency doubler stage, indicating any pertinent points which will distinguish this circuit as that of a frequency doubler. Describe its operation.

450. Draw a block diagram of a MOPA radiotelegraph transmitter with the master oscillator operating on 2017.5 kc. and the transmitter output on 8,070 kc.

451. What factors are most important in the operation of a vacuum tube as a frequency doubler?

452. If a 1500-kilocycle radio wave is modulated by a 2000-cycle sine wave tone, what frequencies are contained in the modulated wave?

453. What precautions should be observed in tuning a transmitter to avoid damage to components?

454. Draw a complete schematic diagram of a system of inductive coupling between the output of a radio-frequency amplifier and an antenna system.

455. What is the result of excessive coupling between the antenna and output circuits of a self-excited type of vacuum tube transmitter?

456. Draw a simple schematic diagram of a system of keying in the primary of the transformer supplying high voltage to a vacuum tube transmitter. Indicate any values of inductance, resistance, capacitance which may be deemed necessary to fully understand the correct operation of this type of keying.

457. In a transmitter involving a master-oscillator, intermediate amplifier and final amplifier, describe the order in which circuits should be adjusted in placing this transmitter in operation.

458. Should the antenna circuit of a master-oscillator, power-amplifier type of transmitter be adjusted to the resonant frequency before the plate tank circuit of the final stage? Give the reason(s) for your answer.

459. What may cause a radio-frequency amplifier tube to have excessive plate current?

460. What are the disadvantages of using a self-excited oscillator-type of transmitter for shipboard service?

461. How is the degree of coupling varied in a pi network used to transfer energy from a vacuum tube plate circuit to an antenna?

462. Compare the selectivity and sensitivity of the following receivers:

- (a) Tuned radio-frequency receiver.
- (b) Superregenerative receiver.
- (c) Superheterodyne receiver.

463. Why is it sometimes necessary to provide a radio-frequency filter in the plate circuit of a detector tube?

464. In a radio-frequency amplifier, employing fixed bias, as the plate circuit is varied in adjustment from a point below resonance to a point above resonance, what effect will be observed on the grid current?

465. In a self-biased radio-frequency amplifier stage having a plate voltage of 1,250, a plate current of 150 milliamperes, a grid current of 15 milliamperes, and a grid leak resistance of 4,000 ohms, what is the value of operating grid bias?

466. In a series-fed plate circuit of a vacuum-tube amplifier, what would be the effect of a short circuit of the plate supply bypass condenser?

467. In a shunt-fed plate circuit of a vacuum-tube amplifier, what would be the effect of an open circuit in the plate radio-frequency choke?

468. Explain how you would determine the value of cathode-bias resistor for a specific amplifier stage.

469. Draw a simple schematic diagram showing a method of "link" coupling between two radio-frequency amplifier stages.

470. What is the advantage of link coupling between radio-frequency amplifier stages?

471. What is the effect of excessive coupling between the output circuit of a simple oscillator and an antenna?

472. How is the power output of a marine vacuum tube radiotelegraph transmitter ordinarily adjusted?

473. Why should a transmitter be tuned initially at reduced power?

474. What is meant by "split tuning"?

475. What is meant by a "self-rectified" circuit, as employed in marine vacuum tube radiotelegraph transmitters?

476. If the power of a 500-kilocycle transmitter is increased from 150 watts to 300 watts, what would be the percentage change in field intensity at a given distance from the transmitter? What would be the db change in field intensity?

477. Draw a sketch of a typical shipboard antenna for transmitting on 500 kilocycles showing the supporting insulators, the safety link and the lead-in wire. How does voltage vary along the length of the lead-in and along the antenna?

478. Draw a block diagram of an FM transmitter.

479. Show by a diagram how a radiotelegraph transmitter can be keyed by the use of a keying relay.

480. List the various points in a radiotelegraph transmitter where keying can be accomplished.

481. What is meant by break-in operation at a radiotelegraph station and how is it accomplished?

482. What is meant by frequency shift keying and how is it accomplished?

483. Draw a simple circuit diagram of a transmitter using an oscillator coupled to the antenna, with the oscillator using a

self-rectifying circuit for operation directly from an a. c. generator.

484. Does the code speed or number of words per minute transmitted have any effect on the band width of the emission from a radiotelegraph transmitter?

485. How is the keying of a simple oscillator-type of emergency marine transmitter usually accomplished?

486. If the plate current of the final radio-frequency amplifier in a transmitter suddenly increased and radiation decreased, although the antenna circuit is in good order, what would be the possible causes?

487. What care should be taken in hoisting the antenna of a shipboard radiotelegraph station to avoid damage to the antenna wire and insulators?

488. If a 500-kilocycle transmitter of constant power produces a field strength of 100 microvolts per meter at a distance of 100 miles from the transmitter, what would be the theoretical field strength at a distance of 200 miles from the transmitter?

489. If the antenna current at a 500-kilocycle transmitter is reduced 50 percent, what would be the percentage change in the field intensity at the receiving point?

490. At what point on a shipboard antenna system will the maximum potential be found?

491. What are some of the indications of a defective vacuum tube in a transmitter?

492. A master-oscillator, power-amplifier type of transmitter has been operating normally. Suddenly the antenna ammeter reads zero, although all filaments are burning and plate and grid meters are indicating normal voltages and currents. What would be the possible cause(s)?

493. What is the effect upon a transmitter of dirty or salt-encrusted antenna insulation?

494. Describe a means of reducing sparking at the contacts of a key used with a radiotelegraph transmitter.

495. What will be the effect of a swinging antenna upon the output of a self-excited oscillator transmitter? A master-oscillator-power-amplifier transmitter?

496. What effect upon the plate current of the final amplifier stage will be observed as the antenna circuit is brought into resonance?

497. How may instruments used to indicate various direct currents and voltages in a transmitter be protected against damage due to stray r. f. energy?

498. In a radiotelegraph transmitter employing a d. c. gen-

erator as a source of plate voltage, an a. c. generator as filament supply and grid bias keying, if it is noted that when the key contacts are open the emission continues, what could be the trouble?

499. A station has an assigned frequency of 8,000 kilocycles and a frequency tolerance of plus or minus 0.04 percent. The oscillator operates at one-eighth of the output frequency. What is the maximum permitted deviation of the oscillator frequency, in cycles, which will not exceed the tolerance?

500. A transmitter is operating on 5000 kilocycles, using a 1000-kilocycle crystal with a temperature coefficient of -4 cycles/megacycle/degree centigrade. If the crystal temperature increases 6° centigrade, what is the change in the output frequency of the transmitter?

501. What should be the approximate surge impedance of a quarter wave length matching line used to match a 600-ohm feeder to a 70-ohm antenna?

502. What determines the surge impedance of a 2-wire non-resonant radio-frequency transmission line?

503. Draw a simple schematic diagram of a "key click filter" suitable for use when a vacuum tube transmitter is keyed in the negative high-voltage circuit.

504. What is the crystal frequency of a transmitter having three "doubler" stages and an output frequency of 16,870 kilocycles?

505. Draw a simple schematic diagram showing how a radio-telegraph transmitter may be keyed by the "grid blocking" method.

506. What is the effect on the resonant frequency of connecting a capacitor in series with an antenna? Of connecting an inductor in series with an antenna?

507. What is the relationship between the electrical and physical length of a Hertzian antenna?

508. If you desire to operate on a frequency lower than the resonant frequency of an available Marconi antenna, how may this be accomplished?

509. What will be the effect upon the resonant frequency if the physical length of a Hertzian antenna is reduced?

510. Which type of antenna has a minimum of directional characteristics in the horizontal plane?

511. If the resistance and the current at the base of a Marconi antenna are known, what formula could be used to determine the power in the antenna?

512. Describe the directional characteristics, if any, of the following types of antennas:

- (a) Horizontal Hertz antenna.
- (b) Vertical Hertz antenna.
- (c) Vertical loop antenna.
- (d) Horizontal loop antenna.
- (e) Vertical Marconi antenna.

513. What type of modulation is largely contained in "static" and "lightning" radio waves?

514. What is the difference between a Hertz and a Marconi antenna?

515. Draw a diagram showing how current varies along a half-wave length Hertz antenna.

516. What is meant by polarization of a radio wave? How does polarization affect the transmission and reception of a radio wave?

517. What are the lowest radio frequencies useful in radio communication?

518. What radio frequencies are useful for long-distance communications requiring continuous operation?

519. What frequencies have substantially straight-line propagation characteristics analogous to those of light waves and unaffected by the ionosphere?

520. What effect do sunspots and aurora borealis have on radio communications?

521. What is meant by harmonic radiation?

522. Why does harmonic radiation from a transmitter sometimes cause interference at distances from a transmitter where the fundamental signal cannot be heard?

523. What is the primary reason for the suppression of radio-frequency harmonics in the output of a transmitter?

524. Draw a simple schematic diagram of a wave trap in an antenna circuit for attenuating an interfering signal.

525. Define type A1, A2, A3, A4, and B emissions. (R. & R. 2.201.)

526. Name four devices that could be used to indicate oscillation in a crystal oscillator.

527. Why is an artificial antenna sometimes used in testing a transmitter? By what other names is this instrument known?

528. What are the general characteristics of the emission of a radiotelegraph transmitter which uses a chopper to obtain A-2 emission?

529. In general, what advantages may be expected from the use of high frequencies in radio communication?

530. Why do many marine transmitters employ variometers rather than variable condensers as the tuning elements?

531. What is the relationship between the antenna current and radiated power of an antenna?

532. What is the purpose of the iron compound cylinders which are found in the inductances of certain marine radiotelegraph transmitters? The position of these cylinders, with respect to the inductances, is adjustable for what purpose?

533. What is the meaning of "high level" modulation?

534. Draw a block diagram of a superheterodyne receiver capable of receiving continuous wave radiotelegraph signals.

535. Draw a block diagram of superheterodyne receiver designed for reception of FM signals.

536. Draw a block diagram of a tuned radio-frequency type receiver.

537. Describe the principle of operation of a "super regenerative" receiver.

538. What is the purpose of a tuned radio-frequency amplifier stage ahead of the mixer stage of a superheterodyne receiver?

539. What is the "mixer" tube in the superheterodyne receiver?

540. Knowing the intermediate frequency and the signal to which a superheterodyne receiver is tuned, how would you determine the most probable frequency on which "image" reception would occur?

541. A superheterodyne-type receiver is adjusted to 2738 kilocycles. The intermediate frequency is 475 kilocycles; what is the frequency to which the grid circuit of the second detector must be tuned?

542. Explain the reasons why a superheterodyne receiver may not be successfully used for reception of frequencies very near the frequency of the intermediate frequency amplifier.

543. Why do some superheterodyne receivers employ a crystal-controlled oscillator in the first detector?

544. How should a superheterodyne communications receiver be adjusted for maximum response to weak CW signals? To strong CW signals?

545. Why should a superheterodyne receiver, used for the reception of A-1 signals, be equipped with at least one stage of radio-frequency amplification ahead of the first detector?

546. What is the chief advantage to be gained in the utilization of high intermediate frequencies in a superheterodyne receiver?

547. If a superheterodyne receiver is receiving a signal on

1000 kilocycles, and the mixing oscillator is tuned to 1500 kilocycles, what is the intermediate frequency?

548. How may "image response" be minimized in a super-heterodyne receiver?

549. In a tuned radio frequency receiver, what is the advantage of heterodyne reception as compared to autodyne reception?

550. Describe the operation of a regenerative-type receiver.

551. Discuss the relative advantages and disadvantages of a stage of radio-frequency amplification as compared to a stage of audio-frequency amplification for use in connection with regenerative receiver?

552. What controls determine the selectivity of a 3-circuit receiver?

553. What are the objections to the operation of a regenerative, oscillating detector receiver, when directly coupled to an antenna?

554. If a ship's regenerative receiver failed to oscillate when the regeneration control was advanced, explain the possible causes and remedies.

555. Explain how you would test the various components of a receiver of the 3-circuit regenerative-type in "trouble shooting".

556. What may be the cause of noisy operation of a regenerative, 3-circuit receiver, having 2 stages of audio-frequency amplification?

557. Describe how you could test a regenerative receiver to determine if the detector is in an oscillating condition.

558. Using a regenerative receiver, without radio-frequency amplifier stages, describe how you would adjust to receive radiotelegraph signals through interference.

559. If broadcast signals interfered with your reception of signals on 500 kilocycles while aboard ship, how would you reduce or eliminate such interference?

560. How may a regenerative-type receiver be adjusted for maximum sensitivity?

561. What types of radio receivers do not respond to static interference?

562. Name three causes of an audio "howl" in a regenerative receiver.

563. Draw a circuit diagram of a crystal detector receiver and explain its principle of operation. Name two substances that can be used as the crystal in such a receiver.

564. Draw a simple schematic circuit diagram of an FM receiver discriminator.

565. If signals are heard with the headphones plugged into

the detector plate circuit of a receiver, but no signals are heard when phones are plugged into the first audio-frequency amplifier stage plate circuit, what might be the cause and how could it be remedied?

566. What is the purpose of an oscillator in a receiver operating on a frequency near the intermediate frequency of the receiver?

567. What is the purpose of a wave-trap in a radio receiver?

568. Draw a diagram showing a method of obtaining grid bias for a filament-type vacuum tube by use of resistance in the plate circuit of the tube.

569. Give four reasons which would prevent a regenerative receiver from oscillating.

570. Why are bypass condensers used across the cathode bias resistors of a radio-frequency amplifier?

571. What is the purpose of shielding between radio-frequency amplifier stages?

572. Draw a simple schematic diagram showing a method of "impedance" couplings between two stages of a radio-frequency amplifier.

573. Draw a simple schematic diagram showing a method of inductive or transformer coupling between two stages of a radio-frequency amplifier.

574. What is the purpose of an electrostatic shield?

575. What is the purpose of an auxiliary receiving antenna installed on a vessel which is also fitted with a direction finder?

576. How is "automatic volume control" accomplished in a receiver?

577. What is the purpose of a center-tap connection in a filament-supply transformer?

578. Draw a simple schematic diagram showing a method of coupling between two tetrode vacuum tubes in a tuned radio-frequency amplifier.

579. Draw a simple schematic diagram showing a method of coupling between two triode vacuum tubes in a tuned radio-frequency amplifier and a method of neutralizing to prevent oscillation.

580. Draw a simple schematic circuit of a regenerative detector.

581. What might be the cause of low sensitivity of a 3-circuit regenerative receiver?

582. What effects might be caused by a shorted grid condenser in a 3-circuit regenerative receiver?

583. Explain the purpose and operation of the first detector in a superheterodyne receiver.

584. Draw a diagram showing a method of obtaining grid bias for an indirectly heated cathode-type vacuum tube by use of resistance in the cathode circuit of the tube.

585. What is the advantage of using iron cores of special construction in radio-frequency transformers and inductances?

586. In the operation of a regenerative-type receiver how is oscillation of the detector indicated?

587. Draw a circuit diagram of a superheterodyne receiver with automatic volume control and explain the principle of operation.

588. To what frequency, or band of frequencies, is an approved auto-alarm receiver tuned?

589. What signal will cause an approved auto-alarm receiver to ring the warning bell?

590. What factor(s) determine the setting of the sensitivity control of an auto-alarm receiver approved for installation on a vessel of the United States?

591. On a vessel of the United States, equipped with an approved type of auto-alarm which employs a linear detector and an electronic selector, what factors cause the bell to sound? The warning light to operate?

592. With an auto alarm of the type which employs a square law detector and a mechanical selector, what factors cause the bell to sound? The warning light to operate?

593. With an auto alarm of the type which employs a linear detector and an electronic selector, what is the most probable cause of the intermittent ringing of the bells?

594. If you were a radio operator on a vessel of the United States, equipped with an approved type of auto alarm which employs a linear detector and an electronic selector, what would happen upon failure of a vacuum tube filament?

595. If an auto-alarm bell rings, and upon pressing the release button it stops, what could be the cause(s) of the ringing?

596. If an auto-alarm bell rings, and upon pressing the release button it does not stop, what could be the cause(s)?

597. With an auto alarm of the type which employs a square-law detector and a mechanical selector, why does this alarm receiver not respond to type A-1 emission?

598. If a vacuum-tube heater burns out, in an approved auto alarm, what causes the warning bells to ring?

599. Why are the unused portions of inductances in receivers sometimes shorted?

600. How may harmonic radiation of a transmitter be prevented?

601. What is a "crystal filter" as used in a superheterodyne receiver?

602. What means usually are provided to prevent the operation of the ship's transmitter when the auto-alarm receiver is in use?

603. What is indicated in a radio-telephone transmitter by an increase in antenna current without carrier shift?

604. If a vacuum tube in the only radio-frequency stage of your receiver burned out, how could you make temporary repairs to permit operation of the receiver if no spare vacuum tube was available?

605. What is the purpose of a crystal filter in the IF stage of a superheterodyne communications receiver? Under what conditions is this filter used?

606. Describe the construction and characteristics of a "D'Arsonval"-type meter.

607. If 2 ammeters are connected in series, how may the total current through the 2 meters be determined?

608. If 2 ammeters are connected in parallel, how may the total current through the 2 meters be determined?

609. If two voltmeters are connected in series, how would you be able to determine the total drop across both instruments?

610. Describe the construction and characteristics of a repulsion-type ammeter.

611. Describe the construction and characteristics of a dynamometer-type indicating instrument.

612. Describe the construction and characteristics of a thermocouple-type of meter; of a wattmeter.

613. How may a d. c. milliammeter, in an emergency, be used to indicate voltage?

614. What is the purpose of a multiplier resistor used with a voltmeter?

615. What is the purpose of a "shunt" as used with an ammeter?

616. Show by a diagram how a voltmeter and ammeter should be connected to measure power in a d. c. circuit.

617. Draw a simple circuit diagram showing the principle of operation of an ohmmeter.

618. Indicate by a diagram how the total current in 3 branches of a parallel circuit can be measured by 1 ammeter.

619. What instrument measures electric power?

620. What instrument measures electrical energy?

621. What is indicated if a voltmeter connected between the negative side of a ship's d. c. line and ground reads the full-line voltage?

622. Why are copper-oxide rectifiers, associated with d. c. voltmeters for the purpose of measuring a. c., not suitable for the measurement of voltages at radio frequencies?

623. Is the angular scale deflection of a repulsion iron vane ammeter proportional to the square or square root of the current or merely directly proportional to the current?

624. How may the power in an a. c. circuit be determined?

625. The product of the readings of an a. c. voltmeter and ammeter in an a. c. circuit is called what?

626. Does an a. c. ammeter indicate peak, average, or effective values of current?

627. What types of meters may be used to measure radio-frequency currents?

628. How may the range of a thermocouple ammeter be increased?

629. Does the scale of an a. c. ammeter indicate peak, effective, or average current values? Explain your answer.

630. By what factor must the voltage of an a. c. circuit, as indicated on the scale of an a. c. voltmeter, be multiplied in order to obtain the average voltage value?

631. A milliammeter with a full-scale deflection of 1 milliampere and having an internal resistance of 25 ohms is used to measure an unknown current by shunting it with a 4-ohm resistance. When the meter reads 0.4 milliampere, what is the actual value of current?

632. If a d. c. voltmeter is used to measure effective alternating voltages by the use of a bridge-type full-wave rectifier of negligible resistance, by what factor must the meter readings be multiplied in order to give corrected readings?

633. By what factor must the voltage of an a. c. circuit, as indicated on the scale of an a. c. voltmeter, be multiplied in order to obtain the peak value?

634. What precautions should be used when an absorption-type frequency-meter is used to measure the output of a self-excited oscillator?

635. What is the meaning of "zero beat" as used in connection with frequency-measuring equipment?

636. If a wavemeter, having an error proportional to the frequency, is accurate to 20 cycles, when set at 1,000 kilocycles, what is its error when set at 1,250 kilocycles?

637. What precautions should be taken before using a heterodyne-type of frequency meter?

638. What are the advantages and disadvantages of using an absorption-type wavemeter in comparison to other types of frequency meters?

639. Draw a simple schematic diagram of an absorption-type wavemeter.

640. An absorption-type wavemeter indicates that the approximate frequency of a ship transmitter is 500 kilocycles and at the same time the transmitter signal produces a zero beat on an accurately calibrated heterodyne-frequency meter at a dial reading of 374.1. The frequency-meter calibration book indicates dial readings of 367.0, 371.5 and 376.0 for frequencies of 499.4/998.8, 499.6/999.2, and 499.8/999.6 kilocycles, respectively. What is the frequency of the ship transmitter?

641. A certain frequency meter contains a crystal oscillator, a variable oscillator, and a detector. What is the purpose of each of these stages in the frequency meter?

642. What is a "multivibrator"? Explain its principle of operation.

643. Draw a simple circuit diagram of a multivibrator oscillator.

644. What determines the fundamental operating frequency of a multivibrator oscillator?

645. How do multivibrator oscillators differ from Hartley oscillators? In what circuits do multivibrator oscillators find application?

646. Do oscillators operating on adjacent frequencies have a tendency to synchronize oscillation or drift apart in frequency?

647. With measuring equipment that is widely available, is it possible to measure a frequency of 10,000,000 cycles to within 1 cycle of the exact frequency?

648. What is the directional reception pattern of a loop antenna?

649. What is the reception pattern of a vertical antenna.

650. What is the principal function of a vertical antenna, associated with a unilateral radio direction finder?

651. What is the principal function of a vertical antenna associated with a bilateral radio direction finder?

652. What figure represents the reception pattern of a properly adjusted unilateral radio direction finder?

653. From how many simultaneous directions is a direction finder capable of receiving signals if adjusted to take unilateral bearings through 360° ?

654. How is the unilateral effect obtained in a direction finder?
655. What is the function of the "balancing" condenser in a direction finder?
656. Why are loop antennas, associated with radio direction finders, metallicly shielded?
657. What is a "compensator" as used with radio direction finders, and what is its purpose?
658. What is indicated by the bearing obtained by the use of a bilateral radio direction finder?
659. On shipboard, what factors may affect the accuracy of a direction finder after it has been properly installed, calibrated, and compensated?
660. Describe the construction and operation of a shielded loop antenna as used with a marine direction finder.
661. Draw a sketch showing how a "fix" on a ship station can be obtained by taking direction finder bearings.
662. What is indicated by the bearing obtained by the use of a unilateral radio direction finder?
663. Within what frequency-band limits do all United States marine radio-beacon stations operate?
664. In what part of the radio-frequency spectrum do marine radar systems operate?
665. Draw a simple block diagram showing the essential components of a radar system. Label the components such as receiver, indicator, etc.
666. Approximately at what speed does the antenna of a navigational radar rotate?
667. How should a radar set be adjusted by the operator to reduce "sea return"?
668. What is the average plate power input to a radar transmitter if the peak pulse power is 15 kilowatts, the pulse length is 2 microseconds and the pulse repetition frequency is 900 cycles?
669. In determining a "fix" or position by a marine loran system, what is the minimum number of land transmitters involved?
670. What is the relationship between a master and a slave station in reference to loran navigation systems?
671. How can the operator of a loran receiver on shipboard identify the transmitting stations that are being received?
672. During daytime hours approximately what is the maximum distance in nautical miles from loran transmitting stations that loran lines of position can be determined?
673. Explain why pulse emission rather than continuous waves

is used by loran transmitters. Approximately what pulse repetition frequency, pulse duration, and operating frequency are used in loran systems?

674. When several pairs of loran transmitting stations are operating on the same frequency, how does the operator at a loran receiver select the desired pair of transmitting stations?

675. Draw a simple sketch showing relative position of pairs of master and slave stations of a loran navigation system and indicate lines of position of each pair of stations.

676. What is the purpose of "blinking" in a loran navigational system and how is blinking recognized at the receiver?

677. What precautions should an operator or serviceman observe when working with cathode ray tubes and the associated circuits of radar and loran receivers?

678. If the velocity of a radio wave is 186,000 statute miles per second, how many nautical miles does a radar pulse travel in 1 microsecond?

679. What is the primary standard of frequency for radio-frequency measurements for all licensed radio stations? (R. & R. 2.1.)

680. What is the meaning of "frequency tolerance"? (R. & R. 8.7.)

681. For what period of time must a station log, which contains entries incident to a disaster, be retained? (R. & R. 8.115.)

682. Under what circumstances may a station be operated by an unlicensed person?

683. In all cases other than those in which the transmitter output must be maintained at a fixed value, what amount of power should be employed for routine communication?

684. What is the definition of a "station open to public service"?

685. If an operator is employed at more than one station, how may he comply with the rule requiring the posting of operator licenses? (R. & R. 13.74.)

686. In the transmission of the International Morse Code what are the relative time lengths of dashes, dots, and spaces? (T. R. 34-4.)

687. Why is the clock in a compulsorily equipped ship radio-telegraph station required to have a sweep seconds hand? (R. & R. 8.515, 8.206.)

688. Between what points on a ship, compulsorily equipped with a radio-telegraph installation, is a reliable intercommunication system required? (R. & R. 8.513.)

689. What experience is the holder of a first- or second-class

radiotelegraph operator license required to have before he is permitted to act as chief or sole operator on a compulsorily radio-equipped cargo ship? (R. & R. 13.61.)

690. Are there any age requirements that a person must meet before he can be issued a radiotelegraph operator license? (R. & R. 13.12.)

691. What action, if any, may a radio operator take when he observes a ship station flagrantly violating the international radio regulations and causing harmful interference to other stations? (R. & R. 8.602.)

692. Upon compulsorily equipped vessels, which are required to have an accurate clock in the radio room, how frequently must this clock be adjusted and compared with standard time? (R. & R. 8.330.)

693. Under what conditions may a ship station close if its service is not required to be continuous? (Art. 35-11.)

694. What exceptions are permitted to the regulation which states that a ship station, which has no fixed working hours, must advise the coast station with which it is in communication of the closing and reopening time of its service? (Art. 35-11, 12.)

695. How frequently should an entry be made in a ship radiotelegraph log while a radio watch is being maintained? (R. & R. 8.330.)

696. At what time(s) must the international silent period be observed? (Art. 33-9.)

697. At what time(s) are routine transmissions forbidden in the bands 485 to 515 kilocycles? (Art. 33-9.)

698. Under what circumstances must log entries be made regarding observance of the international silence period? (R. & R. 8.330.)

699. What time system shall be used in making log entries with respect to the observance of the international silence period? (R. & R. 8.330.)

700. What is the international radiotelegraph distress frequency for stations in the mobile service? (Art. 37-4.)

701. Describe how a distress call should be made. (Art. 37-8.)

702. What transmission should precede the transmission of the distress call? (Art. 37-9.)

703. What station shall be in control of distress traffic? (Art. 37-22.)

704. During what periods must a distress message be repeated following the initial transmission? (Art. 37-16.)

705. During what periods must the safety signal be transmitted? (Art. 37-42.)

706. How long must mobile stations listen after hearing an urgency signal? (Art. 37-38.)

707. Describe the number of dashes, or dots, and spaces which compose the international auto-alarm signal and indicate the time intervals involved. (R. & R. 8.6.)

708. When the auto-alarm bell rings, what should the operator do?

709. Under what circumstances, and by whom may the international auto-alarm signal be transmitted to announce an urgent cyclone warning? (Art. 37-30.)

710. What space of time should elapse between the transmission of the international auto-alarm signal and the distress call? (Art. 37-9.)

711. While a vessel is at sea, how frequently must the auto alarm be tested? (R. & R. 8.206.)

712. What interval of time must elapse between the end of the auto-alarm signal and an urgent cyclone warning? (Art. 37-30.)

713. Under what circumstances is a station in the mobile service not required to listen to distress traffic? (Art. 37-24.)

714. Upon hearing an "SOS", what should an operator do? (Art. 37-13.)

715. What is the purpose of an automatic-alarm-signal keying device on a compulsorily equipped ship?

716. On a vessel of the United States, equipped with an approved auto alarm, where is the control button which silences the warning bells located? (R. & R. 8.511.)

717. With what type(s) of emission and upon what frequency should a radio-telegraph transmitter be adjusted to transmit a distress call?

718. If you received a distress call signed by a call signal composed of five letters, could you determine the type of craft which transmitted the signal? (Art. 19-5.)

719. While the vessel is in the open sea, how frequently must the specific gravity of the emergency battery be taken? (R. & R. 8.505.)

720. How frequently must the quantity of fuel in the supply tank for use with an oil- or gas-driven emergency generator be checked while the vessel is in the open sea? (R. & R. 8.505.)

721. While a vessel is in port, how frequently should the emergency equipment be tested? (R. & R. 8.505.)

722. You intercept "CQ CQ WSV TFC QSY 735 AS". What does this mean?

723. Upon hearing a safety signal, what should the operator at the receiving station do? (Art. 37-43.)

724. Explain the use and meaning of the following indicators or prefixes on radiotelegrams and describe the difference in handling of the various types of radiotelegrams: RP, TC, PC, FS, PR, TR, MSG, CDE, OBS, PDH, CODH.

725. Explain cable count and the use of standard service abbreviations and show the difference between cable count and domestic word count.

726. Construct a plain language radiotelegram and indicate what portions comprise (a) the preamble, (b) the address, (c) the text, and (d) the signature.

727. Upon what band, in addition to the 350-515 kilocycles band, must a main receiver on a United States ship be capable of operation? What is the purpose of this additional band? (R. & R. 8.503.)

728. If, upon being called by another station, a called station is unable to proceed with the acceptance of traffic, what should the operator of the called station do? (Art. 29.)

729. After a distress call has been transmitted, every distress traffic radiotelegram shall contain what symbol in the preamble? (Art. 37-21.)

730. For how long a period of continuous operation should the emergency power supply of a compulsorily equipped ship station be capable of energizing the emergency radiotelegraph installation? (R. & R. 8.504.)

731. While the vessel is in the open sea, how frequently must the emergency equipment be tested? (R. & R. 8.505.)

732. Indicate the order of priority of the various types of radio communications. (R. & R. 8.177.)

733. What is the principal port of the United States on the Pacific coast, at which navigation lines terminate?

734. In what city is the major telecommunication center of the United States located?

735. What is the approximate latitude of Colon, Republic of Panama?

736. In what ocean is the island of Guam located?

737. To what continent do the greatest number of telecommunication channels from the United States extend?

738. What is the principal Atlantic coast port of the United States at which navigation lines terminate?

739. What is the GMT time and the day of the week in Shanghai when it is Wednesday noon in New York City?

740. In a ship radiotelegraph station, where may information be found concerning the forwarding charges for radio telegrams?

ELEMENT VII

AIRCRAFT RADIOTELEGRAPH

Regulation and Treaty

1. Under what conditions is a flight radio operator required aboard scheduled aircraft engaged in flights outside the continental United States? (CAR 41.68.)

2. Under what conditions are flight radio operators required in United States irregular air carrier operation? (CAR 42.41 (d).)

3. Is it mandatory that one crew member, other than the flight radio operator, be capable of operating the radio equipment in an emergency? (CAR 41.71.)

4. What are the Federal Communication Commission's license requirements for an aircraft radiotelegraph operator? (R. & R. 13.61 (a), (b).)

5. What is meant by "long-distance operation" in scheduled air carrier flights outside the continental United States? (CAR 41.92.)

6. An aircraft is engaged in "long-distance operation." What radio equipment is required aboard for this type of operation? (CAR 41.22.)

7. For "long-distance" operation outside the continental United States, what ground radio navigational aids are required at scheduled stops and alternate airports? (CAR 41.13 (b).)

8. What are the requirements for a two-way air-to-ground communications system in scheduled air carrier operation outside the continental United States? (CAR 41.11.)

9. For "long-distance" scheduled air carrier operations outside the continental United States, what is the required communications range from aircraft to airport traffic-control towers at airports approved for the route? (CAR 41.22 (a).)

10. For "long-distance" scheduled air carrier operations outside the continental United States, what are the aircraft receiver requirements for receiving communications, meteorological, and navigational information? (CAR 41.22 (b), (c), (d).)

11. For "long-distance" scheduled air carrier operations outside the continental United States, what aircraft transmitting

equipment is required and over what distances should this equipment operate? (CAR 41.22.)

12. What radio equipment is required aboard foreign-flag aircraft operating into the United States and outlying possessions? (CAR 44.4.)

13. Discuss the requirements for electrical power and radio equipment under required equipment for continuance of flight. (CAR 41.25 (g), (h).)

14. An aircraft is at midocean and experiences a communication failure. What procedure would the pilot follow after being advised by the flight radio operator that the aircraft is out of communication? (CAR 41.115.)

15. Define the point-of-no-return as used in air carrier operations. (CAR 41.137 (m).)

16. If a flight radio operator noted an irregularity or hazard which, in his opinion, made for unsafe operation, to whom should he report such hazard or irregularity? (CAR 41.131.)

17. With regard to air-to-ground communication, what is the order of priority for communications on a channel that is used for point-to-point as well as air-to-ground contacts? (CAR 41.132.)

18. What is meant by "type certification" of radio equipment used on U. S. scheduled air carrier aircraft? (CAR 16.)

19. What is an air carrier operating certificate and by whom is it issued? (CAR 41.1.)

20. What are the requirements regarding marker beacon receivers on United States irregular air carrier aircraft operating outside the continental United States? (CAR 42.23 (b).)

21. Is it mandatory that U. S. irregular air carriers operating outside the continental United States maintain a ground communications system to provide radio contact at all times with their aircraft?

22. When a United States irregular air carrier aircraft is operating outside the continental United States on long-distance flights over water or uninhabited terrain, what transmitting means are required? (CAR 42.23 (b).)

23. Define a "route segment" as used in scheduled air carrier operations outside the continental U. S. (CAR 41.137 (q).)

24. When an aircraft is in distress, upon what frequency or frequencies should the first radio transmission of distress call and messages be made? (ICAO Annex 10-5.4.2.1.)

25. In event of an aircraft in distress, how often should the distress message be repeated? (ICAO Annex 10-5.4.7.1.)

26. Under what conditions should an aircraft, becoming aware

that another aircraft is in distress, transmit the distress call and message? (ICAO Annex 10-5.4.9.1.)

27. What is the distress signal used on VHF A3 emission? (ICAO Annex 10-5.4.5.3.)

28. List the order of priority in the establishment of communications in aeronautical mobile radio service. (ICAO Annex 10-5.1.7.1.)

29. A control station receiving a distress message from an aircraft shall forward the information immediately to what offices? (ICAO Annex 10-5.4.12.2.)

30. In aircraft distress communications, what is the normal speed of radiotelegraph transmissions? (ICAO Annex 10-5.4.1.3.)

31. List the information that should be transmitted, if time permits, from an aircraft in distress. (ICAO Annex 10-5.4.6.1.)

32. What action should be taken by the flight radio operator immediately prior to ditching or crash landing? (ICAO Annex 10-5.4.8.2.)

33. List the distress frequency for aircraft in the MF band. (R. & R. 8.352.)

34. What is the international frequency in the high-frequency band for use by life rafts for search and rescue communication with stations of the maritime mobile service? (R. & R. 9.312.)

35. What is the common VHF aircraft emergency frequency? (R. & R. 9.312.)

36. How would a flight radio operator alert the Search and Rescue facilities in his particular area? (ICAO Annex 10-5.4.2.1.)

37. What procedure is used by an aircraft to cancel a distress message? (Annex 10-5.4.13.1.)

38. What is the meaning of: (a) Air carrier aircraft station, (b) airdrome control station, (c) aeronautical station, (d) aeronautical fixed station, (e) radio beacon station, (f) radio range station, (g) localizer station, (h) glide path station, (i) aeronautical marker beacon station, (j) surveillance radar station and (k) aeronautical public service station? (R. & R. 9.10.)

39. In general, what language shall be used in radiotelephone communications between aircraft and aeronautical stations in the international service? (ICAO Annex 10-5.3.1.)

40. In event of noncommunication with an aircraft, what offices should be advised immediately by the control station operator? (ICAO Annex 10-5.1.5.4.)

41. In communications between aircraft radio stations, what

station controls the duration of continuous work? (ICAO Annex 10-5.1.4.4.)

42. How should an aircraft flying over the sea signal its position? (ICAO Annex 10-5.4.6.2.)

43. How should an aircraft flying over land signal its position? (ICAO Annex 10-5.4.6.2.)

44. What procedure should an overocean aircraft follow if it is unable to establish communications for any reason other than transmitter failure. (ICAO Annex 10-5.1.5.3.)

45. In air-to-ground radiotelephone communication, how is the "invitation to reply" spoken in standard voice procedures? (ICAO Annex 10-5.3.6.3.)

46. What is meant by the priority prefix SVH? (ICAO Annex 10-4.1.4.2.)

47. After communication has been established between an aircraft and its control station, is it permissible to dispense with the radio call letters in subsequent communication? (ICAO Annex 10-5.3.6.5.)

48. Is it mandatory that an aircraft maintain continuous watch in flight on the air-to-ground route frequency? (ICAO Annex 10-5.1.1.)

49. In radiotelephone communications, what word is spoken to denote that an error has been made in transmission? (ICAO Annex 10-5.3.7.4.1.)

50. In radiotelephone communication, how is termination of communication indicated by the receiving station? (ICAO Annex 10-5.3.7.3.)

51. With which station should an aircraft normally communicate when flying over a particular route? (ICAO Annex 10-5.1.4.2.)

52. What is the radiotelephone spoken equivalent of radiotelegraph signal IMI? (ICAO Annex 10-5.3.7.4.4.)

53. What is the radiotelephone equivalent of the radiotelegraph signal R? (ICAO Annex 10-5.3.7.2.)

54. What is meant by break-in procedures in aircraft radiotelegraph communication?

55. What type of information is generally included in a broadcast service known as NOTAMS? (ICAO Annex 10—Part III—Chapter 1.)

56. Describe the structure of the NOTAM code as used in international flight operations. (ICAO Comm. Codes and Abbreviations.)

57. What is meant by the ICAO abbreviations such as: CNL, ARR, DEP, PLN? (ICAO Comm. Codes and Abbreviations.)

58. How are the ICAO complementary code groups used in air-to-ground communications? (ICAO Comm. Codes and Abbreviations.)

59. What radio information is contained in the IFR flight plan of scheduled air carrier operation outside the continental limits of the United States? (CAR 60.41 (a) (h).)

60. What is the working frequency in the medium frequency band reserved for aircraft flying over the seas? (R. & R. 9.312.)

61. Is it mandatory that United States air carrier aircraft operating within the United States and overseas be equipped with a radio altimeter? (CAR 41.21 & 41.22.)

62. What are the requirements regarding a master switch in an aircraft electrical installation? (CAR 4B.622 (c).)

63. Air carrier aircraft electrical installations incorporate storage batteries in the primary systems. Discuss the requirements for battery vents, cooling, containers, and protection against acids. (CAR 4B.625 (d).)

64. With reference to aircraft generators, what are the requirements concerning: Generator capacity, generator switch, generator rating, generator controls, and a reverse current cut-out? (CAR 4b.606, 4b.621, 4b.622, 4b.624.)

Radio Theory

65. What type of radio wave is the most suitable for aircraft radio direction finding, a vertically or horizontally polarized wave?

66. Explain the term "quadrantal or aircraft error" and what is done to counteract this error in modern aircraft radio installations? How does quadrantal error vary with frequency?

67. Normally, what are the maximum and minimum frequencies upon which a standard transport aircraft D/F loop will give satisfactory operation?

68. An aircraft loop antenna is influenced by the field of a vertically polarized wave front. Will the magnetic lines of force cut the loop from top to bottom or from side to side?

69. It is common practice to employ plastic housings to streamline electrostatically shielded loop antennas on air carrier aircraft. (Do these housings have a conductive or nonconductive surface?)

70. Explain how aircraft D/F loops are constructed so that they intercept electromagnetic waves and reject electrostatic charges.

71. When using a manual direction finder on a homing station, how should the D/F loop and the associated receiver be adjusted?

72. In an aircraft D/F installation, is the loop calibration curve considered accurate for any frequency between 200 and 1800 kilocycles per second?

73. What effect does a coast line have upon radio bearings taken aboard an aircraft flying offshore?

74. In aircraft D/F work, is the minimum or maximum signal used to observe bearings? Explain.

75. In aircraft radio navigation, what is meant by a "reciprocal"?

76. Is quadrantal error in a loop installation aboard an aircraft maximum or minimum at the cardinal points of the azimuth?

77. Describe the function of the sense antenna used in conjunction with an aircraft ADF installation.

78. What is the purpose of the threshold sensitivity control on an aircraft ADF unit?

79. What circuits of an aircraft ADF use thyatron tubes?

80. What is the purpose of the silica gel crystals in an aircraft ADF installation?

81. With reference to ground D/F stations, what is the principal advantage of the ADCOCK station over the early loop D/F stations?

82. What is meant by the term "hunting" in an ADF system?

83. Will static crashes affect the operation of an aircraft ADF?

84. What is the purpose of a compensator cam in an aircraft ADF installation?

85. What is an autosyn as used with ADF systems and what device furnishes power to the autosyn?

86. What type of radio range gives satisfactory ADF operation? What type gives unsatisfactory operation?

87. Why is it inadvisable to take ADF bearings on synchronized broadcast stations?

88. In reference to an ADF system, explain why the position of the loop determines when power will be delivered to the loop motor control circuit.

89. Why is a low inertia type motor used as the loop control motor in an ADF system?

90. When using the aircraft ADF receiver for aural flying of a low-frequency radio range, the function switch should be in the "ANTENNA" position instead of the "COMPASS" position. Explain.

91. What is the purpose of the rotatable scale on the aircraft ADF azimuth indicator?

92. Why it is important than an aircraft employ bonding and shielding of various radio and electrical units?

93. In bonding aircraft radio and electrical units on an aircraft, should the resistance of the bond be of a high or low value?

94. In a carbon-pile voltage regulator, is the carbon pile connected in series or in parallel with the shunt field of the generator?

95. In the resistance element of a carbon-pile voltage regulator, does the resistance vary inversely or directly with the amount of pressure on the carbon?

96. What operating characteristics of the carbon-pile voltage regulator makes it well suited for aircraft use?

97. What is the purpose of the equalizer circuit in a parallel generator system using a carbon-pile voltage regulator?

98. At what speed of the aircraft engine should the generator develop its normal voltage?

99. How is the rating of an aircraft generator usually stated?

100. List at least two sets of figures for generator ratings on present-day transport aircraft.

101. What is the purpose of employing differential-voltage reverse-current relays in aircraft generator systems?

102. Discuss air carrier aircraft electrical systems with regard to general wiring (single-wire, two-wire).

103. Describe the operational characteristics of "trip free" and "non-trip-free" circuit breakers as used in aircraft radio and electrical installations.

104. Name one important reason why a. c. is not ordinarily used for the primary power source on transport aircraft.

105. Explain how transport aircraft generators are driven.

106. What particular electrical system on an aircraft is difficult to shield by the use of filters?

107. Polyethylene-covered antenna wire is being used on many transport aircraft radio installations. What is the advantage of this type of antenna over the small diameter braided copper wire? Over solid copper wire?

108. Name one advantage of using large-diameter bare-aluminum wire for antennas on transport aircraft.

109. What is the purpose of using trailing wicks on the wing tips and tail surfaces of transport aircraft?

110. With reference to electrostatic buildups on transport aircraft, which will produce the higher charging rate, dry snow and ice crystals, or wet snow and rain?

111. Which one of the two, air speed or ground speed, is a

contributing factor in the build-up of high electrostatic potential on an aircraft flying through sleet, snow, or dust?

112. Discuss the progress that has been made in recent years toward the elimination of precipitation static on aircraft.

113. Under conditions of severe precipitation static, why is a loop antenna superior to a fixed antenna in receiving radio signals?

114. What is meant by corona or St. Elmo's fire? What design in aircraft antennas aids in preventing corona?

115. What is the advantage of the SBRA-type range station over the MRL-type range station when using the aircraft D/F for bearings?

116. What are the principal advantages of the ADCOCK radio range over the loop-type radio range?

117. Explain the principle of operation and the type of emission obtained from an aerophare.

118. What is the general shape of the radiation pattern of an aerophare?

119. What aircraft equipment is necessary to make use of the service of an aerophare?

120. Explain the principle of operation of the omni-directional range.

121. How is the rotating signal in an omnirange initially set with respect to true north or magnetic north?

122. Upon what frequency do marker beacon receivers operate?

123. What is the purpose of the "HIGH-LOW" switch used in conjunction with the aircraft marker beacon receiver?

124. Explain how overloading in a radio range receiver may cause apparent reversal of quadrant signals of a low-frequency range.

125. Explain the principle of operation of the radio range filter as used on United States aircraft radio installations.

126. What types of aircraft antennas are used for radio range flying?

127. What are compass locator stations and on what frequencies do they operate?

128. List three disadvantages of the conventional low-frequency radio range.

129. In actual flying practice, how many visual courses does VOR offer simultaneously at any given altitude level—(1) 4, (2) 16, (3) 90, and (4) 360?

130. What is the frequency of the keyed tone producing the VOR station identification signal—(1) 500 cps, (2) 1020 cps, (3) 3010 cps, (4) 3000 cps, and (5) 6210 cps?

131. What is meant by the term MOR with respect to radio aids to air navigation?

132. How does the "Z" marker provide a definite means for the aircraft determining its position over the cone of silence?

133. What audio frequencies are associated with "Z" markers, fan markers and inner and outer markers?

134. What advantage, with respect to approach control, does the new bone-shaped marker offer over the standard fan-shaped marker?

135. If the marker light indicator in the cockpit failed, would the flight personnel have available any other indication that signals from a marker were being received?

136. What is the signal called that is radiated from the center loop of a VOR radio facility?

137. What may be considered as the normal reliable service radiation of the VOR radio facility—(1) 50 miles, (2) 2.5 miles, (3) 3 miles, (4) 3.5 miles, and (5) 100 miles?

138. What are the three main advantages of the VAR radio facility?

139. What is the average usable range of the VAR facility?

140. Why are the blue and yellow visual and the "A" and "N" aural areas of a VAR referred to as sectors rather than quadrants?

141. Describe the method of orientation used in the VAR.

142. How is the "on-course" signal produced in a low-frequency radio range station?

143. What is meant by the "Twilight" zone in radio range flying?

144. How is the cone of silence produced over a low-frequency radio range station?

145. In radio range flying what is meant by "multiple courses"?

146. If an aircraft is flying at right angles to a range leg affected by multiple courses, what signals would be heard in the radio range receiver?

147. Explain the operation of the ground portion of an ILS.

148. In the ILS, which is the sharpest course—the localizer or the glide path?

149. On what frequency do marker beacons used in conjunction with ILS operate?

150. What aircraft radio equipment is necessary to make use of all units of ILS?

151. What type of instrument is used for the cross-pointer indication on the instrument panel of an aircraft when using ILS?

152. What is the purpose of the aircraft flag warning used with the ILS indicator?

153. Is the following statement TRUE or FALSE? "In the ILS, regardless of the position or heading of an aircraft, the localizer needle will always be deflected in that color area in which the aircraft is flying."

154. In flying the ILS, when the aircraft is above the glide path, will the horizontal needle be deflected UP or DOWN?

155. If noise breaks through in the headset on a VHF communications unit, what adjustment can be made?

156. Certain aircraft communications receivers have an antenna aligning control on the panel. Electrically, what is accomplished when this control is adjusted?

157. What are the approximate CW, MCW, and VOICE power ratings of transmitters used in United States air carrier aircraft operating overseas?

158. What is the purpose of an isolation amplifier in an aircraft radio installation?

159. What is the purpose of the sidetone feature in an aircraft radio installation? How is sidetone obtained?

160. What may cause severe arcing in aircraft transmitters at high altitude?

161. In tuning an aircraft radio transmitter can it always be expected that the same antenna current will be secured on all frequencies?

162. In aircraft communications, how does the line-of-sight communication range vary with the altitude of the aircraft? At an altitude of 5,000 feet over level terrain, what maximum line-of-sight VHF communication range may be expected from the aircraft to a ground station?

163. When using automatic keying on the AN/CRT-3 (modified Gibson Girl life raft transmitter), what signals are transmitted and upon what frequencies?

164. Discuss the advantages and disadvantages of the following aircraft antennas: fixed; trail; whip; stub mast and loop.

165. What type of aircraft antennas will permit maximum radiation on such medium frequencies as 333 and 500 kilocycles?

166. Explain the principle of operation of the antenna change-over relay in an aircraft radio installation. What is a vacuum antenna relay?

167. How may an aircraft D/F loop be utilized for antistatic reception of radio range signals?

168. Describe the physical construction of antennas used with the aircraft radio altimeter.

169. Explain the principle of operation of the flux gate compass system.

170. What type of power supply is used in the flux gate compass system?

171. Explain the purpose of the gain control on the amplifier unit of the flux gate compass system.

172. What functions are performed by the amplifier unit of the flux gate compass?

173. Why is the sensitive compass element in the flux gate system usually located in a remote spot such as the aircraft wing tip?

174. In what portion of the flux gate compass system is a low inertia motor used?

175. In the flux gate compass system, the gyro is a self-erecting vertical gyro. Explain the function of the gyro.

176. What is meant by "caged" and "uncaged" in a flux gate compass?

177. In loran terminology, what would be indicated by the Legend 1L3-2120?

178. How is a loran fix indicated on a loran navigation chart?

179. Does precipitation static affect operation of the loran receiver-indicator?

180. What is the approximate usable overwater range in nautical miles of the loran system in both DAY and NIGHT operation?

181. To what reading, or indication, is sky wave correction applied in loran navigation?

182. What frequency channels are used in the present loran system?

183. What type of power supply is used with the loran receiver aboard aircraft?

184. CONSOL is a long-range radio aid to navigation undergoing considerable practical use in certain sections of the world. Explain briefly the principle of operation of the CONSOL system.

185. What aircraft radio equipment is necessary to make use of RACON beacons?

Operating Procedures

186. In air traffic control procedures, what is meant by a service known as "approach control"? How are communications handled between aircraft and approach control?

187. A Constellation aircraft of Midway Airways, trip 14, with radio call KHCBX, licensed as NC18947, is entering the traffic

pattern at a particular airport. What is the correct procedure to be followed by the air traffic control tower in establishing radio-telephone communication with this aircraft?

188. Certain U. S. Coast Guard radio beacons have undergone modifications to permit satisfactory use with aircraft ADF. Describe.

189. What aircraft radio equipment is needed to carry out a GCA problem?

190. Define the following terms as used in air traffic control procedures: Approach clearance; approach sequence; approach time; control area; control zone; control altitude; essential traffic; local traffic; traffic pattern; IFR; VFR; downwind leg; base leg; final approach.

191. Is it possible for an aircraft to contact United States radio range stations by using A-2 emission?

192. What is the "attention" signal used on United States radio range station transmissions?

193. Explain how marker beacons identify the legs of a four-course radio range station. If the legs of a radio range station are spaced at 040° , 140° , 230° and 320° , respectively, what range leg would an approaching aircraft be on if a marker beacon identification of two dashes (— —) were intercepted?

194. Explain the method of determining "overhead" on a radio beacon using the aircraft manual D/F loop.

195. What U. S. Government document gives the location, frequency, identifier and hours of operation of all marine radio beacon stations?

196. What agency of the United States Government may be called upon to render emergency direction finding aid to aircraft? How is this agency contacted?

197. A control station operator desires to determine whether or not an aircraft is flying in accordance with VFR. What is the appropriate signal to use?

198. An aircraft is approaching its point-of-no-return and desires amendments to the flight forecast. What is the correct signal?

199. An aircraft is preparing to make a QDM approach at a foreign terminal. What signals are used to request a series of QDM's from the ground D/F station?

200. An overocean aircraft desires to check its distances out from an OSV by using the vessel's radar equipment. What signals are used to obtain this information?

201. A flight radio operator copies the following signals from

the control station. QAK QAH 8500 FT IMT. The pilot should be advised immediately. Why?

202. What signal would the flight radio operator transmit to request the surface wind at a particular airport?

203. An aircraft is estimated to be within D/F range of a certain radiobeacon, but the signals cannot be heard on the aircraft. To request information as to whether or not the radio beacon is in operation, the "Q" signal ----- should be transmitted.

204. An aircraft cleared to cruise at 12,000 is climbing on course under IFR conditions. OATC, through the control station, requests the aircraft to report immediately upon reaching cruising altitude. What are the correct "Q" signals?

205. What is meant by the terms POMAR, METAR, NAREPS, RAWIN, PIBALS, PIREPS?

206. What is the meaning of the following signals?

QAA through QAZ

QBC (used with QMI, QFT, QBJ, QMZ and QTH)

QBF, QBG, QBH, QBI, QBS, QBX, QCB, QCE, QDR, QDX, QFE, QFG, QFH, QFM, QGJ, QGZ, QHH, QJD, QLH, QMH, QNI, QNT, QUG, QUO, QUR, QUS, QUU, QUV, QUX, QRF.

207. What is an ocean station vessel (OSV)?

208. How are radiobeacon transmissions from ocean station vessels identified?

209. What type of radiobeacon service is maintained by an ocean station vessel when it is driven off station with position unknown?

210. What radiobeacon service is maintained by an ocean station vessel when it is off station proceeding on a distress mission?

211. How does an ocean station vessel indicate "On Station"; "Off Station"?

212. With reference to ocean station vessels, what is meant by the grid system? Explain its operation.

213. Name frequencies used by stations WWV, NSS and NPG for transmitting time signals.

214. List one typical *DAY* CW frequency and one *NIGHT* CW frequency used in a CAA Overseas Foreign Aeronautical Communications Station.

215. Which one of the following frequencies would work satisfactorily for CW air-to-ground communication and homing with the aircraft ADF?

(1) 1638 kc., (2) 2970 kc., (3) 8465 kc., (4) 11,319 kc.

216. Under normal conditions in a daylight flight between two

points of approximately 1,100 nautical miles apart, what would be a good pair of CW air-to-ground frequencies to select?

217. Why do scheduled aircraft change from *DAY* to *NIGHT* frequencies in radio communications? Which frequency, 5692 kc. or 3162 kc., is better suited for day operation?

218. An overocean aircraft is circling at the scene of distress where another aircraft has ditched. What would be an appropriate frequency for the circling aircraft to transmit homing signals on to permit surface vessels and other aircraft to effect a rendezvous at the scene?

219. What is meant by simplex operation in air-to-ground communication?

220. What is meant by "night effect" in reference to aircraft direction finding? What can be done to counteract night effect when taking aircraft radio bearings?

221. How is wind drift compensated for when using a radio compass for homing?

222. Is it possible for one aircraft to use a second aircraft as a homing facility with the presently installed ADF equipment? Explain.

223. How is aircraft ADF equipment used to make an instrument approach?

224. What is the minimum number of ground stations required to provide an instantaneous radio fix with the aircraft D/F?

225. In aircraft radio direction finding, what is an instantaneous fix? A running fix?

226. Discuss briefly the D/F procedure known as "boxing."

227. Radio bearing errors due to terrain effect decrease as the altitude of the aircraft decreases. TRUE or FALSE.

228. Will flying in or near the vicinity of a severe electrical storm cause erratic functioning of an aircraft ADF unit?

229. Does the aircraft's heading affect the error in radio bearings caused by coast line refraction?

230. An aircraft is flying parallel to a coast line and observes a relative bearing of 10° on a radiobeacon located ahead of the aircraft's position. Will the correct relative bearing be greater or less than the observed 10° relative? Explain.

231. Explain fully the procedure in obtaining a radio fix on two stations using the aircraft D/F loop.

232. What angular separation of transmitting stations will give best results when taking radio bearings to get a three-station fix?

233. Explain the "45°-90°" distance-off procedure of determining distance from an aircraft to a radiobeacon station.

234. On which side of an aircraft is a radiobeacon located if the relative bearings taken aboard the aircraft are progressively increasing?

235. Describe the procedure for determining sense (orientation) using an aircraft manual D/F loop and an aerophare.

236. Upon what factors does the usable range of an aircraft D/F loop depend?

237. With reference to loop orientation, what is meant by the "pointer-progression" method?

238. An aircraft is establishing a fix with radio bearings on two stations. One station is dead ahead, the second station approximately abeam to the right. Which bearing is it advisable to secure first, the speed line or the course line?

239. Explain the method of determining the aircraft's position by "doubling the angle."

240. Why is it necessary to maintain constant heading and level flight when taking radio bearings with the aircraft D/F?

241. To increase the relative bearing on an aircraft D/F loop, should the aircraft be turned RIGHT or LEFT?

242. Describe briefly the operational procedure for calibrating an ADF installation in flight.

243. Define the following: Relative bearing; magnetic bearing; true bearing; Mercator bearing; true course; track; magnetic heading; compass heading; true heading; compass error, advanced bearing; retarded bearing; radio line of position.

Radio Navigation of Aircraft

244. Explain why Mercator charts are used in long range air navigation. What is a rhumb line? What is a great circle?

245. Give the rules for applying Mercator correction to a radio bearing taken by the aircraft; by the ground D/F station.

246. On a Mercator chart, are the rhumb line and great circle tracks always represented by a straight line?

247. Explain why it is necessary to apply Mercator correction to radio bearings.

248. Under what conditions is it unnecessary to apply Mercator correction to an observed true bearing?

249. What is meant by compass deviation? Magnetic variation?

250. What is the relative bearing of a radio station as observed on an aircraft if the true bearing from a radio station to the air-

craft is 060° and the aircraft has a compass heading of $020'$ with a compass error of 2° W. and a variation of 10° W.?

251. An aircraft is flying from station A to station B using the dual ADF with the *RED* pointer on a station A and the *GREEN* pointer on a station B. What ADF readings would indicate that the aircraft is on course with a 15° drift angle?

252. An aircraft is on a true headings of 225° . Variation is 2° W. and deviation is 3° E. What relative bearings would be necessary to obtain true bearings of 275° and 45° ?

253. An aircraft is on a magnetic heading of 50° and relative bearings are being taken on a station off to the RIGHT. If it is desired to turn directly toward the station when a QDM of 90° is reached, what relative bearing will give the desired QDM?

254. An aircraft is on a true bearing of 100° from a radio beacon. What is the relative bearing if the magnetic heading is 015° , and the variation is 10° W.?

255. An aircraft observes a relative bearing of 254° on an aerophare. If the compass heading is 41° , deviation 2° E., variation 8° W., what is the true bearing of the aerophare?

256. What is the true bearing of an aerophare with respect to an aircraft flying a magnetic heading of 127° if the loop reading is 10° left, deviation 3° W., variation 4° E. and the quadrantal error is plus 2° ?

257. An aircraft is flying on a CH of 058° in position $45^\circ30'$ N. and $14^\circ10'$ W. A relative bearing of 250° is taken on a radio station located at $47^\circ35'$ N. and $16^\circ00'$ W. Compass deviation is 3° E. and magnetic variation is 10° W. What bearing should be plotted on a Mercator chart?

258. An aircraft is tracking 315° at a ground speed of 240 miles per hour. At 1800 GMT a radio station bears 315° relative and at 1805 GMT the same station bears 270° relative. What is the distance from the aircraft to the ground station at 1805 GMT?

259. An observed relative bearing is 75° Which direction and how many degrees must the aircraft be turned to move the relative bearing to 125° ?

260. An aircraft is flying in extreme turbulence. The first relative bearing is 90° and the second relative bearing is 95° . Is it safe to assume that the station is on the RIGHT?

261. An aircraft is homing on a radio station. The correct relative bearing is zero. If the null moves slowly from 0 to 355, 350, 345, and the compass heading remains constant, is the drift RIGHT or LEFT?

262. The compass heading is 125° . The aircraft is south of the radiobeacon and both deviation and variation are 0° . What relative bearing will be indicated when the aircraft intercepts the 175° azimuth from the station?

263. Given: Compass heading _____ 195°
 Deviation _____ 9° West
 Variation _____ 6° East

Find: True heading.

264. If the compass heading is 289° , deviation 5° W., variation 7° E., and the relative bearing on the station 172° , what is the true bearing?

265. An aircraft is on a compass heading of 236° . The relative bearing on a radio station is 326° . Variation is 23° E., deviation 2° W., and the loop correction is minus ($-$) 4° . What is the true bearing?

266. The true bearing from a radio station to an aircraft is 068° . The aircraft is flying a compass heading of 016° , deviation 2° W., variation 11° W. What is the relative bearing on the aircraft loop?

ELEMENT VIII

SHIP RADAR TECHNIQUES

1. What are the FCC license requirements for the operator who is responsible for the installation, servicing and maintenance of ship radar equipment? (R. & R. 8.155.)
2. Who may operate a ship-radar station? (R. & R. 8.155.)
3. Under what conditions may a person who does not hold a radio operator license operate a ship-radar station? (R. & R. 8.155.)
4. Who may make entries in the installation and maintenance record of a ship radar station? (R. & R. 8.405.)
5. What entries are required in the installation and maintenance record of a ship radar station? (R. & R. 8.405.)
6. Who has the responsibility for making entries in the installation and maintenance record of a ship radar station? (R. & R. 8.405.)
7. Within what frequency bands do ship radar transmitters operate? (R. & R. 8.404.)
8. 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? (R. & R. 8.155.)
9. Explain briefly why radar interference to a radiotelephone receiver is frequently characterized by a steady tone in the radio loudspeaker.
10. Describe how various types of interference from a radar installation may be apparent to a person when listening to a radio communications receiver.
11. How are the various types of radar interference recognized in (a) auto alarm equipment, (b) direction finding equipment?
12. On what frequencies should the radar serviceman look for radar interference to communication receivers on ships equipped with radar?
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?
14. List at least two types of indications on a LORAN scope that signify that a radar installation is causing interference to the LORAN.

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?

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"?

17. What steps might be taken by a radar serviceman to reduce "grass" on a LORAN scope or motor-generator noise in communication receiver?

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

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

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

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

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

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

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

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

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

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

28. Describe briefly the construction of a waveguide. Why should the interior of the waveguide be clean, smooth and dry?

29. When installing waveguides, why should long perfectly level sections of waveguides be avoided? Why is a small hole about one-eighth inch in diameter sometimes drilled on the underside of an elbow in a waveguide near the point where it enters the radar transmitter?

30. Why are waveguides used in preference to coaxial lines for

the transmission of microwave energy in most shipboard radar installations?

31. Why are rectangular cross-sectional waveguides generally used in preference to circular cross-sectional waveguides?

32. Describe how waveguides are terminated at the radar antenna reflectors.

33. What precautions should be taken when installing vertical sections of waveguides with choke coupling flanges to prevent moisture from entering the waveguide?

34. Why are choke joints often used in preference to flange joints to join sections of waveguides together?

35. Draw a longitudinal section of a waveguide choke joint and explain briefly its principle of operation.

36. Describe how a radar beam is formed by a paraboloidal reflector.

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

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?

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

40. Explain briefly the principle of operation of a radar system.

41. Draw a simple block diagram of a radar duplexer system, labeling the waveguide, the TR box, anti-TR box, the receiver and the transmitter.

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.

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.

44. Explain briefly the principle of operation of the magnetron.

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

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

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

48. Explain briefly the principle of operation of the reflex klystron.

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

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

51. Describe briefly the construction and operation of radar TR and anti-TR boxes. What is the purpose of a "keep alive" voltage?

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

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

54. What is "sea return" on a radar scope?

55. Explain briefly the purpose of the sensitivity time control circuit in a radar set.

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?

57. What is the purpose of an "artificial transmission line" in a radar set?

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

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

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

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

62. 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?

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

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

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

66. What is the purpose of aquadag coatings on radar cathode ray tubes?

67. Explain the principle of operation of the cathode ray PPI tube and explain the function of each electrode.

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

69. Draw a simple diagram showing how a syncro generator located in the radar antenna assembly is connected to syncro motor located in the indicator to drive the deflection coils. Show proper designation of all leads, designating where AC voltages (if needed) are applied.

APPENDIX I

EXTRACTS FROM THE COMMUNICATIONS ACT OF 1934, AS AMENDED: INTERNATIONAL TELECOMMUNICATION CONVENTION, ATLANTIC CITY, 1947; INTERNATIONAL RADIO REGULATIONS (ATLANTIC CITY, 1947); TELEGRAPH REGULATIONS (PARIS REVISION, 1949); CIVIL AIR REGULATIONS; INTERNATIONAL CIVIL AVIATION ORGANIZATION PUBLICATIONS; AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND CANADA FOR PROMOTION OF SAFETY ON THE GREAT LAKES BY MEANS OF RADIO; RULES AND REGULATIONS, FEDERAL COMMUNICATIONS COMMISSION

(For use in preparing for Commercial Radio Operator Examinations)

*EXTRACTS FROM THE COMMUNICATIONS ACT OF 1934,
AS AMENDED*

SECTION 1. For the purpose of regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges, for the purpose of the national defense, for the purpose of promoting safety of life and property through the use of wire and radio communication, and for the purpose of securing a more effective execution of this policy by centralizing authority heretofore granted by law to several agencies and by granting additional authority with respect to interstate and foreign commerce in wire and radio communication, there is hereby created a Commission to be known as the "Federal Communications Commission," which shall be constituted as hereinafter provided and which shall execute and enforce the provisions of this act.

* * * * *
SEC. 301. It is the purpose of this Act, among other things, to maintain the control of the United States over all the channels of interstate and foreign radio transmission; and to provide for the use of such channels, but not the ownership thereof, by persons for limited periods of time, under licenses granted by Federal authority, and no such license shall be construed to create any right, beyond the terms, conditions, and periods of the license. No person shall use or operate any apparatus for the transmission of energy or communications or signals by radio (a) from one place in any Territory or possession of the United States or in the District of Columbia to another place in the same Territory, possession, or district; or (b) from any State, Territory, or possession of the United States, or from the District of Columbia to any other State, Territory, or possession of the United States; or (c) from any place in any State,

Territory, or possession of the United States, or in the District of Columbia, to any place in any foreign country or to any vessel; or (d) within any State when the effects of such use extend beyond the borders of said State, or when interference is caused by such use or operation with the transmission of such energy, communications, or signals from within said State to any place beyond its borders, or from any place beyond its borders to any place within said State, or with the transmission or reception of such energy, communications, or signals from and/or to places beyond the borders of said State; or (e) upon any vessel or aircraft of the United States; or (f) upon any other mobile stations within the jurisdiction of the United States, except under and in accordance with this Act and with a license in that behalf granted under the provisions of this Act.

* * * * *

SEC. 303. Except as otherwise provided in this Act, the Commission from time to time, as public convenience, interest, or necessity requires, shall—

* * * * *

(m) (1) Have authority to suspend the license of any operator upon proof sufficient to satisfy the Commission that the licensee—

(A) Has violated any provision of any Act, treaty, or convention binding on the United States which the Commission is authorized to administer, or any regulation made by the Commission under any such Act, treaty, or convention; or

(B) Has failed to carry out a lawful order of the master or person lawfully in charge of the ship or aircraft on which he is employed; or

(C) Has willfully damaged or permitted radio apparatus or installations to be damaged; or

(D) Has transmitted superfluous radio communications or signals or communications containing profane or obscene words, language, or meaning, or has knowingly transmitted—

(1) False or deceptive signals or communications, or

(2) A call signal or letter which has not been assigned by proper authority to the station he is operating; or

(E) Has willfully or maliciously interfered with any other radio communications or signals; or

(F) Has obtained or attempted to obtain, or has assisted another to obtain or attempt to obtain, an operator's license by fraudulent means.

(2) No order of suspension of any operator's license shall take effect until fifteen days' notice in writing thereof, stating the cause for the proposed suspension, has been given to the operator licensee who may make written application to the Commission at any time within said fifteen days for a hearing upon such order. The notice to the operator licensee shall not be effective until actually received by him, and from that time he shall have fifteen days in which to mail the said application. In the event that physical conditions prevent mailing of the application at the expiration of the fifteen-day period, the application shall then be mailed as soon as possible thereafter, accompanied by a satisfactory explanation of the delay. Upon receipt by the Commission of such application for hearing, said order of suspension shall be held in abeyance until the conclusion of the hearing which shall be conducted under such rules as the Commission may prescribe. Upon the conclusion of said hearing the Commission may affirm, modify, or revoke said order of suspension.

(n) Have authority to inspect all radio installations associated with stations required to be licensed by any Act or which are subject to the provisions of any Act, treaty, or convention binding on the United States, to ascertain

whether in construction, installation, and operation they conform to the requirements of the rules and regulations of the Commission, the provisions of any Act, the terms of any treaty or convention binding on the United States, and the conditions of the license or other instrument of authorization under which they are constructed, installed, or operated.

* * * * *

SEC. 318. The actual operation of all transmitting apparatus in any radio station for which a station license is required by this Act shall be carried on only by a person holding an operator's license issued hereunder, and no person shall operate any such apparatus in such station except under and in accordance with an operator's license issued to him by the Commission: *Provided, however*, That the Commission if it shall find that the public interest, convenience, or necessity will be served thereby may waive or modify the foregoing provisions of this section for the operation of any station except (1) stations for which licensed operators are required by international agreement, (2) stations for which licensed operators are required for safety purposes, (3) stations engaged in broadcasting and (4) stations operated as common carriers on frequencies below thirty thousand kilocycles: *Provided further*, That the Commission shall have power to make special regulations governing the granting of licenses for the use of automatic radio devices and for the operation of such devices.

* * * * *

SEC. 325. (a) No person within the jurisdiction of the United States shall knowingly utter or transmit, or cause to be uttered or transmitted, any false or fraudulent signal of distress, or communication relating thereto, nor shall any broadcasting station rebroadcast the program or any part thereof of another broadcasting station without the express authority of the originating station.

* * * * *

SEC. 326. Nothing in this Act shall be understood or construed to give the Commission the power of censorship over the radio communications or signals transmitted by any radio station, and no regulation or condition shall be promulgated or fixed by the Commission which shall interfere with the right of free speech by means of radio communication.*

* * * * *

SEC. 501. Any person who willfully and knowingly does or causes or suffers to be done any act, matter, or thing, in this Act prohibited or declared to be unlawful, or who willfully or knowingly omits or fails to do any act, matter, or thing in this Act required to be done, or willfully and knowingly causes or suffers such omission or failure, shall, upon conviction thereof, be punished for such offense, for which no penalty (other than a forfeiture) is provided in this Act, by a fine of not more than \$10,000 or by imprisonment for a term not exceeding one year, or both; except that any person, having been once con-

*The last sentence of Sec. 326 was repealed and recodified as § 1464 of the Criminal Code 18 U. S. C. 1464 by "An Act to revise, codify and enact into positive law title 18 of the United States Code, entitled 'Crimes and Criminal Procedure'", Public No. 772, 80th Cong. 2d Session, approved June 25, 1948, effective September 1, 1948. The last sentence of Section 326 was as follows: "No person within the jurisdiction of the United States shall utter any obscene, indecent, or profane language, by means of radio communication".

§ 1464, Public No. 772, 80 Cong. 2d Session reads as follows: § 1464. *Broadcasting Obscene Language. Whoever utters any obscene, indecent, or profane language by means of radio communication shall be fined not more than \$10,000 or imprisoned not more than two years or both.*"

victed of an offense punishable under this section, who is subsequently convicted of violating any provision of this Act punishable under this section, shall be punished by a fine of not more than \$10,000 or by imprisonment for a term not exceeding two years, or both.

SEC. 502. Any person who willfully and knowingly violates any rule, regulation, restriction, or condition made or imposed by the Commission under authority of this Act, or any rule, regulation, restriction, or condition made or imposed by any international radio or wire communications treaty or convention, or regulations annexed thereto, to which the United States is or may hereafter become a party, shall, in addition to any other penalties provided by law, be punished, upon conviction thereof, by a fine of not more than \$500 for each and every day during which such offense occurs.

* * * * *

SEC. 605. No person receiving or assisting in receiving, or transmitting, or assisting in transmitting, any interstate or foreign communication by wire or radio shall divulge or publish the existence, contents, substance, purport, effect, or meaning thereof, except through authorized channels of transmission or reception, to any person other than the addressee, his agent, or attorney, or to a person employed or authorized to forward such communication to its destination, or to proper accounting or distributing officers of the various communicating centers over which the communication may be passed, or to the master of a ship under whom he is serving, or in response to a subpoena issued by a court of competent jurisdiction, or on demand of other lawful authority; and no person not being authorized by the sender shall intercept any communication and divulge or publish the existence, contents, substance, purport, effect, or meaning of such intercepted communication to any person; and no person not being entitled thereto shall receive or assist in receiving any interstate or foreign communication by wire or radio and use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto; and no person having received such intercepted communication or having become acquainted with the contents, substance, purport, effect, or meaning of the same or any part thereof, knowing that such information was so obtained, shall divulge or publish the existence, contents, substance, purport, effect, or meaning of the same or any part thereof, or use the same or any information therein contained for his own benefit or for the benefit of another not entitled thereto: *Provided*: That this section shall not apply to the receiving, divulging, publishing, or utilizing the contents of any radio communication broadcast, or transmitted by amateurs or others for the use of the general public, or relating to ships in distress.

**EXTRACTS FROM THE INTERNATIONAL TELECOMMUNICATION
CONVENTION, ATLANTIC CITY, 1947**

ARTICLE 32

1. Members and Associate Members agree to take all possible measures, compatible with the system of telecommunication used, with a view to insuring the secrecy of international correspondence.

* * * * *

ARTICLE 43

1. Stations performing radio communication in the mobile service shall be bound, within the limits of their normal employment, to exchange radiocommunications reciprocally without distinction as to the radio system adopted by them.

* * * * *

ARTICLE 44

1. All stations, whatever their purpose, must be established and operated in such a manner as not to result in harmful interference to the radio services or communications of other Members or Associate Members or of recognized private operating agencies, or of other duly authorized operating agencies which carry on radio service, and which operate in accordance with the provisions of the Radio Regulations.

* * * * *

ARTICLE 45

1. Radio stations shall be obligated to accept, with absolute priority, distress calls and messages regardless of their origin, to reply in the same manner to such messages, and immediately to take such action in regard thereto as may be required.

* * * * *

ARTICLE 46

Members and Associate Members agree to take the steps required to prevent the transmission or circulation of false or deceptive distress or safety signals and the use, by a station, of call signs which have not been regularly assigned to it.

EXTRACTS FROM THE INTERNATIONAL RADIO REGULATIONS ANNEXED TO THE INTERNATIONAL TELECOMMUNICATIONS CONVENTION, ATLANTIC CITY, 1947

ARTICLE 13

372 § 1. Unnecessary transmissions and transmission of superfluous signals and correspondence are forbidden to all stations.

* * * * *

383 § 9. The transmission of signals without identification is forbidden to all stations.

* * * * *

ARTICLE 19

420 § 5. Call signs in the international series are formed as stated below. It is understood, however, that in accordance with the table in 419, the first letter in certain series is replaced by a digit:

* * * * *

424 (d) Five letters in the case of aircraft stations (for aircraft stations using radiotelephony see 431.)

* * * * *

431 § 6. (4) Aircraft stations using radiotelephony may use as a call sign:

- a call sign established in conformity with 424;
- a combination of characters corresponding to the official registration mark assigned to the aircraft.

* * * * *

ARTICLE 29

610 § 6. (1) Before emitting, every station must listen for a period long enough to satisfy itself that it will not cause harmful interference to transmissions in progress within its range; if such interference is likely, the station awaits the first break in the transmission with which it might interfere.

* * * * *

649 § 15. *Difficulties in reception.*

650 (1) If the station called is prevented from receiving, it replies to the call as indicated in 636, but it replaces the letter K by the signal . . . (wait), followed by a number indicating in minutes the probable duration of the waiting time. If the probable duration exceeds 10 minutes (5 minutes in the case of aircraft stations communicating with stations of the maritime mobile service), the reason for the delay must be given.

651 (2) When a station receives a call without being certain that such a call is intended for it, it must not reply until the call has been repeated and understood. When, on the other hand, a station receives a call which is intended for it, but is uncertain of the call sign of the calling station, it must reply immediately, using the service abbreviation in place of the call sign of this latter station.

* * * * *

679 § 26. Where it is necessary for a mobile station to send signals for testing or adjustment which are liable to interfere with the working of a neighbouring coast or aeronautical station, the consent of the station must be obtained before such signals are sent.

680 § 27. When it is necessary for a station in the mobile service to make test signals, either for the adjustment of a transmitter before making a call or for the adjustment of a receiver, they must not continue for more than 10 seconds and must be composed of a series of VVV followed by the call sign of the station emitting the test signals.

* * * * *

ARTICLE 31

704 § 1. Two types of calling signal "To all stations" are recognized:

705 (a) Call CQ followed by the letter K (see 707 and 708);

706 (b) Call CQ not followed by the letter K (see 709).

707 § 2. Stations desiring to enter into communication with stations of the mobile service, without, however, knowing the names of any such stations within their range of action, may use the enquiry signal CQ, in place of the call sign of the station called in the calling formula, the call being followed by the letter K (general call to all stations in the mobile service with request for reply).

708 § 3. In the maritime mobile service, in regions where traffic is congested, the use of the call CQ followed by the letter K is forbidden. As an exception it may be used with signals denoting urgency.

709 § 4. The call CQ not followed by the letter K (general call to all stations without request for reply) is used before the transmission of information of any kind intended to be read or used by anyone who can intercept it.

* * * * *

ARTICLE 33

733 § 9. (1) In order to increase the safety of life at sea and over the sea, all stations of the maritime mobile service normally keeping watch on frequencies in the authorized bands between 405 and 535 kc/s must, during their hours of service, take the necessary measures to ensure watch on the international distress frequency 500 kc/s for three minutes twice an hour beginning at x h 15 and x h 45, Greenwich mean time (G. M. T.).

734 (2) During the periods mentioned above, except for the emissions provided for in article 37 (see 934 to 949) :

735 (a) Transmissions must cease within the bands 485 to 515 kc/s;

736 (b) Outside this band, transmissions of stations of the mobile service may continue; stations of the maritime mobile service may listen to these transmissions on the express conditions that they first ensure watch on the distress frequency as provided by 733.

* * * * *

ARTICLE 34

811 § 6. As far as is reasonable and practicable, the provisions concerning the radiotelegraph service relating to:

- procedure (article 29),
 - calling (article 30),
 - distress urgency and safety signals (article 37).
- and

—conditions of closure of the service (article 35),
are applicable to the maritime mobile radiotelephone service.

* * * * *

815 § 9. (1) The frequency 2 182 kc/s may be used for calls and replies, and it is the frequency to be used for the distress call and traffic, as well as for urgency and safety signals and messages.

816 (2) Its use for call and reply purposes between ship and coast stations is permitted only within the service areas of coast stations duly authorized by their administrations to this effect after a special arrangement if necessary. This information shall be indicated in the list of Coast and Ship Stations.

817 (3) However, an administration may assign to a station other frequencies for call and reply.

818 (4) The distress signal in radiotelephony is defined in 873.

* * * * *

ARTICLE 35

852 § 11. (1) Ship stations whose service is not continuous may not close before:

853 (a) Finishing all operations resulting from a distress call, urgency or safety signal;

854 (b) Exchanging so far as practicable all traffic originating in or destined for coast stations situated within their range and mobile stations which being within their range, have indicated their presence before the actual cessation of work.

855 (2) Any ship station not having fixed working hours must inform the coast stations, with which it is in communication, of the time of closing and the time of reopening its service.

856 § 12. (1) (a) Any mobile station arriving in port, and whose service is therefore about to close, must so notify the nearest coast station and, if necessary, the other coast stations with which it generally communicates.

857 (b) It must not close until after the disposal of traffic on hand, unless the regulations in force in the country where it is calling do not permit this.

858 (2) Upon departure from port the mobile station must notify the coast station or stations concerned that its service is reopening from the moment when such reopening is permitted by the regulations in force in the country where the port of departure is situated.

* * * * *

ARTICLE 37

866 § 3. (1) The speed of telegraph transmission in cases of distress, urgency or safety must not in general exceed 16 words a minute.

867 (2) The speed of transmission for the alarm signal is indicated in 920.

868 § 4. Ships.

(1) In case of distress, the frequency to be used shall be the international distress frequency, that is, 500 kc/s (see 714); it must preferably be used on class A2 or B emissions.

869 (2) In case of distress for radiotelephone stations working in the authorized bands between 1 605 and 2 850 kc/s, the frequency to be used is the distress frequency 2 182 kc/s (see article 34 and particularly 815).

870 (3) Ship stations which cannot transmit on the above distress frequencies shall use their normal calling frequency.

* * * * *

872 § 6. (1) In radiotelegraphy, the distress signal consists of the group ... — — — ... transmitted as a single signal in which the dashes must be emphasized so as to be distinguished clearly from the dots.

873 (2) In radiotelephony, the distress signal consists of the word MAY-DAY pronounced as the French expression "m'aider".

874 § 7. These distress signals indicate that the ship, aircraft, or other vehicle sending the distress signal is threatened by grave and imminent danger and requests immediate assistance.

875 § 8. The distress call and message are sent only on the authority of the master or person responsible for the ship, aircraft or other vehicle carrying the mobile station.

876 § 9. (1) The distress call, when sent by radiotelegraphy on 500 kc/s is, as a general rule, preceded by the alarm signal as defined in 920.

877 (2) When circumstances permit, the transmission of the call is separated from the end of the alarm signal by an interval of two minutes. In this case, the alarm signal must be followed immediately by the distress signal ... — — — ... sent three times, in order to operate the automatic apparatus mentioned in 931.

878 § 10. The distress call sent by radiotelegraphy comprises:

—the distress signal transmitted three times;

—the word DE;

—the call sign of the mobile station in distress, sent three times.

879 § 11. The distress call, when sent by radiotelephony, is generally pre-

ceded by the signal . . . — — — . . . produced by a whistle or any other suitable means.

880 § 12. The distress call sent by radiotelephony comprises:

- the distress signal MAYDAY spoken three times;
- the words THIS IS, followed by the identification of the mobile station in distress, the whole repeated three times.

881 § 13. The distress call has absolute priority over other transmissions. All stations which hear it must immediately cease any transmission capable of interfering with the distress traffic and must listen on the frequency used for the emission of the distress call. This call must not be addressed to a particular station and acknowledgment of receipt is not to be given before the distress message is sent.

882 § 14. (1) The distress call must be followed as soon as possible by the distress message. This message comprises:

- the distress call;
- the name of the ship, aircraft, or vehicle in distress;
- particulars of its position, the nature of the distress and the kind of assistance desired;
- any other information which might facilitate the rescue.

883 (2) As a general rule, a ship signals its position in latitude and longitude (Greenwich), using figures for the degrees and minutes, together with one of the words NORTH or SOUTH and one of the words EAST or WEST. The signal . — . — . — is used to separate the degrees from the minutes. When practicable, the true bearing and distance in nautical miles from a known geographical point may be given.

884 (3) As a general rule, and if time permits, an aircraft shall transmit in its distress message the following information:

- estimated position and time of the estimate;
- true heading and indicated air speed;
- altitude;
- type of aircraft;
- nature of distress;
- intention of person in command (such as forced alighting on the sea or crash landing).

885 (4) As a general rule, an aircraft in flight signals its position:

- if possible by latitude and longitude (Greenwich), using figures for the degrees and minutes, together with one of the words NORTH or SOUTH and one of the words EAST or WEST; or
- by the name of the nearest place, and its approximate distance in relation thereto, together with one of the words NORTH, SOUTH, EAST, or WEST, as the case may be, or, when practicable, by words indicating intermediate directions.

* * * * *

887 § 16. (1) The distress message must be repeated at intervals, especially during the period of silence prescribed in 733, until an answer is received.

888 (2) The alarm signal may also be repeated, if necessary.

889 (3) The intervals must, however, be sufficiently long to allow time for stations preparing to reply to start their sending apparatus.

890 (4) When the mobile station in distress receives no answer to a distress message sent on a distress frequency, the message may be repeated on any other available frequency on which attention might be attracted.

* * * * *

892 § 18. A mobile station which learns that another mobile station is in distress may transmit the distress message in either of the following cases:

893 (a) The station in distress is not itself in a position to transmit it;

894 (b) The master or person responsible for the ship, aircraft or other vehicle carrying the station which intervenes, believes that further help is necessary.

895 § 19. (1) Stations of the mobile service which receive a distress message from a mobile station which is, beyond any possible doubt, in their vicinity, must immediately acknowledge receipt (see 913, 914 and 915). If the distress call has not been preceded by the alarm signal, these stations may transmit this alarm signal with the permission of the authority responsible for the station (for mobile stations see 565), taking care not to interfere with the transmission of acknowledgments of receipt sent by other stations.

896 (2) Stations of the mobile service which receive a distress message from a mobile station which, beyond any possible doubt, is not in their vicinity, must allow a short interval of time before acknowledging receipt of the message, in order to permit stations nearer to the mobile station in distress to answer and acknowledge receipt without interference.

* * * * *

898 § 20. Distress traffic comprises all messages relative to the immediate assistance required by the mobile station in distress.

899 § 21. In distress traffic, the distress signal must be sent before the call and at the beginning of the preamble of any radiotelegram.

900 § 22. The control of distress traffic is the responsibility of the mobile station in distress or of the mobile station which, by the application of the provisions of 892 and 893, has sent the distress call. These stations may, however, delegate the control of the distress traffic to another station.

* * * * *

904 § 24. (1) Any station which hears a distress call must comply with the provisions of 881.

905 (2) Any station of the mobile service which has knowledge of distress traffic must follow such traffic, even if it does not take part in it.

906 (3) For the entire duration of distress traffic, it is forbidden for all stations which are aware of this traffic and which are not taking part in it:

907 (a) To transmit on the frequencies on which the distress traffic is taking place;

908 (b) To use class B emissions.

909 (4) A station of the mobile service which, while following distress traffic, is able to continue its normal service, may do so when the distress traffic is well established and on condition that it observes the provisions of 906, 907 and 908 and does not interfere with the distress traffic.

910 § 25. A land station receiving a distress message must without delay take the necessary action to advise the authorities participating in the operation of rescue facilities.

* * * * *

913 § 27. The acknowledgment of receipt of a distress message is given in the following form:

—call sign of the mobile station in distress (three times);

—the word DE;

—call sign of the station acknowledging receipt (three times);

—group RRR;

—distress signal.

914 § 28. (1) Every mobile station which acknowledges receipt of a distress message must, on the order of the master or person responsible for the ship, aircraft or other vehicle, transmit, as soon as possible, the following information in the order shown:

- its name;
- its position in the form prescribed in 883 and 885;
- the speed at which it is proceeding towards the ship, aircraft or other vehicle in distress.

915 (2) Before sending this message, the station must ensure that it will not interfere with the emissions of other stations better situated to render immediate assistance to the station in distress.

916 § 29. (1) Any station of the mobile service which is not in a position to render assistance and which has heard a distress message which has not been immediately acknowledged, must take all possible steps to attract the attention of stations of the mobile service which are in a position to render assistance.

917 (2) For this purpose, with the approval of the authority responsible for the station, the distress call or the distress message may be repeated. This repetition is made on full power either on the distress frequency or on one of the frequencies which may be used in case of distress (see 868 to 871). At the same time all necessary steps are taken to notify the authorities who may be able to intervene usefully.

918 (3) In radiotelegraphy, the repetition of the distress call or distress message is generally preceded by the transmission of the alarm signal as defined in 920. A sufficient interval of time is to be allowed between the transmission of an alarm signal and the repetition of the distress call or distress message, so that mobile stations, which do not keep continuous watch and which are warned by the sounding of their automatic alarm apparatus, have time to go on watch.

919 (4) A station which repeats a distress call or distress message, follows it by the word DE and its own call sign transmitted three times.

920 § 30. (1) The alarm signal shall consist of a series of twelve dashes sent in one minute, the duration of each dash being four seconds and the duration of the interval between two consecutive dashes one second. It may be transmitted by hand but its transmission by means of an automatic instrument is recommended.

921 (2) Any ship station working in the band 405 to 535 kc/s which is not provided with an automatic apparatus for the transmission of the alarm signal, must be permanently equipped with a clock, clearly marking the seconds, preferably by means of a sweep hand completing one revolution per minute. This clock must be placed at a point sufficiently visible from the operator's table in order that the operator may, by keeping it in view, easily and correctly time the different elements of the alarm signal.

922 (3) This special signal has for its sole purpose the actuation of the automatic devices giving the alarm. It must be used solely either to announce that a distress call or message is about to follow or to announce the transmission of an urgent cyclone warning; in the latter case it may be used only by the coast stations duly authorized by their government.

923 (4) In cases of distress, the use of the alarm signal is governed by 876; in the case of an urgent cyclone warning, the transmission of the warning must not begin until two minutes after the end of the alarm signal.

* * * * *

934 § 35. (1) In radiotelegraphy, the urgency signal consists of three repetitions of the group XXX, sent with the letters of each group and the successive groups clearly separated from each other. It is sent before the call.

* * * * *

943 § 40. (1) In radiotelegraphy, the safety signal consists of three repetitions of the group TTT, sent with the letters of each group and the successive groups clearly separated from each other. It is sent before the call.

* * * * *

940 § 38. (1) Mobile stations which hear the urgency signal must continue to listen for at least three minutes. At the end of this period, if no urgency message has been heard, they may resume their normal service.

941 (2) However, land and mobile stations which are in communication on frequencies other than those used for the transmission of the urgency signal and of the call which follows it may continue their normal work without interruption provided the urgency message is not addressed "to all stations" (CQ).

* * * * *

947 § 42. (1) With the exception of messages transmitted at fixed times, the safety signal, when it is used in the maritime mobile service, must be transmitted towards the end of the first available period of silence (see 733); the message is transmitted immediately after the period of silence.

948 (2) In the cases prescribed in 1050, 1053 and 1056, the safety signal and the message which follows it must be transmitted as soon as possible, but must be repeated as just indicated, at the end of the first period of silence which follows.

949 § 43. All stations hearing the safety signal must continue to listen on the frequency on which the safety signal has been transmitted until they are satisfied that the message is of no interest to them. They must, moreover, not make any transmissions likely to interfere with the message.

RADIOTELEGRAMS

ARTICLE 38

Order of Priority of Communications in the Mobile Service

950 The order of priority of communications in the mobile service is as follows:

1. Distress calls, distress messages and distress traffic.
2. Communications preceded by the urgency signal.
3. Communications preceded by the safety signal.
4. Communications relative to radio direction-finding bearings.
5. Radiotelegrams relative to the navigation and safe movement of aircraft.
6. Radiotelegrams relative to the navigation, movements, and needs of ships; weather observation messages destined for an official meteorological service.
7. Government radiotelegrams for which priority right has been claimed.
8. Service radiotelegrams relating to the working of the radiocommunication service or to radiotelegrams previously transmitted.
9. All other communications.

**EXTRACTS FROM TELEGRAPH REGULATIONS
(PARIS REVISION, 1949)**

ARTICLE 84

249 § 4. Morse Code Signals.

Spacing and length of the signals:

250 (a) A dash is equal to three dots;

251 (b) The space between the signals forming the same letter is equal to one dot;

252 (c) The space between two letters is equal to three dots;

253 (d) The space between two words is equal to seven dots;

254 (e) On the Wheatstone instrument, where perforators are used, the space between two letters shall be equal to one "centre hole" and the space between two words shall be equal to three "centre holes."

EXTRACTS FROM CIVIL AIR REGULATIONS

16.10 *Scope.* Aircraft radio equipment required by the Civil Air Regulations to be type certificated and installed in certificated aircraft is eligible for a type certificate upon meeting the requirements hereinafter prescribed.

* * * * *

16.20 *General.* To be eligible for a type certificate for aircraft radio equipment, an applicant must submit the following technical data:

16.21 *Drawings.* One set of drawings in blueprint or equivalent form folded to approximately 9 x 12 inches containing the manufacturer's designation of the aircraft radio equipment and all details of design, construction, assembly, and materials used which are necessary for the reproduction of such aircraft radio equipment: *Provided*, That adequate photographs may be substituted for such drawings if such photographs are suitably marked to indicate the details required herein.

16.22 *Drawing list.* A drawing list setting forth in numerical order or by other suitable classification, the title and number or date of each drawing submitted under § 16.21.

16.23 *Parts list.* A list specifying each component part of the aircraft radio equipment submitted to the Administrator for certification. The list shall indicate the physical or circuit location of each item and the type or model designation assigned to such item by the manufacturer.

16.30 *Design and tests.* To be eligible for type certification, aircraft radio equipment must be so designed and construed that it will satisfactorily perform the function or functions for which it is intended to be used in aircraft under all flight conditions which may be met in regular service and must:

(a) Be free from hazard both in itself and in its method of operation;

(b) Be constructed of suitable and dependable materials;

(c) Satisfactorily pass a visual inspection of the construction, layout, an electrical arrangement of all components of the particular aircraft radio equipment and such electrical, humidity, temperature, pressure, vibration, drop, and other tests as the Administrator may prescribe.

16.40 *General.* The prescribed inspections and tests shall be conducted by

¹Application for type certification of aircraft radio equipment should be made as prescribed in Part 02. The provisions of §§ 02.2 and 02.3 providing for a production certificate and the rules for the operation under such certificate shall not be applicable to the case of type certification of aircraft radio equipment.

the applicant under the supervision of representatives of the Administrator at a designated time and place and in such manner and under such conditions as they may deem necessary.

16.41 *Facilities.* All engineering, technical, and physical facilities which may be necessary for the conduct of all of the prescribed inspections and tests shall be provided by the applicant.

16.42 *Report.* The applicant shall submit in duplicate a written report of the results of the prescribed inspections and tests which shall be in such detail as the Administrator may require.

16.50 *Identification.* Type certificated aircraft radio equipment shall be plainly and suitably marked with at least the following information:

- (a) Name and address of manufacturer;
- (b) Manufacturer's type or model designation;
- (c) Weight to the nearest pound and fraction thereof;
- (d) Serial number or date of manufacture;
- (e) Type certificate number.

16.51 *Modification.* No change shall be made in the approved specifications under which type certificated aircraft radio equipment is manufactured prior to the approval of such change by the Administrator.

16.52 *List changes.* The holder of a type certificate for aircraft radio equipment shall keep all lists furnished the Administrator current by submitting revised lists containing all changes made subsequent to original certification.

* * * * *

SEC. 41.1 *Issuance.* An air carrier operating certificate prescribing the type of operation, the routes over which such operation may be conducted, the airports which may be used, and such other specifications and restrictions as may be reasonably required in the interest of safety shall be issued by the Administrator to an applicant who demonstrates that he is capable of conducting the proposed operations in accordance with the applicable regulations specified in this part.

(a) *Alaskan air carriers.* Whenever, upon investigation, the Administrator finds that the general standards of safety required for air carrier operations within the Territory of Alaska require or permit a deviation from any specific requirement of this part for a particular operation or a class of operations for which an application for an air carrier operating certificate has been made, he may issue an air carrier operating certificate with appropriate changes, specifying therein the period during which such deviations may be permitted. The Administrator shall promptly notify the Board of any deviations included in the air carrier operating certificates and the reasons therefor.

* * * * *

SEC. 41.11 *Communications facilities.* A two-way ground-to-aircraft radio communications system shall be available at such points as are necessary to insure adequate communication between plane and ground over the entire route.

* * * * *

SEC. 41.13 (b) *Long distance operation.* Each route shall be equipped with radio navigational facilities so located as to permit the obtaining of reliable radio bearings when within 200 miles of any regular or approved alternate airport and a facility shall be so located with respect to each such airport as to provide adequate means for making an instrument approach: *Provided,* That the Administrator, at particular airports, may approve facilities

which provide less coverage than that required in this section if he finds that adequate safety is provided.

* * * * *

Instruments and Equipment

SEC. 41.21 *Radio equipment; short distance operation.* (a) For day contact operations over routes on which navigation can be accomplished by visual reference to landmarks, each aircraft shall be equipped with such radio facilities as are necessary to accomplish the following:

(1) Transmit communications and meteorological information to at least one ground station from any point on the route and transmit, from a distance of not less than 25 miles, to airport traffic control towers located at airports approved for the route;

(2) Receive communications at any point on the route;

(3) By either of two independent means, receive meteorological information at any point on the route and receive instructions from airport traffic control towers located at airports approved for the route.

If appropriate, one of the means provided for compliance with subparagraph (3) of this paragraph may be employed for compliance with subparagraph (2).

(b) For day contact operations over routes on which navigation cannot be accomplished by visual reference to landmarks and for night contact, day or night instrument operations, each aircraft shall be equipped with such radio facilities as are necessary to accomplish the following:

(1) Transmit communications and meteorological information to at least one ground station from any point on the route and transmit, from a distance of not less than 25 miles, to airport traffic control towers located at airports approved for the route;

(2) Receive communications at any point on the route;

(3) By either of two independent means, receive meteorological information at any point on the route and receive instructions from airport traffic control towers located at airports approved for the route;

(4) By either of two independent means, satisfactorily receive radio navigational signals from any radio aid to navigation required by § 41.13 (a).

If appropriate, one of the means provided for compliance with subparagraph (3) of this paragraph may be employed for compliance with subparagraph (2) of this paragraph or the means provided for compliance with subparagraph (4) of this paragraph may be employed for compliance with subparagraph (3) of this paragraph.

SEC. 41.22 *Radio equipment; long distance operation.* Each aircraft shall be equipped with such radio facilities as are necessary to accomplish the following:

(a) By either of two independent means, transmit communications and meteorological information to at least one ground station from any point on the route and transmit, from a distance of not less than 25 miles, to airport traffic control towers located at airports approved for the route;

(b) By either of two independent means, receive communications at any point on the route;

(c) By either of two independent means, receive meteorological information at any point on the route and receive instructions from airport traffic control towers located at airports approved for the route;

(d) By either of two independent means, satisfactorily receive radio navigational signals from any radio aid to navigation required by § 41.13 (b).

If appropriate, equipment provided for compliance with paragraph (c) of this section may be employed for compliance with either paragraph (b) or this paragraph.

* * * * *

SEC. 41.25 *Instruments and equipment required for continuance of flight.* If any required instrument or item of equipment in an aircraft becomes un-serviceable in flight, a landing must be made at either the nearest suitable landing area or at the next point of intended landing whichever, in the opinion of the pilot, is the safer procedure, unless the equipment specified in this section for the type of operation indicated is in serviceable condition, in which case the flight may continue as scheduled to the nearest point where repairs or replacements can be made.

The items listed in this section are required for all types of operation unless otherwise specified:

- * * * * *
- (g) One or more storage batteries or other source of electrical supply sufficient to operate all radio and electrical equipment necessary for the flight,
- (h) (1) Two of the following three units of radio equipment:
- (i) One transmitter for two-way communication,
 - (ii) One receiver for two-way communication,
 - (iii) One receiver capable of receiving navigational signals.
- (2) In addition to the instruments named in subparagraph (1) of this paragraph, one of the radio navigational systems required by § 41.21 (b), if navigational facilities on the route are required by § 41.13,

* * * * *

Flight Radio Operator

SEC. 41.68 *Flight radio operator; when required.* An airman holding a flight radio operator certificate shall be required for flight over any area, route, or route segment over which the Administrator has determined that radiotelegraphy is necessary for communication with ground stations during flight.

* * * * *

SEC. 41.71 *Other flight crew members to be qualified.* In all flights requiring only one flight radio operator, one other flight crew member must be capable of operating the equipment in an emergency.

* * * * *

SEC. 41.92 *Dispatching rules—(a) Short distance operation.* Flights may be dispatched over any approved route between two terminal points.

(b) *Long distance operation.* Flights may be dispatched over any track between two terminal points within the route approved by the Administrator for the operation.

* * * * *

SEC. 41.115 *Communication failure.* In the event of inability to maintain two-way radio communication, the pilot in command shall observe one of the following procedures in the order listed:

(a) Proceed according to current flight plan, maintaining the minimum instrument altitude or the last acknowledged assigned altitude, whichever is higher, to the airport of intended landing and commence descent at approach time last authorized or, if not received and acknowledged, at the estimated time of arrival specified in the flight plan; or

(b) If weather conditions permit, proceed in accordance with contact flight rules or

(c) Land as soon as practicable.

* * * * *

SEC. 41.131 *Irregularity report.* All airmen, including flight and ground personnel, shall immediately report to the operations manager any irregularity or hazard which in their opinion makes for unsafe operation. If such report is found to be justified, notice of the irregularity or hazard must be submitted to the Administrator at once.

SEC. 41.132 *Communication priority.* Where a communications channel serves point-to-point contacts in addition to ground-to-plane, priority shall be given to plane-to-ground and ground-to-plane communications.

* * * * *

SEC. 41.137 (c) *Long distance operation.* A long distance operation is one in which the time interval between stops is of sufficient duration to require that the dispatch be based entirely on forecasts of weather expected at the intended destination and alternates.

* * * * *

SEC. 41.137 (m) *Point-of-no-return.* The term "point-of-no-return" means that point at which the aircraft no longer has sufficient fuel, under existing conditions, to return to the point of departure or any alternate for that point.

* * * * *

SEC. 41.137 (q) *Route segment.* A route segment is a portion of a route, the boundaries of which are identified by:

- (1) A continental or insular geographic location;
- (2) A point at which some specialized aid to air navigation is located; or
- (3) A point at which a definite radio fix is located.

* * * * *

SEC. 42.23 (b) For day VFR operations over routes on which navigation cannot be accomplished by visual reference to landmarks, for night VFR, or for IFR operations, each aircraft shall be equipped as specified in paragraph (a) of this section, and in addition shall be equipped with at least one marker beacon receiver and with such radio equipment as is necessary to receive satisfactorily, by either of two independent means, radio navigational signals from any other radio aid to navigation intended to be used. For operations outside the United States each aircraft operated for long distances over water or uninhabited terrain shall be equipped with two independent means of transmitting to at least one appropriate ground station from any point on the route.

(c) If appropriate, one of the means provided for compliance with paragraph (a) (3) of this section may be employed for compliance with paragraph (a) (2) of this section, and the means provided for compliance with the requirements of paragraph (b) of this section may be employed for compliance with paragraph (a) (1) and (3) of this section.

* * * * *

SEC. 42.41 (d) *Flight radio operator.* An airman holding a flight radio operator certificate shall be required for flight over any area over which the Administrator has determined that radiotelegraphy is necessary for communication with ground stations during flight.

* * * * *

SEC. 44.4 *Radio equipment.* The air carrier shall, subject to compliance with the applicable laws and regulations governing the ownership and operation of radio equipment, provide each aircraft with such radio equipment as is necessary to make proper use of the air navigation facilities along or adjacent to the route to be flown within the United States and to maintain communication with ground stations along and adjacent to such routes.

* * * * *

SEC. 60.41 *IFR flight plan.* Prior to take-off from a point within a control zone or prior to entering a control area or control zone, a flight plan shall be filed with air traffic control. Such flight plan shall contain the following information unless otherwise authorized by air traffic control:

- (a) Aircraft identification, and if necessary, radio call sign;
- (b) Type of aircraft; or, in the case of a formation flight, the types and number of aircraft involved;
- (c) Full name, address, and number of pilot certificate of pilot in command of the aircraft, or of the flight commander if a formation flight is involved;
- (d) Point of departure;
- (e) Cruising altitude or altitudes, and the route to be followed;
- (f) Point of first intended landing;
- (g) Proposed true air speed at cruising altitude;
- (h) Radio transmitting and receiving frequencies to be used;

* * * * *

SEC. 4b.606 *Equipment, systems, and installations—(a) Functioning and reliability.* All equipment, systems, and installations the functioning of which is necessary in showing compliance with the regulations in this subchapter shall be designed and installed to insure that they will perform their intended functions reliably under all reasonably foreseeable operating conditions.

(b) *Hazards.* All equipment, systems, and installations shall be designed to safeguard against hazards to the airplane in the event of their malfunctioning or failure.

(c) *Power supply.* Where an installation the functioning of which is necessary in showing compliance with the regulations of this subchapter requires a power supply, such installation shall be considered an essential load on the power supply, and the power sources and the system shall be capable of supplying the following power loads in probable operating combinations and for probable durations:

- (1) All loads connected to the system with the system functioning normally;
- (2) All essential loads after failure of any one prime mover, power converter, or energy storage device;
- (3) All essential loads after failure of any one engine on two- or three-engine airplanes, or after failure of any two engines on four-or-more-engine airplanes.

* * * * *

SEC. 4b.621 *Electrical system capacity.* The required generating capacity and the number and type of power sources shall be determined by an electrical load analysis and shall comply with § 4b.606 (c)

* * * * *

SEC. 4b.622 *Generating system.* (a) The generating system shall be considered to include electrical power sources, main power busses, transmission cables, and associated control, regulation, and protective devices.

(b) The generating system shall be so designed that the power sources function properly both when connected in combination and independently, and the failure or malfunctioning of any power source cannot create a hazard or impair the ability of the remaining sources to supply essential loads.

(c) Means accessible in flight to appropriate crew members shall be provided for the individual and collective disconnection of electrical power sources from the main bus.

(d) Means shall be provided to indicate to appropriate crew members those generating system quantities which are essential for the safe operation of the system.

NOTE: The voltage and current supplied by each generator are quantities considered essential.

* * * * *

SEC. 4b.624 *Electrical protection.* (a) Automatic protective devices shall be provided to minimize distress to the electrical system and hazard to the airplane in the event of wiring faults or serious malfunctioning of the system or connected equipment.

(b) In the generating system the protective and control devices shall be such as to de-energize and disconnect faulty power sources and power transmission equipment from their associated busses with sufficient rapidity to provide protection against hazardous overvoltage and other malfunctioning.

(c) All resettable type circuit protective devices shall be so designed that, when an overload or circuit fault exists, they will open the circuit irrespective of the position of the operating control.

(d) Protective devices or their controls used in essential load circuits shall be accessible for resetting in flight.

(e) Circuits for essential loads shall have individual circuit protection.

NOTE: This provision does not necessarily require individual protection for each circuit in an essential load system (e. g., each position light in the system).

(f) If fuses are used, there shall be provided spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

* * * * *

SEC. 4b.625 *Electrical equipment and installation.* (a) In showing compliance with § 4b.606 (a) and (b) with respect to the electrical system, equipment, and installation, consideration shall be given to critical environmental conditions.

NOTE: Critical environmental conditions may include temperature, pressure, humidity, ventilation, position, acceleration, vibration, and presence of detrimental substances.

(b) All electrical equipment, controls, and wiring shall be so installed that operation of any one unit or system of units will not affect adversely the simultaneous operation of any other electrical unit or system of units essential to the safe operation of the airplane.

(c) Cables shall be grouped, routed, and spaced so that damage to essential circuits will be minimized in the event of faults in heavy current-carrying cables.

(d) Batteries and their installations shall provide for ventilation, drainage of fluids, venting of gases, and protection of other parts of the airplane from corrosive battery fluids.

* * * * *

*EXTRACTS FROM THE INTERNATIONAL CIVIL AVIATION
ORGANIZATION PUBLICATIONS*

ANNEX 10—PART III—PROCEDURES

CHAPTER 1. DEFINITIONS

NOTAM. A notice, containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the rapid distribution of which, to personnel concerned with aircraft flight operations, is essential for the safe and efficient operation of aircraft.

* * * * *

CHAPTER 4. AERONAUTICAL FIXED SERVICE

4.1.4.2. *Messages for the safety of human life.* Messages for the safety of human life shall be preceded by the letters SVH, in lieu of a priority prefix.

NOTE: Messages for the safety of human life comprise a category of message corresponding to urgency and safety messages in the mobile service (see 5.5 and 5.6).

* * * * *

4.3.5. *Break-in-procedure.* The receiving station shall not break-in on the transmitting station except to advise that equipment is not functioning properly or that transmissions are so mutilated that transcription and fill-ins would not be justified.

* * * * *

CHAPTER 5. AERONAUTICAL MOBILE SERVICE

5.1.1 *Hours of service.* During flight, aircraft stations shall maintain watch when required by the competent authority and shall operate on the appropriate radio frequency. Aircraft stations shall not cease watch, except for reasons of safety, without informing the air-ground control radio station.

* * * * *

5.1.4.2 Aircraft stations shall communicate with the air-ground control radio station appropriate to the area in which the aircraft are flying, except under the provisions of the following subparagraphs:

5.1.4.2.1 Aircraft stations may communicate with other aeronautical stations when traffic can be handled more effectively than through the air-ground control radio station.

5.1.4.2.2 Under abnormal circumstances, aircraft stations may use any relay means available to transmit messages to an air-ground control radio station. An air-ground control radio station may also use any relay means available to transmit messages to aircraft stations.

* * * * *

5.1.4.4 In communications between aircraft stations, the duration of communication shall be controlled by the aircraft station which is receiving, subject to the intervention of an aeronautical station.

* * * * *

5.1.5.3 When an aircraft station is unable to establish communication due to receiver failure, it shall transmit periodical reports at scheduled times, or positions, on the frequency in use.

5.1.5.4 The air-ground control radio station shall notify the appropriate air traffic control office and the aircraft operating agency, as soon as possible, of any failure in air-ground communication.

* * * * *

5.1.7.1 The order of priority in the establishment of communications and transmissions of messages in the aeronautical mobile service shall be as illustrated in the box below.

NOTE: A NOTAM may qualify for any of the priorities 3 to 7 inclusive. The decision as to which priority will depend on the contents of the NOTAM and its importance to the aircraft concerned.

Order of Priority (see 5.1.7.1)

<i>Type of message</i>	<i>Radiotelegraph signal</i>	<i>Radiotelephone signal</i>
1. Distress calls, distress messages and distress traffic-----	SOS	MAYDAY
2. Urgency messages -----	XXX	PAN
3. Safety messages -----	TTT	SECURITE
4. Communications relating to direction finding -----	---	---
5. Flight safety messages -----	---	---
6. Meteorological messages -----	---	---
7. Flight regularity messages -----	---	---

* * * * *

5.3.1 *Language to be used.*

5.3.1.1 RECOMMENDATION.—In general, the air-ground radiotelephony communications shall be conducted in the language normally used by the station on the ground.

NOTE: The language normally used by the station on the ground may not necessarily be the language of the State in which it is located.

5.3.1.2 RECOMMENDATION.—Pending the development and adoption of a more suitable universal aeronautical radiotelephone language, the English language should be used as such, and should be available on request from any aircraft station unable to comply with 5.3.1.1, at all stations on the ground serving designated airports and routes used by international air services.

NOTE 1: While the Contracting State designates the airports to be used and the routes to be followed by international air services, the formulation of ICAO opinion and recommendations to Contracting States concerned is carried out periodically by Council, ordinarily on the basis of recommendations of Regional Air Navigation Meetings.

NOTE 2: In certain regions the availability of another language, in addition to English, may be agreed upon regionally as a requirement for stations on the ground in that region.

NOTE 3: The development of an International Language for Aviation (ILA) to be used in radiotelephony is the subject of continuing study and the broad principles of this study are laid down in Attachment A to Part III of this Annex.

5.3.1.3 RECOMMENDATION.—Pending implementation of 5.3.1.2 and when the aircraft station and the station on ground cannot use a common language, arrangements should be made between the competent authority and the air-

craft operating agency concerned for the provision of an interpreter by the latter.

5.3.1.4 When provided, such interpreters shall be permitted to have access to and use of radiotelephone channels under the supervision of the controller on duty.

5.3.1.5 The language normally used by and other languages that may be used on request at a station on the ground shall form part of the Aeronautical Information Publications and other published aeronautical information concerning such facilities.

* * * * *

5.3.2 *Word spelling in radiotelephony.* When proper names, service abbreviations and words of which the spelling is doubtful are spelled out in radiotelephony, the following alphabet shall be used:

A—Alfa	N—Nectar
B—Bravo	O—Oscar
C—Coca	P—Papa
D—Delta	Q—Quebec
E—Echo	R—Romeo
F—Foxtrot	S—Sierra
G—Golf	T—Tango
H—Hotel	U—Union
I—India	V—Victor
J—Juliett	W—Whiskey
K—Kilo	X—Extra
L—Lima	Y—Yankee
M—Metro	Z—Zulu

5.3.3 *Transmission of numbers in radiotelephony.*

5.3.3.1.1 All numbers except whole thousands shall be transmitted by pronouncing each digit separately. Whole thousands shall be transmitted by pronouncing each digit in the number of thousands followed by the word "THOUSAND".

NOTE: The following examples illustrate the application of this procedure:

Number	Transmitted as—
10	One zero
75	Seven five
100	One zero zero
583	Five eight three
5000	Five thousand
11000	One one thousand
25000	Two five thousand
38143	Three eight one four three

* * * * *

5.3.6.2.2 After communication has been established when using the call sign prescribed in 5.3.6.2.1. (c), an abridged call sign may be used consisting of the radiotelephone abbreviations of the airline and the last two characters of the call sign.

* * * * *

5.3.6.3 *Radiotelephone calling procedure.*

5.3.6.3.1 The calling procedure of an aircraft attempting to establish communication with an aeronautical station shall be as follows: (see table 1 below).

5.3.6.3.2 The reply to the above calls shall be as follows: (see table 2 below).

NOTE: When the procedure 5.3.6.2.2 is applied, the aircraft identification in both the call and reply would be Speedbird CD or when the spelling alphabet is used, Speedbird Coca Delta (see 5.3.2).

TABLE 1.—Radiotelephone Calling Procedure (see 5.3.6.3.1)

Designation of the station called	Type (a) New York radio	Type (b) New York radio	Type (c) New York radio	Type (d) New York radio
The words "This is"-----	This is	This is	This is	This is
Designation of the station calling -----	GABCD*	N 3578*	Speedbird GABCD*	Clipper 14*
Invitation to reply -----	OVER	OVER	OVER	OVER

*Each letter in the call sign is to be spoken separately; when desired, the individual letters may be spelled out using the spelling system contained in 5.3.2. Numerals are to be spoken in accordance with 5.3.3.

TABLE 2.—Radiotelephone Reply Procedure (see 5.3.6.3.2)

Designation of the station called	Type (a) GABCD*	Type (b) N 3578*	Type (c) Speedbird GABCD*	Type (d) Clipper 14*
The words "This is"-----	This is	This is	This is	This is
Designation of the answering station -----	New York radio	New York radio	New York radio	New York radio
Invitation to proceed with transmission -----	GO AHEAD	GO AHEAD	GO AHEAD	GO AHEAD

*Each letter in the call sign is to be spoken separately; when desired, the individual letters may be spelled out using the spelling system contained in 5.3.2. Numerals are to be spoken in accordance with 5.3.3.

* * * * *

5.3.6.5 After contact has been established, continuous two-way communication shall be permitted without further identification or call (if no mistake in identity is likely to occur) until termination of the contact.

* * * * *

5.3.7.2 *Acknowledgment of receipt.* An acknowledgment of receipt shall not be given until the receiving operator is certain that the transmitted information has been received correctly. A receiving station shall acknowledge receipt by transmitting its own identification followed by the word ROGER. For verification, the receiving operator may repeat back the message as an acknowledgment of receipt.

5.3.7.3 *End of conversation.* A radiotelephone conversation shall be terminated by the receiving station using its own identification followed by OUT. This will indicate that no response is expected.

* * * * *

5.3.7.4.1 When an error has been made in transmission, the word CORRECTION shall be spoken, the last correct group or phrase repeated, and then the correct version transmitted.

* * * * *

5.3.7.4.4 If repetition of an entire message is required, the words SAY AGAIN shall be spoken. If repetition of a portion of a message is required, the operator shall state: "SAY AGAIN ALL BEFORE . . . (first word satisfactorily received)"; or "SAY AGAIN . . . (word before missing portion) TO . . . (word after missing portion)"; or "SAY AGAIN ALL AFTER . . . (last word satisfactorily received)".

* * * * *

5.4.1.3 RECOMMENDATION.—In handling distress traffic, the speed of transmission by radiotelegraph should not, in general, exceed 16 words per minute.

* * * * *

5.4.2.1 The first transmission of the distress call and message by the aircraft station shall be on the designated air-ground route frequency in use at the time.

* * * * *

5.4.5.3 The distress call sent by radiotelephony shall comprise:

- the distress signal MAYDAY spoken three times;
- the words THIS IS;
- the identification of the aircraft in distress spoken three times.

NOTE: The distress call, when sent by radiotelephony, may be preceded by the signal SOS produced by a whistle or any other suitable means.

* * * * *

5.4.5.4 The distress call shall have absolute priority over other transmissions. All stations which hear it shall immediately cease any transmission capable of interfering with the distress traffic and shall listen on the frequency used for the emission of the distress call. This call shall not be addressed to a particular station and acknowledgment of receipt shall not be given before the distress message is sent.

* * * * *

5.4.6.1. The distress call shall be followed as soon as possible by the distress message. This message shall comprise:

- (a) The distress call, except as provided for in 5.4.6.1.1;
- (b) The identification of the aircraft in distress, except as provided for in 5.4.6.1.1 and 5.4.6.1.2;
- (c) Particulars of the position (including, if time permits, estimated position, time of estimate; heading, stating whether magnetic or true; indicated air speed; altitude and type of aircraft);
- (d) Nature of distress and kind of assistance desired;
- (e) Any other information which might facilitate the rescue (this should include the intention of person in command, such as forced alighting on the sea or crash landing).

5.4.6.1.1 If the aircraft in distress is able immediately to follow the distress call (see 5.45) with the information listed under 5.4.6.1 (c), (d), and (e),

items (a) and (b) may be omitted from the distress message, on the authority of the person in command of the aircraft.

NOTES The transmission of the distress call prior to and separate from the distress message, serves to alert stations which hear it and to ensure their compliance with 5.4.5.4. The procedure in 5.4.6.1.1 is intended to be applied only when the person in command of the aircraft considers that the circumstances are such that it is necessary to transmit the distress message without transmitting a separate distress call.

5.4.6.1.2 When the distress message cannot immediately follow the distress call and when the aircraft in distress is sending the distress message, item 5.4.6.1 (b) may be omitted since, in such case, item 5.4.6.1 (a) will already contain this information.

5.4.6.2 **RECOMMENDATION.**—An aircraft in distress should signal its position:

(a) If possible, by latitude and longitude (Greenwich), using figures for the degrees and minutes, together with one of the words NORTH or SOUTH and one of the words EAST or WEST: or

(b) By the name of nearest place, and its approximate distance in relation thereto, together with one of the words, NORTH, SOUTH, EAST, OR WEST, as the case may be, or, when practicable, by words indicating intermediate directions.

* * * * *
5.4.7.1 The distress message shall be repeated at intervals by the aircraft station originating the same until an answer is received.

* * * * *
5.4.8.2 **RECOMMENDATION.**—Immediately prior to a forced or a crash landing of an aircraft, as well as before total abandonment, the radio apparatus should, if it is considered that there is no additional risk of fire and if circumstances permit, be set for continuous transmission.

* * * * *
5.4.9.1 **RECOMMENDATION.**—An aircraft station becoming aware that another aircraft or other mobile station is in distress, should transmit the distress message when:

(a) The station in distress is not itself in a position to transmit the message; or

(b) The person in command of the aircraft which intervenes believes that further help is necessary.

* * * * *
5.4.12.2 Aeronautical stations acknowledging receipt shall take the following action:

(a) Forward the information immediately to the area control centre or flight information centre, and also to the aircraft operating agency if locally represented, unless arrangements exist whereby such information may be made available to it by other means. Such information shall include, if direction-finding facilities are available, any bearings taken on the aircraft in distress;

(b) Continue to guard the aircraft frequency last used, and, as far as possible, any other frequency which may be used by that particular aircraft. Under no circumstances shall the frequency last used by the aircraft be left unguarded. A continuous watch shall, if possible, be established immediately on the authorized international distress frequencies;

(c) Notify any direction-finding station which may be of assistance unless

arrangements exist whereby the air traffic services take this action on receipt of the information provided for in (a).

* * * * *

5.4.13.1 When the aircraft is no longer in distress, the aircraft station shall transmit, on the same frequency, or frequencies on which distress message was sent, a message cancelling the state of distress. When it is no longer necessary to observe silence, or when the distress traffic is ended, the station which has controlled the traffic shall send on the distress frequency, and on the frequency used for the distress traffic, a message addressed "to all station" (CQ), indicating that the distress traffic is ended and shall so inform the area traffic control centre, the flight information centre, and the aircraft operating agency if locally represented. This message shall take the following form:

(a) In radiotelegraphy:

- distress signal SOS;
- call "to all stations" (CQ) (three times);
- the word DE;
- call sign of the station sending the message (once);
- time of handing-in of the message;
- name and call sign of the aircraft station which was in distress (once);
- service abbreviation QUM;
- signal VA;
- call sign of the station sending the message (once).

(b) In radiotelephony:

- the word MAYDAY;
- the words ALL STATIONS (three times);
- the words THIS IS;
- the identification of the station transmitting the message (once);
- time of handing-in, of the message;
- name or identification of the aircraft which was in distress;
- the words DISTRESS TRAFFIC ENDED;
- the word OUT.

* * * * *

COMMUNICATION CODES AND ABBREVIATIONS

CHAPTER 7. THE NOTAM CODE

7.1. Introduction

The NOTAM Code is provided to enable the coding of information regarding the establishment, condition or change of radio aids, aerodromes and lighting facilities, dangers to aircraft in flight, or search and rescue facilities. Encoding facilitates the dissemination of NOTAMS by reducing the transmission time over telecommunication channels and eliminating translation.

7.2. Procedures

The transmission of NOTAMS over the International Aeronautical Telecommunication Service is governed by the appropriate sections of the current Communication Procedures and Aeronautical Information Services Procedures. The former document contains information on the acceptability of and priority

to be accorded to NOTAMS for transmission over the International Aeronautical Telecommunication Service, the latter full instructions on the textual format and contents of NOTAMS.

7.3. *Composition*

All NOTAM Code groups contain a total of five (5) letters. The first letter of the Code group is always the letter Q to indicate that it is a Code abbreviation for use in the composition of NOTAMS. The letter Q has been chosen to avoid conflict with any assigned radio call sign.

7.4. *Significations*

The significations assigned to NOTAM Code groups shall be amplified or completed where necessary by the addition of appropriate abbreviations, frequencies, call signs, place names or figures approved for use in the International Aeronautical Telecommunication Service. These approved abbreviations shall be used in preference to plain language wherever possible.

7.5. *Blank Spaces*

The information necessary to complete a signification, as indicated by a blank space, shall be given except when:

(a) The blank spaces are enclosed within parentheses to indicate that their completion is optional.

Example:

(i) = QIEIK CYUL 15 =

Meaning: The Beacon at Montreal Airport (Dorval) is available on 15 minutes' notice.

NOTE: In the above example the meanings assigned to *IE* and *IK* have been amplified by the use of the optional sections of each maning [*IE* (at ... location). *IK* (or at ... minutes' notice)] enclosed within parentheses.

(b) An alternative meaning shown in parentheses is selected and the blank space in this alternative meaning is completed.

Example:

(ii) = QAUED 3 MC 5813 142359 =

Meaning: The Meteorological communications operating frequency of 3 megacycles will be changed to 5813 kilocycles effective 2359 hours on the 14th day of the present month.

NOTE: In the above example the alternative meaning of *AU* [(... Mc/s)] has been used.

7.5.1 The information used to complete the blank spaces shall be sent immediately after the NOTAM group in the sequence shown in the signification.

7.6. *Parenthetical Expressions*

Expressions or words in parentheses which do not include blank spaces, have the following significance:

(a) When following a blank space

Example:

(i) ... (time or place)
... (date/time)

The explanation of information to be used in filling the preceding blank.
 (b) When following a word or expression

Example:

(ii) "is (are)"

An alternative to the word or expression.

7.7. *Use*

Five (5) letter NOTAM Code groups are formed in the following manner:

FIRST LETTER:

The letter Q. [See paragraph 7.3.]

SECOND AND THIRD LETTERS:

The appropriate combination of two letters selected from the "Second and Third Letters" section of the Code to identify the facility, service or danger to aircraft in flight being reported upon. It should be noted that the second letter has been restricted to A, E, I, O or U.

FOURTH AND FIFTH LETTERS:

The appropriate combination of two letters selected from the "Fourth and Fifth Letters" section of the Code to denote the status of operation of the facility, service or danger to aircraft in flight reported upon. It should be noted that the fourth letter has been restricted to A, E, I, O or U.

7.7.1 The first five (5) letter NOTAM Code group in any NOTAM text shall in all cases be immediately preceded by the full name of the location of the particular facility, service, or danger to aircraft in flight being reported except that, in cases where an ICAO place name abbreviation has been assigned, this shall be used to identify the geographical location.

Examples: 1 2 3 4 5 6
 (a) = FFOL QAROS 210800 211500 =

Meaning: The radio range at Orly will be out of service from 0800 hours GMT on the 21st day of the present month until 1500 hours GMT on the same day.

Explanation:

- (1) ICAO place name abbreviation identifying Orly (France), the location of the facility being reported
- (2) the letter "Q" identifying a five (5) letter Code group as a NOTAM Code group
- (3) Second and Third Letters "AR" identifying "radio range"
- (4) Fourth and Fifth Letters "OS" denoting "Out of service from ... (date/time) until ... (date/time)"
- (5) Date/time group completing the first blank in signification of Fourth and Fifth Letters "OS"
- (6) Date/time group completing the second blank in signification of Fourth and Fifth Letters "OS"

NOTE: It should be noted that in the above examples, the signification assigned to Fourth and Fifth Letters "OS" has been amplified by the use of that optional section of the signification enclosed within brackets.

(b) = KIND QAROS 116.9 MC 210800 =

Meaning: The VHF omnidirectional radio range on frequency 116.9 Mc/s. at Indianapolis will be out of service from 0800 hours GMT on the 21st day of the present month for an unknown duration.

NOTE: It should be noted that at Indianapolis (USA) both MF and VOR type radio ranges are installed and both ranges have identical identifications—hence the requirement to specify the frequency of the particular installation being reported in order to avoid confusion.

(c) = SASO QOMAO TREES =

Meaning: All runways at Stockholm (Bromma) are marked by trees.

NOTE: The use of plain language (TREES) to complete intelligence in this particular example should be noted [Swedish winter snow conditions].

(d) = CYUL QUIAZ 210800 211100 4537N 7400W 20000 FT MER QUEAY 10 NM =

Meaning: Montreal advises that on the 21st day of the present month gun-firing to an altitude of 20,000 feet will take place from 0800 hours GMT until 1100 hours GMT at location (latitude) 45°37' North, (longitude) 74°00' West. Aircraft are to avoid the area, the radius of danger being 10 nautical miles.

7.7.2 In those significations where the expression "on . . . kc/s (or . . . Mc/s)" appears, the figures groups used alone will indicate the frequency in kilocycles. To express a frequency in megacycles, the figures group is immediately followed by the abbreviation MC [*meaning Megacycles*].

CHAPTER 8.—THE NOTAM CODE—DECODE
Second and Third Letters—Radio Aids

Second and third letters	Signification	Second and third letters	Signification
AA	. . . air traffic control receiver . . . kc/s. (or . . . Mc/s.) [specify TWR, APP, ATC or OAC].	AK	Radio receiving facilities.
AB	Inner marker, Instrument Landing System.	AL	Localizer, Instrument Landing System.
AC	. . . air traffic control transmitter . . . kc/s. (or . . . Mc/s.) [specify TWR, APP, ATC or OAC].	AM	Compass locator, inner, Instrument Landing System.
AD	Middle marker, Instrument Landing System.	AN	
AE	Outer marker, Instrument Landing System.	AO	Compass locator, outer, Instrument Landing System.
AF	Fan-type marker.	AP	
AG	Glide path, Instrument Landing System.	AQ	
AH	Radio beacon homing facility.	AR	Radio range [. . . kc/s.* (or . . . Mc/s.)].
AI	Instrument Landing System (ILS).	AS	Radio range leg.
AJ	Radio range and associated voice communications [. . . kc/s.* (or . . . Mc/s.)].	AT	Attention signal
		AU	Meteorological communications . . . kc/s. (or . . . Mc/s.).
		AV	Voice communications . . . kc/s. (or Mc/s.).
		AW	
		AX	Radio beacon homing and voice facility.

Second and Third Letters—Radio Aids (Contd.)

Second and third letters	Signification	Second and third letters	Signification
AY	200 Mc/s. Distance Measuring Equipment (DME).	EL	Loran.
AZ	Station location marker VHF.	EM	MF DF.
EA	Consol station (. . . position).	EN	1000 Mc/s. Distance Measuring Equipment (DME).
EB		EO	Beam Approach Beacon System (BABS)
EC		EP	Surveillance Approach Radar.
ED	EQ	Transmitting facility(ies) . . . kc/s. (or . . . Mc/s.).	
EE	Ground Controlled Approach System (GCA).	ER	All radio-navigation facilities (except . . .).
EF	Aerodrome Control Radar System (ACR).	ES	Teletypewriter transmitting facility(ies).
EG	Ge.	ET	VHF DF.
EH	HF DF.	EU	
EI	Automatic radio range track monitoring device.	EV	SBA system, localizer.
EJ	All air-ground facilities (except . . .).	EW	SBA system, inner marker.
EK	Precision Approach Radar (PAR).	EX	SBA system, outer marker.
		EY	
		EZ	

*For use when reporting locations at which both MF and VOR installations are located—in these instances the appropriate frequency is given to avoid confusion.

Lighting Facilities

Second and third letters	Signification	Second and third letters	Signification
IA	Boundary lights.	IN	Approach lights with descent path indication.
IB		IO	Obstruction lights.
IC	Channel lights.	IP	Approach lights (for runway number . . .).
ID		IQ	Runway lights (for runway number . . .).
IE	IR	Strip lights.	
IF	Flood lights.	IS	Threshold lights.
IG	Angle-of-approach lights	IT	
IH	Taxiway lights.	IU	Flares.
II	Threshold lights.	IV	
IJ		IX	Aerodrome identification beacon.
IK	IY	Airway course lights.	
IL	IZ		
IM			

*Second and Third Letters—Aerodromes: Search and Rescue:
Dangers to Aircraft in Flight*

Second and third letters	Signification	Second and third letters	Signification
OA	Land aerodrome.	UA	
OB	Beaching facilities.	UB	Mooring buoys.
OC	Water aerodrome.	UC	
OD	Meteorological forecast service.	UD	
OE	Meteorological observation service.	UE	Aircraft.
OF		UF	Fixed balloons.
OG		UG	Bombing.
OH		UH	Air exercises.
OI		UI	Gun-firing.
OJ		UJ	Glider flying.
OK		UK	Demolition of explosives.
OL		UL	Landing direction indicator.
OM	All runways [except number(s) ...].	UM	Mooring and docking facilities.
ON		UN	
OO	Taxiway(s).	UO	
OP	Rescue vessel.	UP	
OQ	Ocean Station Vessel.	UQ	Apron.
OR	Refuelling facilities.	UR	Runway(s) number(s) ...
OS	Search and rescue aircraft [specify VLR, LRG, MRG, SRG or HEL].	US	
OT		UT	Grass landing area.
OU		UU	
OV		UV	For dispersal equipment.
OW		UW	
OX		UX	
OY		UY	
OZ	Warship.	UZ	

Fourth and Fifth Letters—Hazard or Status of Operation

Fourth and fifth letters	Signification	Fourth and fifth letters	Signification		
AA	Usable for length of . . . and width of . . .	EL	Military operations only.		
AB		EM			
AC		Covered by snow to a depth of . . . <i>Note.—This snow is not compacted.</i>		EN	
				EO	
AD		Operating without tone modulation.		EP	Available on prior permission only.
				EQ	
				ER	
				ES	
				ET	
				EU	
	EV				
	EW				
	EX				
	EY				
AK	Covered by compacted snow to a depth of . . .	EZ	Report of apparent unreliability or track displacement hereby is cancelled. Available on request to . . . Flight checked and found reliable.		
AL	Operating on reduced power.	IA			
AM	Snow clearance in progress.	IB			
AN	Grass cutting in progress.	IC			
AO	Marked by . . .	ID			
AP	Work is in progress.				
AQ	Work completed.				
AR	Snow clearance completed.				
AS	Grass cutting completed.				
AT	Appears unreliable.			IE	
AU			IF		
AV			IG		
AW			IH		
AX			II		
AY		Are to avoid areas, radius of danger being . . .	IJ		
AZ		Will take place from . . . (date/time) for an unknown duration [or until . . . (date/time)] at . . . location at . . . height above . . . datum.	IK		
			IL		
			IM		
EA		Location change to . . . effective . . . (date/time).	IN	Operative or reoperative from . . .	
EB	IO				
EC	Characteristics or identification or radio call sign changed to . . .	IP	Operating normally. Track(s) reported to be displaced (. . . degrees) (. . . direction) of published bearing(s), other tracks probably have shifted.		
		ED		Operating frequency(ies) will be changed to . . . kc/s. (or . . . Mc/s.) effective . . . (date/time).	IQ

Fourth and Fifth Letters—Hazard or Status of Operation—Continued

Fourth and fifth letters	Signification	Fourth and fifth letters	Signification	
EE	Not heard.	IR	Magnetic track(s) towards station is (are) now . . . [will be . . . at . . . (<i>date/time</i>)].	
EF		IS		
EG		IT	Aircraft restricted to runways and taxiways.	
EH		IU	Unserviceable for aircraft heavier than . . . tons.	
EI		OZ		
EJ		UA	Closed to all operations from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)].	
EK		UB		
		UC		
		UD	Closed to all night operations from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)].	
		UE		
IV	Unsafe from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)].	UF	Closed for an unknown duration due to flood.	
IW	Resumed operation—ground checked only, awaiting flight check.	UG	Closed for an unknown duration [or until . . . (<i>date/time</i>)] due to ice or snow.	
IX		UH	Closed for an unknown duration (or until . . . (<i>date/time</i>)) due to thaw.	
IY		UI	Closed from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)] for maintenance.	
IZ		UJ		
		UK		
OA		UL		
OB		UM		
OC		UN	Operative but caution advised due to flood.	
OD		UO	Operative but caution advised due to ice or snow.	
OE		UP	Operative but caution advised due to thaw.	
OF	UQ	Operative but caution advised due to repairs or construction.		
OG	UR	Operative but caution advised due to obstruction.		
	Resumed normal operation. Track(s) ground checked, approved for instrument flying.			
OH				
OI				
OJ				
OK				
OL				
OM		Shut down for maintenance from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)]—disregard all signals.		
ON				
OO				
OP				
OQ				
OR	Previously promulgated shutdown has been cancelled.			
OS	Out of service from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)].			

Fourth and Fifth Letters—Hazard or Status of Operation—Continued

Fourth and fifth letters	Signification	Fourth and fifth letters	Signification	
OT	New facility in operation.	US	Operative but caution advised due to rough water.	
OU		UT		
OV	Operating without interruption for voice transmissions from . . . (<i>date/time</i>) for an unknown duration [or until . . . (<i>date/time</i>)].	UU	Operative but caution advised due to special conditions.	
OW		UV		
OX		UW		
OY		Exercising at . . . (<i>date/time, location and height above the specified datum</i>).		UX
				UY
				UZ

CHAPTER 11.—APPROVED ABBREVIATIONS FOR IDENTIFYING MESSAGES

The following abbreviations of types of messages are approved for use by Air Traffic Control authorities as the first word of the text of a message:

Abbreviation	Signification
ARR	Arrival message
CNL	Cancellation message
CTL	Any other Air Traffic Control message
DEL	Delay message
DEP	Departure message
PLN	Flight Plan message
TFR	Transfer of Control message

EXTRACTS FROM AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND CANADA FOR THE PROMOTION OF SAFETY ON THE GREAT LAKES BY MEANS OF RADIO

REGULATION 2.—TRIAL OF RADIOTELEPHONE INSTALLATION

Each calendar day that a vessel is navigated, unless the normal use of the radiotelephone installation demonstrates that the equipment is in proper operating condition for an emergency, a test communication for this purpose shall be made by a properly qualified person. Should the equipment be found by some person other than the master not to be in proper operating condition for an emergency, the master shall be promptly notified thereof. A record shall

be made in the record provided for by Article 9 of the agreement and Regulation 4 showing the operating condition of the equipment as determined by either the normal communication or the test communication referred to above, and showing that, if an improper operating condition was found, the master was properly notified thereof.

*EXTRACTS FROM THE RULES AND REGULATIONS OF THE
FEDERAL COMMUNICATIONS COMMISSION*

PART 1—RULES RELATING TO PRACTICE AND PROCEDURE

SEC. 1.401 *Notice of violation.* Any licensee who appears to have violated any provision of the Communications Act of 1934 or of the Rules and Regulations of the Federal Communications Commission shall be served with a notice calling the facts to his attention and requesting a statement concerning the matter. Within 3 days from receipt of such notice, or such other period as may be specified, the licensee shall send a written answer direct to the office of the Commission originating the official notice. If an answer cannot be sent, nor an acknowledgment made within such 3-day period by reason of illness or other unavoidable circumstances, acknowledgment and answer shall be made at the earliest practicable date with a satisfactory explanation of the delay. The answer to each notice shall be complete in itself and shall not be abbreviated by reference to other communications or answers to other notices. If the notice relates to violations that may be due to the physical or electrical characteristics of transmitting apparatus, the answer shall state fully what steps, if any, have been taken to prevent future violations, and if any new apparatus is to be installed, the date such apparatus was ordered, the name of the manufacturer, and promised date of delivery. If the installation of such apparatus requires a construction permit, the file number of the application shall be given, or if a file number has not been assigned by the Commission such identification shall be given as will permit ready identification thereof. If the notice of violation relates to lack of attention to or improper operation of the transmitter, the name and license number of the operator in charge shall be given.

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PART 2—FREQUENCY ALLOCATIONS AND TREATY MATTERS; GENERAL RULES AND REGULATIONS

SEC. 2.1 *Definitions.* The following definitions are issued:

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

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Carrier. In a frequency stabilized system, the sinusoidal component of a modulated wave whose frequency is independent of the modulating wave; or

The output of a transmitter when the modulating wave is made zero; or

A wave generated at a point in the transmitting system and subsequently modulated by the signal; or

A wave generated locally at the receiving terminal which when combined with the side bands in a suitable detector produces the modulating wave.

Carrier frequency. The frequency of the carrier.

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Citizens radio service. A radiocommunication service of fixed, land, or mobile stations, or combinations thereof, intended for use by citizens of the United States for private or personal radiocommunication (including radio signaling, control of objects by radio, and other purposes.)

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Domestic fixed service. 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.

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

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

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Fixed service. A service of radiocommunication between specified fixed points.

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Industrial radio service. Any service of radiocommunication essential to, 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. Devices which use Hertzian waves for industrial, scientific, medical, or any other purposes including the transfer of energy by radio and which are neither used nor intended to be used for radiocommunication.

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Land station (FL). A station in the mobile service not intended for operation while in motion.

Land transportation radio services. Any service of radio communication operated by, and for the sole use of certain inland transportation carriers, the radio transmitting facilities of which are defined as fixed, land, or mobile stations.

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Mobile station (MO). A station in a mobile service intended to be used while in motion or during halts at unspecified points.

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Primary standard of frequency. 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.

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

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Public safety radio service. 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.

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SEC. 2.102. *Nomenclature of frequencies.* Frequencies shall be expressed in kilocycles per second (kc) at and below 30,000 kilocycles per second and in megacycles per second (Mc) above this frequency.

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SEC. 2.103. *Assignment of frequencies.*

<i>Frequency subdivision</i>	<i>Frequency range</i>
VLF (very low frequency) -----	Below 30 kc.
LF (low frequency) -----	30 to 300 kc.
MF (medium frequency) -----	300 to 3,000 kc.
HF (high frequency) -----	3,000 to 30,000 kc.
VHF (very high frequency) -----	30,000 kc. to 300 Mc.
UHF (ultra high frequency) -----	300 Mc. to 3,000 Mc.
SHF (super high frequency) -----	3,000 Mc. to 30,000 Mc.
EHF (extreme high frequency) -----	30,000 Mc. to 300,000 Mc.

(a) Except as otherwise provided in this section the assignment of frequencies and bands of frequencies to all stations and classes of stations and the licensing and authorizing of the use of all such frequencies between 10 kc. and 30,000 Mc., and the actual use of such frequencies for radiocommunication or for any other purpose, including the transfer of energy by radio, shall be in accordance with the table of frequency allocations herein, except that in individual cases the Commission may, without rule-making proceedings, authorize, on a temporary basis only, the use of a frequency or frequencies not in accordance with the table below for projects of short duration or emergencies where the Commission finds that important or exceptional circumstances require such utilization: *Provided*, That no such authorization will be granted where harmful interference would be caused thereby to any service operating in accordance with the table of frequency allocations: *And provided further*, That such authorizations are not intended to develop a service to be operated on frequencies other than those allocated such service in the table of frequency allocations.¹

(b) Experimental stations, for the development of techniques or equipment to be employed by services or classes of stations set forth in columns 8 and 9 of the table of frequency allocations in § 2.104 (a), may be authorized to use frequencies allocated to those services or classes of stations: *Provided*, That no harmful interference will be caused to the services or stations to which these frequencies are regularly assigned.

(c) The use of frequencies in the bands above 25 Mc allocated exclusively to Government stations and the use of frequencies below 25 Mc which may not be in accordance with § 2.104 (a) may be authorized to non-Government stations in those instances where the Commission finds, after consultations with the appropriate Government agency or agencies, that such assignment is

¹From time to time when the Commission moves a service from one band to another it provides that existing stations may continue on the old band for a certain length of time, usually in order to provide for the amortization of equipment. Nothing in this section shall be construed as inconsistent with such authorizations.

necessary for intercommunication with Government stations or where such use by non-Government stations is required for coordination with Government activities.

(d) Aircraft stations may use those frequencies below 30 Mc allocated to the maritime mobile service as shown in column 8 of § 2.104 (a) (5) in accordance with paragraphs 570 and 571 of the Atlantic City 1947 Radio Regulations which are quoted herewith:

570 (1) Aircraft stations may communicate with stations of the maritime mobile service.

571 (2) For this purpose only, they may utilize frequencies allocated to the maritime mobile service and must then conform to the provisions of these Regulations relating to the maritime mobile service.

SEC. 2.201 *Emission, modulation and transmission characteristics.* The following system of designating emission, modulations and transmission characteristics shall be employed.

(a) The emission characters used in connection with frequency assignments express:

- (1) Necessary bandwidth.
- (2) Type of modulation or emission.
- (3) Type of transmission.
- (4) Supplementary characteristics authorized.

(b) Types of modulation and emission are symbolized according to the following letters:

- | | |
|-------------------------------------------|---|
| (1) Amplitude modulation | A |
| (2) Frequency (or phase) modulation | F |
| (3) Pulsed emission | P |

(c) Types of transmission are symbolized according to the following numbers:

- | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| (1) Absence of any modulation intended to carry information..... | 0 |
| (2) Telegraphy without the use of modulating audio frequency..... | 1 |
| (3) 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) | 2 |
| (4) Telephony | 3 |
| (5) Facsimile | 4 |
| (6) Television | 5 |
| (7) Composite transmissions and cases not covered by the above..... | 9 |

(d) Supplementary characteristics are symbolized in accordance with the following letters:

- | | |
|-----------------------------------------------------|--------|
| (1) Double sideband, full carrier..... | (None) |
| (2) Single sideband, reduced carrier..... | a |
| (3) Two independent sidebands, reduced carrier..... | b |
| (4) Other emissions, reduced carrier..... | c |
| (5) Pulse, amplitude modulated..... | d |
| (6) Pulse, width modulated..... | e |
| (7) Pulse, phase (or position) modulated..... | f |

(e) The classification of emissions is tabulated below:

Type of modulation or emission	Type of transmission	Supplementary characteristics	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 sideband, full carrier -----	A3
		Single sideband, reduced carrier.	A3a
		Two independent sidebands, reduced carrier.	A3b
	Facsimile -----	-----	A4
	Television -----	-----	A5
	Composite transmission 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).	-----	P2d
		Audio frequency or audio frequencies modulating their pulse in amplitude.	P2e
		Audio frequency or audio frequencies modulating the width of the pulse.	P2f
		Audio frequency or audio frequencies modulating the phase (or position) of the pulse.	
	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

(f) Type B emission. As an exception to the above principles, damped waves are symbolized in the Commission's rules and regulations as type B emission.

PART 3—RULES GOVERNING RADIO BROADCAST SERVICES

SEC. 3.10 *Experimental period.* The term "experimental period" means that time between 12 midnight and local sunrise. This period may be used for experimental purposes in testing and maintaining apparatus by the licensee of any standard broadcast station on its assigned frequency and with its authorized power, provided no interference is caused to other stations maintaining a regular operating schedule within such period. No station licensed for "daytime" or "specified hours" of operation may broadcast any regular or scheduled program during this period.

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SEC. 3.13 *Auxiliary transmitter.* The term "auxiliary transmitter" means a transmitter maintained only for transmitting the regular programs of a station in case of failure of the main transmitter.

SEC. 3.14 *Technical definitions—(a) Combined audio harmonics.* The term "combined audio harmonics" means the arithmetical sum of the amplitudes of all the separate harmonic components. Root sum square harmonic readings may be accepted under conditions prescribed by the Commission.

(b) *Effective field.* The term "effective field" or "effective field intensity" is the root-mean-square (RMS) value of the inverse distance fields at a distance of 1 mile from the antenna in all directions in the horizontal plane.

(c) *Operating power.* "Operating power" is the power that is actually supplied to the radio station antenna.

(d) *Maximum rated carrier power.* "Maximum rated carrier power" is the maximum power at which the transmitter can be operated satisfactorily and is determined by the design of the transmitter and the type and number of vacuum tubes used in the last radio stage.

(e) *Plate input power.* "Plate input power" means the product of the direct plate voltage applied to the tubes in the last radio stage and the total direct current flowing to the plates of these tubes, measured without modulation.

(f) *Antenna power.* "Antenna input power" or "antenna power" means the product of the square of the antenna current and the antenna resistance at the point where the current is measured.

(g) *Antenna current.* "Antenna current" means the radio-frequency current in the antenna with no modulation.

(h) *Antenna resistance.* "Antenna resistance" means the total resistance of the transmitting antenna system at the operating frequency and at the point at which the antenna current is measured.

(i) *Modulator stage.* "Modulator stage" means the last amplifier stage of the modulating wave which modulates a radio-frequency stage.

(j) *Modulated stage.* "Modulated stage" means the radio-frequency stage to which the modulator is coupled and in which the continuous wave (carrier wave) is modulated in accordance with the system of modulation and the characteristics of the modulating wave.

(k) *Last radio stage.* "Last radio stage" means the oscillator or radio-frequency-power amplifier stage which supplies power to the antenna.

(l) *Percentage modulation (amplitude).* "Percentage modulation" with respect to an amplitude modulated wave means the ratio of half the difference

between the maximum and minimum amplitudes of the amplitude modulated wave to the average amplitude expressed in percentage.

(m) *Maximum percentage of modulation.* "Maximum percentage of modulation" means the greatest percentage of modulation that may be obtained by a transmitter without producing in its output harmonics of the modulating frequency in excess of those permitted by these regulations.

(n) *High level modulation.* "High level modulation" is modulation produced in the plate circuit of the last radio stage of the system.

(o) *Low level modulation.* "Low level modulation" is modulation produced in an earlier stage than the final.

(p) *Plate modulation.* "Plate modulation" is modulation produced by introduction of the modulating wave into the plate circuit of any tube in which the carrier frequency wave is present.

(q) *Grid modulation.* "Grid modulation" is modulation produced by introduction of the modulating wave into any of the grid circuits of any tube in which the carrier frequency wave is present.

(r) *Blanketing.* Blanketing is that form of interference which is caused by the presence of a broadcast signal of 1 v/m or greater intensity in the area adjacent to the antenna of the transmitting station. The 1 v/m contour is referred to as the blanket contour and the area within this contour is referred to as the blanket area.

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SEC. 3.51 *Operating power; how determined.* (a) The operating power of each station shall be determined by direct measurement of the antenna power in accordance with § 3.54 except as provided for in paragraph (b) of this section.

(b) Operating power shall be determined on a temporary basis by the indirect method by means of the plate input power to the last radio stage in accordance with §§ 3.52 and 3.53:

(1) In case of an emergency where the licensed antenna system has been damaged by causes beyond the control of the licensee, or

(2) Pending completion of authorized changes in the antenna system.

SEC. 3.52 *Operating power; indirect measurement.* The operating power determined by indirect measurement from the plate input power of the last radio stage is the product of the plate voltage (E_p), the total plate current of the last radio stage (I_p), and the proper factor (F) given in the following tables: that is

$$\text{Operating power} = E_p \times I_p \times F$$

A. *Factor to be used for stations employing plate modulation in the last radio stage¹*

Factor (F) to be used in determining the operating power from the plate input power

Maximum rated carrier power of transmitter: ²	
100-1,000 watts -----	0.70
5,000 and over watts -----	.80

B. *Factor to be used for stations of all powers using low level modulation¹*

Factor (F) to be used in determining the operating power from the plate input power

Class of power amplifier in the last radio stage:	
Class B -----	0.35
Class BC ³ -----	.65

C. Factors to be used for stations of all powers employing grid modulation in the last radio stage¹

Factor (F) to be used in determining the operating power from the plate input power

Type of tube in the last radio stage:

Table C' -----	0.25
Table D' -----	.35

¹See Power Rating of Vacuum Tubes.

²The maximum rated carrier power must be distinguished from the operating power (See § 3.14 (c) and (d).)

³All linear amplifier operation where efficiency approaches that of class C operation.

SEC. 3.53 *Application of efficiency factors.* In computing operating power by indirect measurement the above factors shall apply in all cases, and no distinction will be recognized due to the operating power being less than the maximum rated carrier power. (See Plate Efficiency of Last Radio Stage.)

SEC. 3.54 *Operating power: direct measurement.* (a) The antenna input power determined by direct measurement (the square of the antenna current times the antenna resistance at the point where the current is measured and at the operating frequency) shall be the operating power of the station.¹³

(b) If any change is made in the antenna system or any change made which may affect the antenna system, the method of determining operating power shall be changed immediately to the indirect method.

SEC. 3.57 *Operating power; maintenance of.* (a) The operating power of each station shall be maintained as near as practicable to the licensed power and shall not exceed the limits of 5 percent above and 10 percent below the licensed power, except that in an emergency when due to causes beyond control of the licensee it becomes impossible to operate with full licensed power, the station may be operated with reduced power for a period not to exceed 10 days, provided the Commission and the Engineer in Charge of the radio district in which the station is located shall be notified immediately after the emergency develops and also upon the resumption of licensed power.

(b) In addition to maintaining the operating power within the above limitations, stations employing directional antenna systems shall maintain the ratio of the antenna currents in the elements of the system within 5 percent of that specified by the terms of the license or other instrument of authorization.

SEC. 3.58 *Indicating instruments.* (a) Each standard broadcast station shall be equipped with indicating instruments which conform with the specifications set forth in the Standards of Good Engineering Practice Concerning Standard Broadcast Stations (Appendix to this subpart) for measuring the DC plate circuit current and voltage of the last radio frequency amplifier stage; the radio frequency base current of each antenna element; and, for stations employing directional antenna systems, the radio frequency current at the point of common input to the directional antenna. (See "Indicating Instruments Pursuant to § 3.58" in the Standards for Good Engineering Practice Concerning Standard Broadcast Stations).

(b) In the event that any one of these indicating instruments becomes defective when no substitute which conforms with the required specifications is available, the station may be operated without the defective instrument pending its repair or replacement for a period not in excess of 60 days without further authority of the Commission: *Provided, That:*

¹³See Further Requirements for Direct Measurements of Power.

(1) Appropriate entries shall be made in the operating log of the station showing the date and time the meter was removed from and restored to service.

(2) The Engineer in Charge of the radio district in which the station is located shall be notified both immediately after the instrument is found to be defective and immediately after the repaired or replacement instrument has been installed and is functioning properly.

(3) If the defective instrument is the antenna current meter of a non-directional station which does not employ a remote antenna ammeter, or if the defective instrument is the common point meter of a station which employs a directional antenna, and does not employ a remote common point meter, the operating power shall be determined by the indirect method in accordance with § 3.52 during the entire time the station is operated without the antenna current meter or common point meter. However, if a remote antenna ammeter or a remote common point meter is employed and the antenna current meter or common point meter becomes defective, the remote meter may be used in determining operating power by the direct method pending the return to service of the regular meter, provided other meters maintained at same value previously employed.

(c) If conditions beyond the control of the licensee prevent the restoration of the meter to service within the above allowed period, informal request in accordance with § 1.332 (d) of this chapter may be filed with the Engineer in Charge of the radio district in which the station is located for such additional time as may be required to complete repairs of the defective instrument.

(d) Remote antenna ammeters and remote common point meters are not required therefore authority to operate without them is not necessary. However if a remote antenna ammeter or common point meter is employed and becomes defective, the antenna base currents may be read and logged once daily for each mode of operation, pending the return to service of the regular remote meter.

SEC. 3.59 *Frequency tolerance.* The operating frequency of each station shall be maintained within 20 cycles of the assigned frequency.

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SEC. 3.68 *Auxiliary transmitter.* Upon showing that a need exists for the use of an auxiliary transmitter¹⁷ in addition to the regular transmitter of a broadcast station, a license therefor may be issued: *Provided, That:*

(a) An auxiliary transmitter may be installed either at the same location as the main transmitter or at another location.

(b) A licensed operator shall be in control whenever an auxiliary transmitter is placed in operation.

(c) The auxiliary transmitter shall be maintained so that it may be put into immediate operation at any time for the following purposes:

(1) The transmission of the regular programs upon the failure of the main transmitter.

(2) The transmission of regular programs during maintenance or modification work on the main transmitter necessitating discontinuance of its operation for a period not to exceed five days.¹⁸

¹⁷All regulations as to safety requirements and spurious emissions applying to broadcast transmitting equipment shall apply also to an auxiliary transmitter. (See Use of Frequency and Modulation Monitors at Auxiliary Transmitter.)

¹⁸Where such operation is required for periods in excess of five days an informal application shall be made.

(3) Upon request by a duly authorized representative of the Commission.

(d) The auxiliary transmitter shall be tested at least once each week to determine that it is in proper operating condition and that it is adjusted to the proper frequency, except that in case of operation in accordance with paragraph (c) of this section during any week, the test in that week may be omitted provided the operation under paragraph (c) is satisfactory. A record shall be kept of the time and result of each test operating under paragraph (c) of this section. Tests shall be conducted only between midnight and 9 a. m., local standard time.

(e) The auxiliary transmitter shall be equipped with satisfactory control equipment which will enable the maintenance of the frequency emitted by the station within the limits prescribed by the regulations in this part.

(f) An auxiliary transmitter which is licensed at a geographical location different from that of the main transmitter shall be equipped with a frequency control which will automatically hold the frequency within the limits prescribed by the regulations in this part without any manual adjustment during operation or when it is being put into operation.

(g) The operating power of an auxiliary transmitter may be less than the authorized power, but in no event shall it be greater than such power.

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SEC. 3.66 Remote control operation. A station which is authorized for non-directional operation with power of 10 kilowatts or less may, upon prior authorization from the Commission, be operated by remote control at the point(s) which shall be specified in the station license. An application for authorization to operate by remote control may be made as a part of an application for construction permit or license, or modification thereof by specifying the proposed remote control point(s). Operation by remote control shall be subject to the following conditions:

(a) The equipment at the operating and transmitting positions shall be so installed and protected that it is not accessible to or capable of operation by persons other than those duly authorized by the licensee.

(b) The control circuits from the operating position to the transmitter shall provide positive on and off control and shall be such that open circuits, short circuits, grounds or other line faults will not actuate the transmitter and any fault causing loss of such control will automatically place the transmitter in an inoperative condition.

(c) Control and monitoring equipment shall be installed so as to allow the licensed operator either at the remote control point or at the transmitter, to perform all of the functions in a manner required by the Commission's rules and Standards.

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SEC. 3.71 Minimum operating schedule. Except Sundays, the licensee of each standard broadcast station shall maintain a minimum operating schedule of two-thirds of the total hours that it is authorized to operate between 6 a. m. and 6 p. m. local standard time, and two-thirds of the total hours it is authorized to operate between 6 p. m. and midnight, local standard time, except that in an emergency when, due to causes beyond the control of the licensee, it becomes impossible to continue operating, the station may cease operation for a period of not to exceed 10 days, provided that the Commission and the Engineer in Charge of the radio district in which the station is located shall be notified in writing immediately after the emergency develops.

SEC. 3.72 *Operation during experimental period.* The licensee of each standard broadcast station shall operate or refrain from operating its station during the experimental period as directed by the Commission in order to facilitate frequency measurement or for the determination of interference. (Stations involved in the after-midnight frequency monitoring programs are notified of their operating and silent schedule.)

SEC. 3.73 *Specified hours.* If the license of a station specifies the hours of operation, the schedule so specified shall be adhered to except as provided in §§ 3.71 and 3.72.

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SEC. 3.165 *Operator requirements.* (a) One or more radio operators holding a valid radiotelephone first-class operator license, except as provided below, shall be in actual charge of the transmitting apparatus and shall be on duty either at the transmitter location or remote control point.

(b) A station which is authorized for non-directional operation with power of 10 kilowatts or less may be operated by persons holding commercial radio operator license of any class, except an aircraft radiotelephone operator authorization or a temporary limited radiotelegraph second-class operator license, when the equipment is so designed that the stability of the frequency is maintained by the transmitter itself within the limits of tolerance specified, and none of the operations, except those specified in subparagraphs (1) through (4) of this paragraph, necessary to be performed during the course of normal operation may cause off-frequency operation or result in any unauthorized radiation.²⁸ Adjustments of transmitting equipment by such operators, except when under the immediate supervision of a radiotelephone first-class operator, shall be limited to the following:

(1) Those necessary to commence or terminate transmitter emissions as a routine matter.

(2) Those external adjustments that may be required as a result of variations of primary power supply.

(3) Those external adjustments which may be necessary to insure modulation within the limits required.

(4) Those adjustments necessary to effect any change in operating power which may be required by the station's instrument of authorization.

Should the transmitting apparatus be observed to be operating in a manner inconsistent with the station's instrument of authorization and none of the above adjustments are effective in bringing it into proper operation, a person holding other than a radiotelephone first-class operator license and not acting under the immediate supervision of radiotelephone first-class operator, shall be required to terminate the station's emissions.

(c) The licensee of a station which is operated by one or more operators holding other than a radiotelephone first-class operator license shall have one or more operators holding a radiotelephone first-class operator license in regular full-time employment at the station whose primary duties shall be to effect and insure the proper functioning of the transmitting equipment. In the event that the licensee also operates an FM broadcast station in the same community, a regular full-time radiotelephone first-class operator or

²⁸A person holding any class of radio operator license or permit who is authorized thereunder to perform limited operation of a standard broadcast station may, when a Conelrad Radio Alert is called, make adjustments necessary to effect operation on a Conelrad authorization: *Provided*, That the station's full-time radiotelephone first-class operator shall have previously instructed such person in the adjustments to the transmitter which are necessary to accomplish Conelrad operation.

operators employed in connection with the standard broadcast station may concurrently be employed to satisfy the requirements of § 3.265 (c) or § 3.565 (c): *Provided*, That the duties of such operator or operators concerning the FM broadcast transmitting equipment shall in nowise interfere with the proper performance of his duties with respect to the standard broadcast transmitter.

(d) The licensed operator on duty and in charge of a standard broadcast transmitter may, at the discretion of the licensee, be employed for other duties or for the operation of another radio station or stations in accordance with the class of operator's license which he holds and the rules and regulations governing such other stations: *Provided, however*, That such duties shall in nowise interfere with the proper operation of the standard broadcast transmitter.

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SEC. 3.167 *Equipment tests.* (a) During the process of construction of a standard broadcast station the permittee, after notifying the Commission and Engineer in Charge of the radio district in which the station is located, may without further authority of the Commission, conduct equipment tests during the experimental period for the purpose of such adjustments and measurements as may be necessary to assure compliance with the terms of the construction permit, the technical provisions of the application therefor the rules and regulations, and the applicable engineering standards. In addition, the Commission may authorize equipment tests other than during the experimental period if such operation is shown to be desirable to the proper completion of construction and adjustment of the transmitting equipment and antenna system. An informal application for such authority, giving full details regarding the need for such tests, shall be filed with the Commission at least two (2) days (not including Sundays and Saturdays and legal holidays when the offices of the Commission are not open) prior to the date on which it is desired to begin such operation.

(b) The Commission may notify the permittee to conduct no tests or may cancel, suspend or change the date for the beginning of equipment tests as and when such action may appear to be in the public interest, convenience, and necessity.

(c) Equipment tests may be continued so long as the construction permit shall remain valid and shall be conducted only during the experimental period (12 midnight to local sunrise) unless otherwise specifically authorized.

(d) Inspection of a station will ordinarily be required during the equipment test period and before the commencement of program tests. After construction and after adjustments and measurements have been completed to show compliance with the terms of the construction permit, the technical provisions of the application therefor, the rules and regulations and the applicable engineering standards, the permittee should notify the Engineer in Charge of the radio district in which the station is located that it is ready for inspection.

(e) The authorization for tests embodied in this section shall not be construed as constituting a license to operate but as a necessary part of construction.

SEC. 3.168 *Program tests.* (a) Upon completion of construction of a standard broadcast station in accordance with the terms of the construction permit, the technical provisions of the application therefor, and the rules and regulations and applicable engineering standards and when an applica-

tion for station license has been filed showing the station to be in satisfactory operating condition,³⁹ the permittee may request authority to conduct program tests: *Provided*, That such request shall be filed with the Commission at least ten (10) days prior to the date on which it is desired to begin such operation and that the Engineer in Charge of the radio district in which the station is located is notified.

(b) Program tests shall not commence until specific Commission authority is received. The Commission reserves the right to change the date of the beginning of such tests or to suspend or revoke the authority for program tests as and when such action may appear to be in the public interest, convenience, and necessity.

(c) Unless sooner suspended or revoked program test authority continues valid during Commission consideration of the application for license and during this period further extension of the construction permit is not required. Program test authority shall be automatically terminated by final determination upon the application for station license.

(d) All operation on program test authority shall be in strict compliance with the rules governing standard broadcast stations and in strict accordance with representations made in the application for license pursuant to which the tests were authorized.

(e) The granting of program test authority shall not be construed as approval by the Commission of the application for station license.

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SEC. 3.254 *Required transmitter performance.* (a) The construction, installation, operation and performance of the FM broadcast transmitting system shall be in accordance with the Standards of Good Engineering Practice Concerning FM Broadcast Stations (Sections 8 and 13). The licensee of each FM broadcast station shall make the following equipment performance measurements at least at yearly intervals. (One such set of measurements shall be made during the four-month period preceding the date of filing application for renewal of station license.)

(1) Audio frequency response from 50 to 15,000 cycles for approximately 25, 50 and 100 percent modulation. Measurements shall be made on at least the following audio frequencies: 50, 100, 400, 1000, 5000, 10,000 and 15,000 cycles. The frequency response measurements should normally be made without deemphasis; however, standard 75 microsecond deemphasis may be employed in the measuring equipment or system provided the accuracy of the deemphasis circuit is sufficient to insure that the measured response is within the prescribed limits.

(2) Audio frequency harmonic distortion for 25, 50 and 100 percent modulation for the fundamental frequencies of 50, 100, 400, 1000, and 5000 cycles. Audio frequency harmonics for 100 percent modulation for fundamental frequencies of 10,000 and 15,000 cycles. Measurements shall normally include harmonics to 30,000 cycles. The distortion measurements shall be made employing 75 microsecond deemphasis in the measuring equipment or system.

(3) Output noise level (frequency modulation) in the band of 50 to 15,000 cycles in decibels below the audio frequency level representing a frequency swing of 75 kilocycles. The noise measurements shall be made employing 75 microsecond deemphasis in the measuring equipment or system.

³⁹All data necessary to show compliance with the terms and conditions of the construction permit must be filed with the license application. If the station is using a directional antenna, a proof of performance must also be filed as required by § 3.33 (b).

(4) Output noise level (amplitude modulation) in the band of 50 to 15,000 cycles in decibels below the level representing 100 percent amplitude modulation. The noise measurements shall be made employing 75 microsecond de-emphasis in the measuring equipment or system. All measurements shall be made with the equipment adjusted for normal program operation and shall include all circuits between the main studio microphone terminals and the antenna output, including telephone lines, pre-emphasis circuits and any equalizers employed except for microphones, and without compression if a compression amplifier is installed.

(5) The above data, diagrams and appropriate graphs together with a description of measurement procedures and instruments, signed by the engineer making the measurements, shall be kept on file at the transmitter and shall be made available upon request to any duly authorized representative of the Federal Communications Commission.

* * * * *

SEC. 3.258 *Indicating instruments.* (a) Each FM broadcast station shall be equipped with indicating instruments, which conform with the specifications set forth in the Standards of Good Engineering Practice Concerning FM Broadcast Stations, for measuring the direct plate voltage and current of the last radio stage and the transmission line radio frequency current, voltage or power. (See "Indicating instruments pursuant to § 3.258" in the Standards of Good Engineering Practice Concerning FM Broadcasting Stations.)

(b) In the event that any one of these indicating instruments becomes defective when no substitute which conforms with the required specifications is available, the station may be operated without the defective instrument pending its repair or replacement for a period not in excess of 60 days: *Provided, That:*

(1) Appropriate entries shall be made in the operating log of the station showing the date and time the meter was removed from and restored to service

(2) The Engineer in Charge of the radio district in which the station is located shall be notified immediately after the instrument is found to be defective and immediately after the repaired or replaced instrument has been installed and functioning properly.

(3) If the defective instrument is a plate voltmeter or plate ammeter in the last radio stage, the operating power shall be maintained by means of the radio frequency transmission line meter.

(c) If conditions beyond the control of the licensee prevent the restoration of the meter to service within the above allowed period, informal request may be filed in accordance with § 1.332 (d) of this chapter with the Engineer in Charge of the radio district in which the station is located for such additional time as may be required to complete repairs of the defective instrument.

* * * * *

SEC. 3.265 *Operator requirements.* (a) One or more radio operators holding a valid radiotelephone first-class operator license, except as provided in this section shall be in actual charge of the transmitting apparatus and shall be on duty either at the transmitter location or remote control point.

(b) A station which is authorized with transmitter power output of 10 kilowatts or less may be operated by persons holding commercial radio operator license of any class, except an aircraft radiotelephone operator authorization or a temporary limited radiotelegraph second-class operator license when the equipment is so designed that the stability of the frequency is maintained by the transmitter itself within the limits of tolerance specified and none of the

operations, except those specified in subparagraphs (1), (2) and (3) of this paragraph, necessary to be performed during the course of normal operation may cause off-frequency operation or result in any unauthorized radiation. Adjustments of transmitting equipment by such operators, except when under the immediate supervision of a radiotelephone first-class operator shall be limited to the following:

(1) Those necessary to commence or terminate emissions as a routine matter.

(2) Those external adjustments that may be required as a result of variations of primary power supply.

(3) Those external adjustments which may be necessary to insure modulation within the limits required.

Should the transmitting apparatus be observed to be operating in a manner inconsistent with the station's instrument of authorization and none of the above adjustments are effective in bringing it into proper operation, a person holding other than a radiotelephone first-class operator license and not acting under the immediate supervision of a radiotelephone first-class operator, shall be required to terminate the station's emissions.

(c) The licensee of a station which is operated by one or more operators holding other than a radiotelephone first-class operator license shall have one or more operators holding a radiotelephone first-class operator license in regular full-time employment at the station whose primary duties shall be to effect and insure the proper functioning of the transmitting equipment. In the event that the licensee also operates a standard broadcast station in the same community, a regular full-time radiotelephone first-class operator or operators employed in connection with the FM broadcast station may concurrently be employed to satisfy the requirements of § 3.165 (c): *Provided*, That the duties of such operator or operators concerning the standard broadcast transmitting equipment shall in nowise interfere with the proper performance of his duties with respect to the FM broadcast transmitter.

(d) The licensed operator on duty and in charge of an FM broadcast transmitter may, at the discretion of the licensee, be employed for other duties or for the operation of another radio station or stations in accordance with the class of operator's license which he holds and the rules and regulations governing such other stations: *Provided, however*, That such duties shall in nowise interfere with the proper operation of the FM broadcast transmitter.

* * * * *

SEC. 3.267. *Operating power; determination and maintenance of.* (a) The operating power of each station shall be determined by the indirect method. This is the product of the plate voltage (E_p) and the plate current (I_p) of the last radio stage, and an efficiency factor, F ; that is:

$$\text{Operating power} = E_p \times I_p \times F$$

The efficiency factor, F , shall be established by the transmitter manufacturer for each type of transmitter for which Commission approval is requested, and shall be specified in the instruction books supplied to the customer with each transmitter. In the case of composite equipment the factor, F , shall be furnished to the Commission along with a statement of the basis used in determining such factor.

(b) The operating power of each station shall be maintained as near as practicable to the authorized operating power, and shall not exceed the limits of 5 percent above and 10 percent below the authorized power, except that in

an emergency when it becomes impossible to operate with the authorized power the station may be operated with reduced power for a period not to exceed 10 days, provided the Commission and the Engineer in Charge of the radio district in which the station is located shall be notified immediately after the emergency develops, and also upon the resumption of normal operating power.

* * * * *

SEC. 3.269 *Frequency tolerance.* The center frequency of each FM broadcast station shall be maintained within 2000 cycles of the assigned center frequency.

* * * * *

SEC. 3.569 *Frequency tolerance.* (a) The center frequency of each non-commercial educational FM broadcast station licensed for transmitter power output of 10 watts or less shall be maintained within 3,000 cycles of the assigned center frequency.

(b) The center frequency of each noncommercial educational FM broadcast station licensed for transmitter power output above 10 watts shall be maintained within 2,000 cycles of the assigned center frequency.

* * * * *

SEC. 3.661 *Operator requirements.* One or more licensed radio-telephone first-class operators shall be on duty at the place where the transmitting apparatus of each station is located and in actual charge thereof whenever it is being operated. The original license (or FCC Form 759) of each station operator shall be posted at the place where he is on duty. The licensed operator on duty and in charge of a television broadcast transmitter may, at the discretion of the licensee, be employed for other duties or for the operation of another station or stations in accordance with the class of operator's license which he holds and by the rules and regulations governing such stations. However, such duties shall in nowise interfere with the operation of the broadcast transmitter.

* * * * *

SEC. 3.681 *Definitions.*

Amplitude modulation (AM). A system of modulation in which the envelope of the transmitted wave contains a component similar to the wave form of the signal to be transmitted.

Antenna height above average terrain. The average of the antenna heights above the terrain from two to ten miles from the antenna for the eight directions spaced evenly for each 45 degrees of azimuth starting with True North. (In general, a different antenna height will be determined in each direction from the antenna. The average of these various heights is considered the antenna height above the average terrain. In some cases less than 8 directions may be used. See § 3.684 (d).)

Antenna power gain. The square of the ratio of the root-mean-square free space field intensity produced at one mile in the horizontal plane, in millivolts per meter for one kilowatt antenna input power to 137.6 mv/m. This ratio should be expressed in decibels (db). (If specified for a particular direction, antenna power gain is based on the field strength in that direction only.)

Aspect ratio. The ratio of picture width to picture height as transmitted.

Aural transmitter. The radio equipment for the transmission of the aural signal only.

Aural center frequency. (1) The average frequency of the emitted wave when modulated by a sinusoidal signal; (2) the frequency of the emitted wave without modulation.

Blanking level. The level of the signal during the blanking interval, except the interval during the scanning synchronizing pulse and the chrominance subcarrier synchronizing burst.

Chrominance. The colorimetric difference between any color and a reference color of equal luminance, the reference color having a specific chromaticity.

Chrominance subcarrier. The carrier which is modulated by the chrominance information.

Color transmission. The transmission of color television signals which can be reproduced with different values of hue, saturation, and luminance.

Effective radiated power. The product of the antenna input power and the antenna power gain. This product should be expressed in kilowatts and in decibels above one kilowatt (dbk). (If specified for a particular direction, effective radiated power is based on the antenna power gain in that direction only. The licensed effective radiated power is based on the average antenna power gain for each horizontal plane direction.)

Field. Scanning through the picture area once in the chosen scanning pattern. In the line interlaced scanning pattern of two to one, the scanning of the alternate lines of the picture area once.

Frame. Scanning all of the picture area once. In the line interlaced scanning pattern of two to one, a frame consists of two fields.

Free space field intensity. The field intensity that would exist at a point in the absence of waves reflected from the earth or other reflecting objects.

Frequency modulation (FM). A system of modulation where the instantaneous radio frequency varies in proportion to the instantaneous amplitude of the modulating signal (amplitude of modulating signal to be measured after pre-emphasis, if used) and the instantaneous radio frequency is independent of the frequency of the modulating signal.

Frequency swing. The instantaneous departure of the frequency of the emitted wave from the center frequency resulting from modulation.

Interlaced scanning. A scanning process in which successively scanned lines are spaced an integral number of line widths, and in which the adjacent lines are scanned during successive cycles of the field frequency.

Luminance. Luminous flux emitted, reflected, or transmitted per unit solid angle per unit projected area of the source.

Monochrome transmission. The transmission of television signals which can be reproduced in gradations of a single color only.

Negative transmission. Where a decrease in initial light intensity causes an increase in the transmitted power.

Peak power. The power over a radio frequency cycle corresponding in amplitude to synchronizing peaks.

Percentage modulation. As applied to frequency modulation, the ratio of the actual frequency swing to the frequency swing defined as 100 percent modulation, expressed in percentage. For the aural transmitter of television broadcast stations, a frequency swing of ± 25 kilocycles is defined as 100 percent modulation.

Polarization. The direction of the electric field as radiated from the transmitting antenna.

Reference black level. The level corresponding to the specified maximum excursion of the luminance signal in the black direction.

Reference white level of the luminance signal. The level corresponding to the specified maximum excursion of the luminance signal in the white direction.

Scanning. The process of analyzing successively, according to a predetermined method, the light values of picture elements constituting the total picture area.

Scanning line. A single continuous narrow strip of the picture area containing highlights, shadows, and half-tones, determined by the process of scanning.

Standard television signal. A signal which conforms to the television transmission standards.

Synchronization. The maintenance of one operation in step with another.

Television broadcast band. The frequencies in the band extending from 54 to 890 megacycles which are assignable to television broadcast stations. These frequencies are 54 to 72 megacycles (channels 2 through 4), 76 to 88 megacycles (channels 5 and 6), 174 to 216 megacycles (channels 7 through 13), and 470 to 890 megacycles (channels 14 through 83).

Television broadcast station. A station in the television broadcast band transmitting simultaneous visual and aural signals intended to be received by the general public.

Television channel. A band of frequencies 6 megacycles wide in the television broadcast band and designated either by number or by the extreme lower and upper frequencies.

Television transmission standards. The standards which determine the characteristics of a television signal as radiated by a television broadcast station.

Television transmitter. The radio transmitter or transmitters for the transmission of both visual and aural signals.

Vestigial sideband transmission. A system of transmission wherein one of the generated sidebands is partially attenuated at the transmitter and radiated only in part.

Visual carrier frequency. The frequency of the carrier which is modulated by the picture information.

Visual transmitter. The radio equipment for the transmission of the visual signal only.

Visual transmitter power. The peak power output when transmitting a standard television signal.

SEC. 3.682 *Transmission standards and changes*—(a) *Transmission standards.* (1) The width of the television broadcast channel shall be six megacycles per second.

(2) The visual carrier frequency shall be nominally 1.25 mc above the lower boundary of the channel.

(3) The aural center frequency shall be 4.5 mc higher than the visual carrier frequency.

(4) The visual transmission amplitude characteristic shall be in accordance with the chart designated as Appendix III, Figure 3.

(5) The chrominance subcarrier frequency shall be 3.579545 mc \pm 10 cycles per second with a maximum rate of change not to exceed one tenth cycle per second per second.

(6) For monochrome and color transmissions the number of scanning lines per frame shall be 525, interlaced two to one in successive fields. The horizontal scanning frequency shall be $\frac{2}{55}$ times the chrominance subcarrier frequency; this corresponds nominally to 15,750 cycles per second (with an actual value of 15,734.264 \pm 0.044 cycles per second). The vertical scanning fre-

quency is $\frac{3}{525}$ times the horizontal scanning frequency; this corresponds nominally to 60 cycles per second (the actual value is 59.94 cycles per second). For monochrome transmissions only, the nominal values of line and field frequencies may be used.

(7) The aspect ratio of the transmitted television picture shall be 4 units horizontally to 3 units vertically.

(8) During active scanning intervals, the scene shall be scanned from left to right horizontally and from top to bottom vertically, at uniform velocities.

(9) A carrier shall be modulated within a single television channel for both picture and synchronizing signals. For monochrome transmission, the two signals comprise different modulation ranges in amplitude, in accordance with the charts designated as Appendix III, Figures 3 and 4 (b). For color transmission, the two signals comprise different modulation ranges in amplitude except where the chrominance penetrates the synchronizing region and the burst penetrates the picture region, in accordance with the charts designated as Appendix III, Figures 3 and 4 (a).

(10) A decrease in initial light intensity shall cause an increase in radiated power (negative transmission).

(11) The reference black level shall be represented by a definite carrier level, independent of light and shade in the picture.

(12) The blanking level shall be transmitted at 75 ± 2.5 percent of the peak carrier level.

(13) The reference white level of the luminance signal shall be 12.5 ± 2.5 percent of the peak carrier level.

(14) The signals radiated shall have horizontal polarization.

(15) An effective radiated power of the aural transmitter not less than 50 percent nor more than 70 percent of the peak radiated power of the visual transmitter shall be employed.

(16) The peak-to-peak variation of transmitter output within one frame of video signal due to all causes, including hum, noise, and low-frequency response, measured at both scanning synchronizing peak and blanking level, shall not exceed 5 percent of the average scanning synchronizing peak signal amplitude.*

(17) The reference black level shall be separated from the blanking level by the setup interval, which shall be 7.5 ± 2.5 percent of the video range from blanking level to the reference white level.

(18) For monochrome transmission, the transmitter output shall vary in substantially inverse logarithmic relation to the brightness of the subject. No tolerances are set at this time.*

(19) The color picture signal shall correspond to a luminance component transmitted as amplitude modulation of the picture carrier and a simultaneous pair of chrominance components transmitted as the amplitude modulation sidebands of a pair of suppressed subcarriers in quadrature.

(20) Equation of complete color signal.

(i) The color picture signal has the following composition.

$$E_u = E_v' + \{ E_{q'}' \sin(\omega t + 33^\circ) + E_{i'}' \cos(\omega t + 33^\circ) \}$$

Where:

$$E_{q'}' = 0.41 (E_{B'}' - E_{V'}') + 0.48 (E_{R'}' - E_{V'}')$$

$$E_{i'}' = -0.27 (E_{B'}' - E_{V'}') + 0.74 (E_{R'}' - E_{V'}')$$

$$E_{V'}' = 0.30 E_{R'}' + 0.59 E_{G'}' + 0.11 E_{B'}'$$

*These items are subject to change but are considered the best practice under the present state of the art. They will not be enforced pending a further determination thereof.

For color-difference frequencies below 500 kc (see (iii) below), the signal can be represented by:

$$E_M = E_V' + \left\{ \frac{1}{1.14} \left[\frac{1}{1.78} (E_B' - E_V') \sin \omega t + (E_R' - E_V') \cos \omega t \right] \right\}$$

(ii) The symbols in (i) have the following significance:

E_M is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

E_V' is the gamma-corrected voltage of the monochrome (black-and-white) portion of the color picture signal, corresponding to the given picture element.²¹

E_Q' and E_I' are the amplitudes of two orthogonal components of the chrominance signal corresponding respectively to narrow-band and wide-band axes.

E_R' , E_G' , and E_B' are the gamma-corrected voltages corresponding to red, green, and blue signals during the scanning of the given picture element.

ω is the angular frequency and is 2π times the frequency of the chrominance subcarrier.

The portion of each expression between brackets in (i) represents the chrominance subcarrier signal which carries the chrominance information.

The phase reference in the E_M equation in (i) is the phase of the burst + 180°, as shown in Figure 4 (c). The burst corresponds to amplitude modulation of a continuous sine wave.

(iii) The equivalent bandwidth assigned prior to modulation to the color difference signals E_Q' and E_I' are as follows:

Q-channel bandwidth:

At 400 kc less than 2 db down.

At 500 kc less than 6 db down.

At 600 kc at least 6 db down.

I-channel bandwidth:

At 1.3 mc less than 2 db down.

At 3.6 mc at least 20 db down.

(iv) The gamma corrected voltages E_R' , E_G' , and E_B' are suitable for a color picture tube having primary colors with the following chromaticities in the CIE system of specification:

	x	y
Red (R) -----	0.67	0.33
Green (G) -----	0.21	0.71
Blue (B) -----	0.14	0.08

and having a transfer gradient (gamma exponent) of 2.2²² associated with each primary color. The voltages E_R' , E_G' , and E_B' may be respectively of the form $E_R 1/\gamma$, $E_G 1/\gamma$, and $E_B 1/\gamma$ although other forms may be used with advances in the state of the art.

(v) The radiated chrominance subcarrier shall vanish on the reference white of the scene.²³

(vi) E_V' , E_Q' , E_I' , and the components of these signals shall match each other in time to 0.05 μ secs.

(vii) The angles of the subcarrier measured with respect to the burst phase, when reproducing saturated primaries and their complements at 75 percent

²¹Forming of the high frequency portion of the monochrome signal in a different manner is permissible and may in fact be desirable in order to improve the sharpness on saturated colors.

²²At the present state of the art it is considered inadvisable to set a tolerance on the value of gamma and correspondingly this portion of the specification will not be enforced.

²³The numerical values of the signal specification assume that this condition will be reproduced as CIE Illuminant C ($x=0.310$, $y=0.316$).

of full amplitude, shall be within $\pm 10^\circ$ and their amplitudes shall be within ± 20 percent of the values specified above. The ratios of the measured amplitudes of the subcarrier to the luminance signal for the same saturated primaries and their complements shall fall between the limits of 0.8 and 1.2 of the values specified for their ratios. Closer tolerances may prove to be practicable and desirable with advance in the art.

(b) *Changes in transmission standards.* The Commission will consider the question whether a proposed change or modification of transmission standards adopted for television would be in the public interest, convenience and necessity, upon petition being filed by the person proposing such change or modification, setting forth the following:

- (1) The exact character of the change or modification proposed;
- (2) The effect of the proposed change or modification upon all other transmission standards that have been adopted by the Commission for television broadcast stations;
- (3) The experimentation and field tests that have been made to show that the proposed change or modification accomplishes an improvement and is technically feasible;
- (4) The effect of the proposed change or modification in the adopted standards upon operation and obsolescence of receivers;
- (5) The change in equipment required in existing television broadcast stations for incorporating the proposed change or modification in the adopted standards; and
- (6) The facts and reasons upon which the petitioner bases his conclusion that the proposed change or modification would be in the public interest, convenience, and necessity.

Should a change or modification in the transmission standards be adopted by the Commission, the effective date thereof will be determined in the light of the considerations mentioned in subparagraph (4) of this paragraph.

* * * * *

SEC. 3.687 *Transmitters and associated equipment*—(a) *Visual transmitter.* (1) For monochrome transmission only, the overall attenuation characteristics of the transmitter, measured in the antenna transmission line after the vestigial sideband filter (if used), shall not be greater than the following amounts below the ideal demodulated curve. (See Appendix III, Figure 7.)

- 2 db at 0.5 mc.
- 2 db at 1.25 mc.
- 3 db at 2.0 mc.
- 6 db at 3.0 mc.
- 12 db at 3.5 mc.

The curve shall be substantially smooth between these specified points, exclusive of the region from 0.75 to 1.25 mc.²⁷

(2) For color transmission, the standard given by § 3.687 (a) (1) applies except as modified by the following: A sine wave of 3.58 mc introduced at those terminals of the transmitter which are normally fed the composite color picture signal shall produce a radiated signal having an amplitude (as measured with a diode on the R. F. transmission line supplying power to the antenna), which is down 6 ± 2 db with respect to a signal produced by a sine wave of 200 kc. In addition, the amplitude of the signal shall not vary by more than ± 2 db between the modulating frequencies of 2.1 and 4.18 mc.

²⁷Output measurement shall be made with the transmitter operating into a dummy load of pure resistance and the demodulated voltage measured across this load. The ideal demodulated curve is that shown in Appendix III, Figure 7.

(3) The field strength or voltage of the lower sideband, as radiated or dissipated and measured as described in subparagraph (4) of this paragraph, shall not be greater than -20 db for a modulating frequency of 1.25 mc or greater and in addition, for color, shall not be greater than -42 db for a modulating frequency of 3.579545 mc (the color subcarrier frequency). For both monochrome and color, the field strength or voltage of the upper sideband as radiated or dissipated and measured as described in subparagraph (4) of this paragraph shall not be greater than -20 db for a modulating frequency of 4.75 mc or greater.^{28a}

(4) The attenuation characteristics of a visual transmitter shall be measured by application of a modulating signal to the transmitter input terminals in place of the normal composite television video signal. The signal applied shall be a composite signal composed of a synchronizing signal²⁹ to establish peak output voltage plus a variable frequency sine wave voltage occupying the interval between synchronizing pulses. The axis of the sine wave in the composite signal observed in the output monitor shall be maintained at an amplitude 0.5 of the voltage at synchronizing peaks. The amplitude of the sine wave input shall be held at a constant value. This constant value should be such that at no modulating frequency does the maximum excursion of the sine wave, observed in the composite output signal monitor, exceed the value 0.75 of peak output voltage. The amplitude of the 200 kilocycle sideband shall be measured and designated zero db as a basis for comparison. The modulation signal frequency shall then be varied over the desired range and the field strength or signal voltage of the corresponding sidebands measured. As an alternate method of measuring, in those cases in which the automatic d-c insertion can be replaced by manual control, the above characteristic may be taken by the use of a video sweep generator and without the use of pedestal synchronizing pulses. The d-c level shall be set for midcharacteristic operation.

(5) A sine wave, introduced at those terminals of the transmitter which are normally fed the composite color picture signal, shall produce a radiated signal having an envelope delay, relative to the average envelope delay between 0.05 and 0.20 mc, of zero microseconds up to a frequency of 3.0 mc; and then linearly decreasing to 4.18 mc so as to be equal to -0.17 μ secs at 3.58 mc. The tolerance on the envelope delay shall be ± 0.05 μ secs at 3.58 mc. The tolerance shall increase linearly to ± 0.1 μ sec down to 2.1 mc, and remain at ± 0.1 μ sec down to 0.2 mc.^{29a} The tolerance shall also increase linearly to ± 0.1 μ sec at 4.18 mc.

(6) The radio frequency signal, as radiated, shall have an envelope as would be produced by a modulating signal in conformity with Appendix III, Figure 4 (a) or (b), as modified by vestigial sideband operation specified by Appendix III, Figure 3.

(7) The time interval between the leading edges of successive horizontal pulses shall vary less than one half of one percent of the average interval. However, for color transmissions, § 3.682 (a) (5) and § 3.682 (a) (6) shall be controlling.

(8) The rate of change of the frequency of recurrence of the leading edges

²⁸Field strength measurements are desired. It is anticipated that these may not yield data which are consistent enough to prove compliance with the attenuation standards prescribed above. In that case, measurements with a dummy load of pure resistance, together with data on the antenna characteristics, shall be taken in place of over-all field measurements.

^{29a}Television stations shall have until July 1, 1954, for compliance with the requirements of this subparagraph with respect to attenuation of the upper sidebands.

²⁹The "synchronizing signal" referred to in this section means either a standard synchronizing wave form or any pulse that will properly set the peak.

^{29a}Tolerances for the interval of 0.0 to 0.2 mc are not specified at the present time.

of the horizontal synchronizing signals shall be not greater than 0.15 percent per second, the frequency to be determined by an averaging process carried out over a period of not less than 20, nor more than 100 lines, such lines not to include any portion of the blanking interval. However, for color transmissions, § 3.682 (a) (5) and § 3.682 (a) (6) shall be controlling.

(9) Sufficient monitoring equipment shall be employed to determine whether the visual signal complies with the requirements of this subpart.

(10) For color transmission the transfer characteristic (that is the relationship between the transmitter RF output and video signal input) shall be substantially linear between the reference black and reference white levels.

(b) *Aural transmitter.* (1) The transmitter shall operate satisfactorily with a frequency swing of ± 25 kilocycles, which is considered 100 percent modulation. It is recommended, however, that the transmitter be designed to operate satisfactorily with a frequency swing of at least ± 40 kilocycles.

(2) The transmitting system (from input terminals of microphone pre-amplifier, through audio facilities at the studio, through telephone lines or other circuits between studio and transmitter, through audio facilities at the transmitter, and through the transmitter, but excluding equalizers for the correction of deficiencies in microphone response) shall be capable of transmitting a band of frequencies from 50 to 15,000 cycles. Pre-emphasis shall be employed in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 75 microseconds. (See Appendix III, Figure 8.) The deviation of the system response from the standard pre-emphasis curve shall lie between two limits as shown by Appendix III, Figure 8. The upper of these limits shall be uniform (no deviation) from 50 to 15,000 cycles. The lower limit shall be uniform from 100 to 7,500 cycles, and three db below the upper limit; from 100 to 50 cycles the lower limit shall fall from three db limit at a uniform rate of one db per octave (4 db at 50 cycles); from 7,500 to 15,000 cycles the lower limit shall fall from three db limit at a uniform rate of two db per octave (5 db at 15,000 cycles).

(3) At any modulating frequency between 50 and 15,000 cycles and at modulation percentages of 25 percent, 50 percent, and 100 percent, the combined audio frequency harmonics measured in the output of the system shall not exceed the root-mean-square values given in the following table:

<i>Modulation frequency</i>	<i>Distortion (percent)</i>
50 to 100 cycles.....	3.5
100 to 7,500 cycles.....	2.5
7,500 to 15,000 cycles.....	3.0

(i) Measurement shall be made employing 75 microsecond de-emphasis in the measuring equipment and 75 microsecond pre-emphasis in the transmitting equipment, and without compression if a compression amplifier is employed. Harmonics shall be included to 30 kc.³⁰

(ii) It is recommended that none of the three main divisions of the system (transmitter, studio to transmitter circuit and audio facilities) contribute over

³⁰Measurements of distortion using de-emphasis in the measuring equipment are not practical at the present time for the range 7,500 to 15,000 cycles for 25 and 50 percent modulation. Therefore, measurements should be made at 100 percent modulation and on at least the following modulating frequencies: 50, 100, 400, 1,000, 5,000, 10,000, and 15,000 cycles. At 25 and 50 percent modulation, measurements should be made on at least the following modulating frequencies: 50, 100, 400, 1,000 and 5,000 cycles.

one-half of these percentages, since at some frequencies the total distortion may become the arithmetic sum of the distortions of the divisions.

(4) The transmitting system output noise level (frequency modulation) in the band of 50 to 15,000 cycles shall be at least 55 db below the audio frequency level representing a frequency swing of ± 25 kc.²¹

(5) The transmitting system output noise level (amplitude modulation) in the band of 50 to 15,000 cycles shall be at least 50 db below the level representing 100 percent amplitude modulation.²²

(6) If a limiting or compression amplifier is employed, precaution should be maintained in its connection in the circuit due to the use of pre-emphasis in the transmitting system.

(7) A modulation monitor shall be in operation at the aural transmitter. The percentage of modulation of the aural transmissions shall be maintained as high as possible consistent with good quality of transmission and good broadcast practice and in no case less than 85 percent nor more than 100 percent on peaks of frequent recurrence during any selection which normally is transmitted at the highest level of the program under consideration.

(c) *Requirements applicable to both visual and aural transmitters.* (1) Automatic means shall be provided in the visual transmitter to maintain the carrier frequency within one kilocycle of the authorized frequency; automatic means shall be provided in the aural transmitter to maintain the carrier frequency within four kilocycles of the assigned aural carrier frequency or, alternatively, 4.5 megacycles above the actual visual carrier frequency within 5 kilocycles. For color transmission the aural carrier shall be maintained 4.5 megacycles above the visual carrier within ± 1 kilocycle. When required by § 3.606, the visual and aural carrier frequencies are to be offset in frequency by 10 kilocycles (plus or minus, as indicated) from the normal carrier frequencies.

(2) The transmitters shall be equipped with suitable indicating instruments for the determination of operating power and with other instruments necessary for proper adjustment, operation, and maintenance of the equipment.

(3) Adequate provision shall be made for varying the output power of the transmitters to compensate for excessive variations in line voltage or for other factors affecting the output power.

(4) Adequate provisions shall be provided in all component parts to avoid overheating at the rated maximum output powers.

(5) Frequency monitors for the visual and aural transmitters, independent of the frequency control of the transmitters, shall be in operation at the transmitters.

(6) In the event the visual monitoring equipment, the aural modulation monitor, or the visual or aural frequency monitor becomes defective, the station may be operated without such equipment pending its repair or replacement for a period not in excess of 60 days without further authority of the Commission: *Provided, That*

(i) Appropriate entries shall be made in the operating log of the station to show the date and time the equipment was removed from and restored to service.

(ii) The Engineer in Charge of the radio district in which the station is located shall be notified both immediately after the equipment is found to be defective and immediately after the repaired or replacement equipment has been installed and is functioning properly.

²¹ ²²For the purpose of these measurements, the visual transmitter should be inoperative since the exact amount of noise permissible from that source is not known at this time.

(iii) During the period when the station is operated without the aural modulation monitor or the visual monitoring equipment, the licensee shall provide other suitable means for insuring that the aural modulation is maintained within the tolerance prescribed in paragraph (b) (7) of this section and that the visual signal is maintained in accordance with the requirements of this subpart.

(iv) During the period when the station is operated without the visual or aural frequency monitor, the respective carrier frequency shall be compared with an external frequency source of known accuracy at sufficiently frequent intervals to insure that the frequency is maintained within the tolerance prescribed in subparagraph (1) of this paragraph. An entry shall be made in the station log as to the method used and the results thereof.

(v) If conditions beyond the control of the licensee or permittee prevent the restoration of the monitor or monitoring equipment to service within the above allowed period, an informal request in accordance with § 1.332 (d) of this chapter may be filed with the Engineer in Charge of the radio district in which the station is located for such additional time as may be required to complete repairs of the defective instrument or equipment.

(d) *Construction.* In general, the transmitters shall be mounted either on racks and panels or in totally enclosed frames protected as required by article 810 of the National Electrical Code,³² and as set forth below:

(1) Means shall be provided for making all tuning adjustments, requiring voltages in excess of 350 volts to be applied to the circuit, from the front of the panels with all access doors closed.

(2) Proper bleeder resistors or other automatic means shall be installed across all the capacitor banks to lower any voltage which may remain accessible with access door open to less than 350 volts within two seconds after the access door is opened.

(3) All plate supply and other high voltage equipment, including transformers, filters, rectifiers and motor generators, shall be protected so as to prevent injury to operating personnel.

(i) Commutator guards shall be provided on all high voltage rotating machinery. Coupling guards should be provided on motor generators.

(ii) Power equipment and control panels of the transmitters shall meet the above requirements (exposed 220-volt A. C. switching equipment on the front of the power control panels is not recommended but is not prohibited).

(iii) Power equipment located at a television broadcast station not directly associated with the transmitters (not purchased as part of same), such as power distribution panels, are not subject to the provisions of this subpart.

(4) The following provisions shall be applicable to metering equipment:

(i) All instruments having more than 1,000 volts potential to ground on the movement shall be protected by a cage or cover in addition to the regular case. (Some instruments are designed by the manufacturers to operate safely with voltages in excess of 1,000 volts on the movement. If it can be shown by

³²The pertinent sections of article 810 of the National Electrical Code read as follows:

"8191. General; Transmitters shall comply with the following:

"a. Enclosing. The transmitter shall be enclosed in a metal frame or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.

"b. Grounding of controls. All external metallic handles and controls accessible to the operating personnel shall be effectually grounded. No circuit in excess of 150 volts shall have any parts exposed to direct contact. A complete dead-front type of switchboard is preferred.

"c. Interlocks on doors. All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts when any access door is opened."

the manufacturer's rating that the instrument will operate safely at the applied potential, additional protection is not necessary.)

(ii) In case the plate voltmeters are located on the low potential side of the multiplier resistors with the high potential terminal of the instruments at or less than 1,000 volts above ground, no protective case is required. However, it is good practice to protect voltmeters subject to more than 5,000 volts with suitable over-voltage protective devices across the instrument terminals in case the winding opens.

(iii) Transmission line meters and any other radio frequency instrument which may be necessary for the operator to read shall be so installed as to be read easily and accurately without the operator having to risk contact with circuits carrying high potential radio frequency energy.

(e) *Wiring and shielding.* (1) The transmitter panels or units shall be wired in accordance with standard practice, such as insulated leads properly cabled and supported, coaxial cables, or rigid bus bar properly insulated and protected.

(2) Wiring between units of the transmitters, with the exception of circuits carrying radio frequency energy or video energy, shall be installed in conduits or approved fiber or metal raceways to protect it from mechanical injury.

(3) Circuits carrying radio frequency or video energy between units shall be coaxial cables, two wire balanced lines, or properly shielded lines.

(4) All stages or units shall be adequately shielded and filtered to prevent interaction and radiation.

(5) The frequency and modulation monitors and associated radio frequency lines to the transmitter shall be thoroughly shielded.

(f) *Auxiliary transmitters.* Auxiliary transmitters may not exceed the power rating of the main transmitters. As a general guide, specifications for auxiliary transmitters should conform as much as possible to those of the main transmitters. No requirements are set forth at this time.

(g) *Installation.* (1) The installation of transmitting equipment shall be made in suitable quarters.

(2) Suitable facilities shall be provided for the welfare and comfort of the operator.

(h) *Spare tubes.* (1) A spare tube of every type employed in the transmitters and the frequency and modulation monitors shall be kept on hand at the equipment location. When more than one tube of any type is employed, the following table determines the number of spares of that type required:

Number of each type employed:	<i>Spares required</i>
1 or 2.....	1
3 to 5.....	2
6 to 8.....	3
9 or more.....	4

(2) An accurate circuit diagram and list of required spare tubes, as furnished by the manufacturer of the equipment, shall be supplied and retained at the transmitter location.

(i) *Operation.* (1) Spurious emissions, including radio frequency harmonics, shall be maintained at as low a level as the state of the art permits. As measured at the output terminals of the transmitter (including harmonic filters, if required) all emissions removed in frequency in excess of 3 Mc above or below the respective channel edge shall be attenuated no less than

60 db. below the visual transmitted power."³² In the event of interference caused to any service greater attenuation will be required.

(2) If a limiting or compression amplifier is used in conjunction with the aural transmitter, due operating precautions should be maintained because of pre-emphasis in the transmitting system.

(j) *Studio equipment.* Studio equipment shall be subject to all the above requirements where applicable, except as follows:

(1) If properly covered by an underwriter's certificate, it will be considered as satisfying safety requirements.

(2) Section 8191 of article 810 of the National Electrical Code shall apply for voltages only in excess of 500 volts.

(3) No specific requirements are made relative to the design and acoustical treatment of studios. However, the design of studios, particularly the main studio, shall be compatible with the required performance characteristics of television broadcast stations.

* * * * *

SEC. 3.689 *Operating power*—(a) *Determination*—(1) *Visual transmitter.* The operating power of the visual transmitter shall be determined at the output terminal of the vestigial sideband filter, if such filter is used; otherwise, at the transmitter output terminal. The average power shall be measured while operating into a dummy load of substantially zero reactance and a resistance equal to the transmission line surge impedance, while transmitting a standard black television picture. The peak power shall be the power obtained by this method, multiplied by the factor 1.68. During this measurement the direct plate voltage and current of the last radio stage and the peak output voltage or current shall be read for use below.

(2) *Aural transmitter.* The operating power of the aural transmitter shall be determined by the indirect method. This is the product of the plate voltage (E_p) and the plate current (I_p) of the last radio stage, and an efficiency factor, F ; that is:

$$\text{Operating power} = E_p \times I_p \times F$$

(i) The efficiency factor, F , shall be established by the transmitter manufacturer for each type of transmitter for which he submits data to the Commission, and shall be shown in the instruction books supplied to the customer with each transmitter. In the case of composite equipment, the factor F shall be furnished to the Commission by the applicant along with a statement of the basis used in determining such factor.

(b) *Maintenance*—(1) *Visual transmitter.* The peak power shall be monitored by a peak reading device which reads proportionally to voltage, current, or power in the radio frequency transmission line, the meter to be calibrated during the measurement described in paragraph (a) (1) of this section. The operating power as so monitored shall be maintained as near as practicable to the authorized operating power and shall not exceed the limits of 10 percent above and 20 percent below the authorized power except in emergencies. As a further check, both the plate voltage and plate current of the output stage shall be measured with a standard black television picture with the

³²Stations authorized prior to July 1, 1953, shall have until October 1, 1954, to comply with this requirement unless actual interference is caused.

³³The 60 db. value for television transmitters specified in this rule should be considered as a temporary requirement which may be increased at a later date, especially when more higher-powered equipment is utilized. Stations should, therefore, give consideration to the installation of equipment with greater attenuation than 60 db.

transmitter operating into the antenna. These values must agree substantially with corresponding readings taken under paragraph (a) (1) of this section.

(2) *Aural transmitter.* The operating power of the aural transmitter shall be maintained as near as practicable to the authorized operating power, and shall not exceed the limits of 10 percent above and 20 percent below the authorized power except in emergencies.

(3) *Reduced power.* In the event it becomes impossible to operate with the authorized power, the station may be operated with reduced power for a period of 10 days or less provided the Commission and the Engineer in Charge of the radio district in which the station is located shall be notified in writing immediately thereafter and also upon the resumption of the normal operating power.²⁴

* * * * *

SEC. 3.767 *Frequency tolerance.* The operating frequencies of international broadcast station transmitters shall be maintained within 0.005% of the assigned frequencies.

PART 4—EXPERIMENTAL AND AUXILIARY BROADCAST SERVICES

SEC. 4.166 *Operator requirements.* One or more radio operators holding radiotelephone first-class or radiotelephone second-class operator licenses shall be on duty at the place where the transmitting apparatus of an experimental television broadcast station is located and in actual charge of its operation. The licensed operator on duty and in charge of a broadcast transmitter may at the discretion of the licensee be employed for other duties or for the operation of another station or stations in accordance with the class of operator's license which he holds and the rules and regulations governing such stations. However, such duties shall in no wise interfere with the operation of the broadcast transmitter.

* * * * *

SEC. 4.536 *Directional antenna required.* Each broadcast STL or FM Intercity Relay station is required to employ a directional antenna. Considering one kilowatt of radiated power as a standard for comparative purposes, such antenna shall provide a free space field intensity at one mile of not less than 435 mv/m in the main lobe of radiation toward the receiver and not more than 20 percent of the maximum value in any azimuth 30° or more off the line to the receiver. Where more than one antenna is authorized for use with a single station, the radiation pattern of each shall be in accordance with the foregoing requirement.

* * * * *

SEC. 4.561 *Frequency tolerance.* The licensee of each broadcast STL or FM Intercity Relay station shall maintain the operating frequency of the station within plus or minus 0.005 percent of the assigned frequency.

* * * * *

PART 7—STATIONS ON LAND IN THE MARITIME SERVICES

SEC. 7.7 *Operational—(a) Safety communication.* The transmission or reception of distress, alarm, urgent, or safety signals, or any communication preceded by one of these signals, or any form of radiocommunication which, if delayed in transmission or reception, may adversely affect the safety of

²⁴See Part O of the Commission's rules for addresses of the Commission's engineering field offices.

life or property; and occasional test transmission or reception as necessary for determining whether or not the radio equipment is in good working condition for purposes of safety.

(b) *Superfluous radiocommunication.* Any transmission that is not necessary to the conduct of the service for which the station is licensed.

(c) *Harmful interference.* Any radiation or any induction which endangers the functioning of a radionavigation service or of a safety service, or obstructs or repeatedly interrupts a radio service operating in accordance with applicable laws, treaties, and regulations.

(d) *Distress signal.* (1) The distress signal is the international radiotelegraph or radiotelephone signal which indicates that a ship, aircraft, or other vehicle is threatened by grave and imminent danger and requests immediate assistance.

(2) In radiotelegraphy, the international distress signal consists of the group "three dots, three dashes, three dots", transmitted as a single signal in which the dashes are emphasized so as to be distinguished clearly from the dots.

(3) In radiotelephony, the international distress signal consists of the oral enunciation of the word "Mayday", pronounced as the French expression "m'aider". In case of distress, transmission of this particular signal is intended to insure recognition of a radiotelephone distress call by stations of any nationality.

(e) *Alarm signal.* The international radiotelegraph signal, consisting of a series of twelve dashes sent in one minute, the duration of each dash being four seconds and the duration of the interval between two consecutive dashes being one second, having for its sole purpose the actuation of automatic devices giving warning by means of an alarm that a distress call or message is about to follow, or that an urgent cyclone warning is about to be sent by a coast station authorized to do so.

(f) *Urgency signal.* (1) The urgency signal is the international radiotelegraph or radiotelephone signal which indicates that the calling station has a very urgent message to transmit concerning the safety of a ship, aircraft, or other vehicle, or of some person on board or within sight.

(2) In radiotelegraphy, the international urgency signal consists of three repetitions of the group "XXX", sent before the call, with the letters of each group and the successive groups clearly separated from each other.

(3) In radiotelephony, the international urgency signal consists of three oral repetitions of the word "Pan" pronounced as the French word "panne" and sent before the call.

(g) *Safety signal.* (1) The safety signal is the international radiotelegraph or radiotelephone signal which indicates that the station sending this signal is ready to transmit a message concerning the safety of navigation or giving important meteorological warnings.

(2) In radiotelegraphy, the international safety signal consists of three repetitions of the group "TTT", sent before the call, with the letters of each group and the successive groups clearly separated from each other.

(3) In radiotelephony, the international safety signal consists of three oral repetitions of the French word "Securite", sent before the call.

(h) *Distress traffic.* All messages relative to the immediate assistance required by the ship, aircraft, or other vehicle in distress.

(i) *500 kilocycles silent period.* The three-minute period twice an hour beginning at x h 15 and x h 45, Greenwich mean time (GMT), during which the International Radio Regulations require that all transmissions (except for

certain emissions designated in those Regulation) must cease on all frequencies within a designated frequency-band centered on 500 kc.

(j) *Watch*. The act of listening for or to sound produced by a telephone receiver when the electric wave energy at audio frequency supplied to the telephone receiver:

(1) Results from simultaneous interception and detection of Hertzian waves of a designated radio frequency or frequencies, and

(2) Is substantially equivalent in frequency to the audio frequency or frequencies generated by detection of the intercepted Hertzian waves.

(k) *Calling*. Transmission from a station solely to secure the attention of another station, or other stations, for a particular purpose.

(l) *Working*. Radiocommunication carried on, for a purpose other than calling, by any station or stations using telegraphy, telephony, or facsimile.

(m) *Control point*. An operating position associated with a particular station or stations which is:

(1) Under the control and supervision of the station licensee or his authorized agent; and

(2) A place at which the required monitoring and control facilities are available; and

(3) A place at which a duly licensed operator (or other person if the requirement for a licensed operator is waived by the Commission) responsible for the operation of the transmitter(s) is stationed.

(n) *Dispatch point*. A place from which radiocommunication may be transmitted under supervision of a responsible operator at a control point.

* * * * *

SEC. 7.64 *Equipment and service tests*. (a) Equipment and service tests of any radio transmitting facilities authorized by a construction permit issued by the Commission in respect to a station subject to this part may be conducted as prescribed in paragraphs (b), (c), and (d) of this section: *Provided*, That necessary precautions are taken to avoid interference to the service of other authorized stations.

(b) *Equipment test*: Upon completion of construction or installation of radio transmitting facilities in a station in exact accordance with the terms of the related construction permit, the technical provisions of the application therefor, and the rules and regulations governing the class of station concerned, and prior to the filing of an application for license or modification of license, the permittee is authorized to test the equipment in accordance with applicable terms of the construction permit for a period not to exceed 10 days: *Provided*, That the Commission's engineer in charge of the radio district in which the station is located is notified two days in advance of the beginning of tests and that the permittee is not notified by the Commission to cancel, suspend, or change the date(s) for such tests.

(c) *Service test*: When equipment tests have been completed, and after application for station license or modification thereof has been filed with the Commission showing the transmitting equipment and associated apparatus to be in satisfactory operating condition, the permittee is authorized to conduct service tests in exact accordance with the terms of the construction permit for a period not to exceed 30 days: *Provided*, That the Commission's engineer in charge of the radio district in which the station is located is notified two days in advance of the beginning of such tests and that the permittee is not notified by the Commission to cancel, suspend, or change the date(s) for such tests.

(d) **Limitations:** The authorization for tests embodied in paragraphs (b) and (c) of this section shall not be construed as constituting a license to operate but as a necessary part of the authorized construction. Equipment and service tests shall not commence after the expiration date of the construction permit.

(e) **Common carrier service tests:** When new stations in common carrier services are ready in all respects to be placed in service, equipment and service tests are authorized to be conducted as outlined in paragraphs (b) and (c) of this section: *Provided*, All necessary precautions are taken to avoid interference to any other authorized station. No service may be furnished to the public during the equipment test period. Charges for service furnished during the service test period may be made, pursuant to the provisions of legally applicable tariffs.

NOTE: See § 61.62 of this chapter.

* * * * *

SEC. 7.179 *Message charges.* (a) (1) No charge shall be made for the service of any public coast station unless effective tariffs applicable to such service are on file with the Commission, pursuant to the requirements of Section 203 of the Communications Act and Part 61 of this chapter.

(2) No charge shall be made for the service of any station subject to this part, other than a public coast station, except as provided by and in accordance with § 7.352.

(b) No charge shall be made by any station in the maritime mobile service of the United States for the transmission of distress messages and replies thereto in connection with situations involving the safety of life and property at sea.

(c) No charge shall be made by any station in the maritime mobile service of the United States for the transmission, receipt, or relay of the information concerning dangers to navigation designated in § 8.303 (b) of this chapter, originating on a ship of the United States or of a foreign country.

(d) Any common carrier subject to the Communications Act may furnish reports of positions of ships at sea to newspapers of general circulation, either at a nominal charge or without charge, provided the name of such common carrier is displayed along with such ship position reports.

(e) Any common carrier subject to the Communications Act may render to any agency of the United States Government free service in connection with the preparation for the national defense. Every such carrier rendering any such free service shall make and file, in duplicate, with the Commission, on or before the 31st day of July and on or before the 31st day of January in each year, reports covering the periods of 6 months ending on the 30th day of June and the 31st day of December, respectively, next prior to said dates. These reports shall show the names of the agencies to which free service was rendered pursuant to this paragraph, the general character of the communications handled for each agency, and the charges in dollars which would have accrued to the carrier for such service rendered to each agency if charges for all such communications had been collected at the published tariff rates.

* * * * *

SEC. 7.192 *Maintenance of station log.* (a) Each station subject to this part which is required, under the provisions of this part pertaining to the particular class of station, to keep a radio station log, shall in addition, comply with the applicable provisions of the following paragraphs of this section; the station licensee and the licensed radio operator (when a licensed operator

is required) in charge of the station shall be responsible for compliance with this section.

(b) The log shall be kept in an orderly manner, in useable form, and in such detail that the information required for the particular class of station concerned is readily available. Key letters or abbreviations may be used if their proper meaning or explanation is contained elsewhere in the same log.

(c) The station log or any portion thereof shall not be erased, obliterated, or wilfully destroyed within the period of retention required by § 7.115. However, during this period any necessary correction may be made of such log but only by the person originating the entry and that person shall strike out the erroneous portion, initial the correction made, and indicate the date of correction.

* * * * *

SEC. 7.302 *Points of communication.* (a) Subject to the conditions and limitations imposed by the terms of the particular coast station license or by the applicable provisions of this part with respect to the use of particular radio-channels, public coast stations using telephony are authorized to communicate:

(1) With any ship station or aircraft station operating in the maritime mobile service for the transmission or reception of safety communication;

(2) With any land station for the purpose of facilitating the transmission or reception of safety communication to or from a ship or aircraft station;

(3) With public ship stations, government ship stations, aeronautical public service stations on board aircraft, and government aircraft stations, for the transmission or reception of public correspondence:

(i) When the mobile station uses telephony on a frequency assignment designated in Part 8 of this chapter for shipshore public correspondence by means of telephony;

(ii) In respect to a United States Government or foreign ship or aircraft station, when such mobile station uses telephony on a frequency assignment available in accordance with the International Radio Regulations for use by ship stations for communication by means of telephony with public coast stations.

(4) With marine fixed stations when the coast station uses for this purpose a frequency assignment below 4000 kc upon the express condition that neither harmful interference nor intolerable delay is caused to communication with mobile stations.

(b) Upon application, a public coast station using telephony may be specifically authorized by the terms of its station authorization to communicate with a designated station (government or non-government) at a remote fixed location isolated from the mainland where other communication facilities are not available; *Provided,*

(1) The station with which communication is carried on is duly authorized to communicate with the particular coast station involved; and

(2) The station with which communication is carried on shall transmit by telephony to the coast station:

(i) On a frequency assignment available for ship-shore public correspondence in accordance with the provisions of Part 8 of this chapter for public ship stations using telephony; or

(ii) On any other frequency assignment designated for this purpose in any other section of the Commission's rules or, with respect to United States

Government stations, on any government frequency assignment duly authorized by the Government for this purpose.

(3) Any communication carried on shall be confined exclusively to that absolutely necessary for public safety or the protection of life or property; and

(4) Neither harmful interference nor intolerable delay is caused to safety communication with ship stations.

(c) Upon application, a public coast station using telephony may be authorized to transmit meteorological and marine navigational information, of benefit to mariners, additionally to designated fixed locations, whenever the same information is transmitted by such coast station simultaneously and primarily to ship stations: *Provided*, A sufficient need for such authorization is shown to exist.

* * * * *

SEC. 7.305 *Frequencies for calling and distress.*

(a) The frequency 2182 kc is the international radiotelephone distress and general calling frequency for the maritime mobile service. It may be used by public coast stations solely for transmission of:

(1) Distress signals and traffic as provided in Supart G of this part.

(2) The international urgency signal, and very urgent messages (preceded by this signal) concerning the safety of a ship, aircraft or other vehicle, or the safety of some person on board or within sight of such ship, aircraft, or vehicle.

(3) The international safety signal, and occasional messages (preceded by this signal) concerning the safety of navigation or giving important meteorological warnings which messages in the interest of safety must be transmitted on this radio-channel instead of on a different radio-channel in accordance with the procedure authorized in subparagraph (5) of this paragraph.

(4) Normal calls, replies, and brief radio operating signals but only when the use of a different carrier frequency for this function appears to be impracticable by reason of operating or equipment limitations of a mobile station.

(5) Brief announcements specifying the nature of a particular communication to be transmitted soon thereafter on other radio-channel(s) by the same coast station to a plurality of mobile stations, when such communication will be of general interest to mobile stations of the maritime mobile service, including ordinary weather and hydrographic information, or will consist of lists of mobile stations with which the coast station desires to communicate.

(6) Brief test signals in accordance with the provisions of § 7.311, as may be necessary to determine whether the radio transmitting equipment of the station is in good working condition on this frequency.

(b) The frequency 156.8 Mc is the international radiotelephone frequency for calling, safety, intership, and harbor control purposes for the maritime mobile service using frequencies within the band 156.25 Mc to 162.05 Mc. This carrier frequency may be used by public coast stations as prescribed in § 7.309.

(c) In addition to the radio-channels of which the carrier frequencies are specifically authorized herein for "calling," the radio-channels authorized in this subpart for "working" may be used for call and reply: *Provided*, Interference is not caused to any communication in progress on the particular working channel.

* * * * *

SEC. 7.310 Identification of station. (a) All radiotelephone emissions of a public coast station shall be clearly identified by voice transmission therefrom in the English language of either the official call sign assigned to that station by the Commission or the approximate geographic location of the station as approved¹ in each case by the Commission upon request made by the station licensee or permittee: *Provided*, That in lieu of identification of the station by voice, the official call sign may be clearly transmitted by tone-modulated telegraphy in the International Morse Code either by a duly licensed radiotelegraph operator or by means of an automatic device approved² for this purpose by the Commission. Identification as herein prescribed shall be made:

- (1) Upon completion of each communication with any other station;
- (2) At the beginning and upon conclusion of each transmission made for any other purpose.

* * * * *

SEC. 7.312 General radiotelephone operating procedure—(a) Limitations on calling. (1) Except when transmitting a general call to all stations within range for announcing or preceding the transmission of distress, urgency, or safety messages, a public coast station shall call the particular station(s) with which it intends to communicate.

(2) Public coast stations may use authorized classes of emission for selective-calling on each radio-channel authorized for working. The use of selective-calling on the radio-channel of which either 2182 kc or 156.8 Mc is the authorized carrier frequency is prohibited.

NOTE: See those provisions of Subpart E of this part relative to authorized classes of emission.

(3) Calling a particular station, either by voice or by other means, shall not continue for a period of more than one minute in each instance. If the called station is not heard to reply, that station shall not again be called until after an interval of three minutes. In the event of an emergency involving safety, the provisions of this subparagraph shall not apply.

(4) Each public coast station, when using selective-calling to secure the attention of a ship station with which it intends to communicate, shall transmit the type of signal and the particular signal code necessary to actuate the automatic attention device (selective ringer) known to be installed in the particular ship station and normally used for monitoring the coast station radio-channel which is used for transmitting such calls.

(5) Except in the event of an emergency involving safety, a public coast station, with respect to operation on any radio-channel which is used also by other coast stations within the same communication area, shall not answer, or attempt to answer, a ship station until the latter has transmitted the call sign or name of the particular coast station with which it desires to communicate.

(6) A public coast station shall not attempt to communicate with a ship station that has specifically called another coast station until it becomes evident that the called station does not answer, or that communication between the ship station and the called station cannot be carried on because of unsatisfactory operating conditions.

(b) *Time limitation on calling frequency.* Transmission by coast stations on the calling channel of which 2182 kc or 156.8 Mc is the authorized carrier

¹Such voice identification as "Washington marine operator" to indicate that the station is located at or near Washington, D. C., may be approved if there will be no conflict with identification of any other station.

²The conditions to be met by such a device in order to obtain the approval of the Commission will be determined and will be incorporated in proposed rule making.

frequency (including calls, answers, operating signals, and conversation pertaining to safety) shall be kept to a minimum and in general any one exchange of communications shall not exceed three minutes in duration. In the event of distress or other emergency, this time limitation shall not apply.

(c) *Change to working frequency.* After establishing communication with another station by call and reply on the calling channel of which 2182 kc or 156.8 Mc is the authorized carrier frequency, coast stations shall change to an authorized working channel for the transmission of messages which, under the provisions of this subpart, cannot be transmitted on the respective calling channel.

(d) *Use of busy signal.* A public coast station, when communicating with a ship station which transmits to the coast station on a radio-channel which is a different channel from that used by the coast station for transmission, may transmit a "busy" signal whenever transmission from the ship stations is being received and during such other periods of time, pending completion of any one exchange of communications with a particular ship station, as may be considered necessary by the coast station to avoid or minimize interference from other stations.

* * * * *

SEC. 7.314 *Station records.* (a) Public coast stations using telephony shall maintain an accurate radiotelephone log during their hours of service, as hereinafter specified:

(1) Each sheet of the log shall be numbered in sequence and dated and shall include the official call sign of the coast station and also the signature(s) of the licensed operator(s) performing operating duties.

(2) The entry "on duty" shall be made by the operator beginning a duty period, followed by his signature. The entry "off duty" shall be made by the operator being relieved of or terminating a duty period, followed by his signature. All log entries shall be currently completed and all entries shall, unless otherwise stated, be made by a licensed operator on duty. The use of initials or signs is not authorized in lieu of any operator's signature required by this section.

(3) The time of making an entry shall be shown opposite the entry and shall be expressed in Greenwich mean time (GMT), except that, in the Great Lakes region, the time shall be expressed in eastern standard time (e. s. t.) (counted from 00:00 to 24:00 o'clock, beginning at midnight) and for public coast stations which communicate exclusively with vessels on inland waters of the United States (other than the Great Lakes) the time shall be expressed in local standard time (e. s. t., c. s. t., etc., counted from 00:00 to 24:00 o'clock, beginning at midnight). The first entry in each hour shall consist of 4 figures; additional entries in the same hour may be expressed in 2 figures by omitting the hour designation. The abbreviation "GMT" (e. s. t. in the Great Lakes area) (e. s. t. c. s. t., etc., for stations serving inland waters exclusively) shall be marked at the head of the column in which the time is entered.

(4) With respect to public coast stations, which by reason of the provisions of Subpart G of this part, are required to maintain a watch on the radio-channel designated for radiotelephone calling and distress (assigned frequency 2182 kc), or on the radiotelephone calling channel above 100 Mc (assigned frequency 156.8 Mc), entries shall be made showing each time this watch is begun, suspended, or concluded; without any requirement, however, of making such entries during interruption of this watch as may be necessary

during hours of service for calling, answering and exchanging operating signals and safety communications on this radio-channel. These entries shall be made by the licensed operator(s) on duty who is (are) designated and authorized by the station licensee to do so; the name and signature of the operator(s) making these entries and the operator(s) who actually maintains such watch shall appear in the log and shall be properly related to each particular entry for this purpose.

(5) All radiotelephone distress, urgency or safety signals and communications made or intercepted; the complete text, if possible, of such communications; and any information which may appear to be of importance to safety of life or property shall be entered, together with the time of such observation or occurrence, identification of the radio-channel(s) on which such signals or messages were transmitted or received, and the position of any ship, or other nobile unit in need of assistance, if this can be determined. These entries shall be made by the licensed operator(s) on duty who is (are) designated and authorized by the station licensee to do so; the name and signature of the operator(s) making these entries shall appear in the log and shall be properly related to each particular entry of this category.

(6) All calls transmitted from or received by a coast station shall be entered, showing the call signs or names of vessels; the time, and the assigned frequencies involved: *Provided, however,* That when the manual operations of switching and handling of telephone calls directly between a ship telephone station and landline telephone facilities are not normally performed by a licensed radio operator, the entries prescribed by this paragraph may be omitted from the station log upon the express condition that equivalent records shall be currently maintained by the station licensee. Such records shall be made available upon request of an authorized Commission representative. The equivalent records shall include the time and such other notations as are necessary to identify the frequency(s) employed and the station(s) communicated with or heard. In addition, for each communication handled, a notation shall be made of the points of origin and destination of the communication. Local standard time may be used to record the occurrence in the equivalent record in lieu of Greenwich mean time or eastern standard time prescribed by subparagraph (3) of this paragraph: *Provided,* That the licensee may be required, upon request of an authorized Commission representative, to convert the standard time recorded to that specified in subparagraph (3) of this paragraph.

(7) Whenever harmful interference is experienced by or reported to the responsible operator, an entry shall be made by such operator to that effect, stating the source of the interference, if known.

(8) All test transmissions shall be entered, together with the time of such transmissions, without regard to whether two-way communication with any other station is established.

(9) A daily entry shall be made regarding comparison of the time indicated by the required clock(s) with standard time, including a statement of any deviations observed and corrections made.

(10) Failure of apparatus to operate as required, failure of power supply, and incidents tending to unduly delay communication shall be entered.

(11) All measurements of the transmitter frequency(s) shall be entered, including such deviations from the assigned frequency(s) as may be observed, and a statement of any corrective action taken.

(12) An entry shall be made giving pertinent details of all installation,

service, or maintenance work performed which may affect the proper operation of the station. The entry shall be made, signed, and dated by the responsible licensed operator who supervised or performed the work, and unless he is regularly employed on a full-time basis at the station and has his operator license properly posted, shall also include his mail address and the class, serial number, and expiration date of his license.

(13) Entries shall be made also in reference to operation of the antenna tower lights when such entries are required by reason of applicable provisions of Subpart G of this part.

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PART 8—STATIONS ON SHIPBOARD IN THE MARITIME SERVICES

SEC. 8.6 *Operational*—(a) *Safety communication*. The transmission or reception of distress, alarm, urgent, or safety signals, or any communication preceded by one of these signals, or any form of radiocommunication which, if delayed in transmission or reception, may adversely affect the safety of life or property; and occasional test transmission or reception as necessary for determining whether or not the radio equipment is in good working condition for purposes of safety.

(b) *Superfluous radiocommunication*. Any transmission that is not necessary in properly carrying on the service for which the station is licensed.

(c) *Harmful interference*. Any radiation or any induction which endangers the functioning of a radionavigation service or of a safety service, or obstructs or repeatedly interrupts a radio service operating in accordance with law.

(d) *Distress signal*. (1) The distress signal is the international radiotelegraph or radiotelephone signal which indicates that a ship, aircraft, or other vehicle is threatened by grave and imminent danger and requests immediate assistance.

(2) In radiotelegraphy, the international distress signal consists of the group "three dots, three dashes, three dots", transmitted as a single signal in which the dashes are emphasized so as to be distinguished clearly from the dots.

(3) In radiotelephony, the international distress signal consists of the oral enunciation of the word "MAYDAY", pronounced as the French expression "m'aider".

NOTE: In case of distress, transmission of this particular signal is intended to insure recognition of a radiotelephone distress call by stations of any nationality.

(e) *Alarm signal*. The international radiotelegraph signal, consisting of a series of twelve dashes sent in one minute, the duration of each dash being four seconds and the duration of the interval between two consecutive dashes being one second, having for its sole purpose the actuation of automatic devices giving warning by means of an alarm that a distress call or message is about to follow, or that an urgent cyclone warning is about to be sent by a coast station authorized to do so.

(f) *Urgency signal*. (1) The urgency signal is the international radiotelegraph or radiotelephone signal which indicates that the calling station has a very urgent message to transmit concerning the safety of a ship, aircraft, or other vehicle, or of some person on board or within sight.

(2) In radiotelegraphy, the international urgency signal consists of three repetitions of the group "XXX", sent before the call, with the letters of each group and the successive groups clearly separated from each other.

(3) In radiotelephony, the international urgency signal consists of three repetitions of the word "PAN" pronounced as the French word "panne" and sent before the call.

(g) *Safety signal.* (1) The safety signal is the international radiotelegraph or radiotelephone signal which indicates that the station sending this signal is ready to transmit a message concerning the safety of navigation or giving important meteorological warnings.

(2) In radiotelegraphy, the international safety signal consists of three repetitions of the group "TTT", sent before the call, with the letters of each group and the successive groups clearly separated from each other.

(3) In radiotelephony, the international safety signal consists of three repetitions of the French word "securite", sent before the call.

(h) *Distress traffic.* All messages relative to the immediate assistance required by the ship, aircraft, or other vehicle in distress.

(i) *500 kilocycles silent period.* The three-minute period twice an hour beginning at x h 15 and x h 45, Greenwich mean time (GMT), during which the International Radio Regulations require that all transmissions (except for certain emissions designated in those Regulations) must cease on all frequencies within a designated frequency band centered on 500 kc.

(j) *Watch.* The act of listening for or to sound produced by a telephone receiver when the electric wave energy at audio frequency supplied to the telephone receiver:

(1) Results from simultaneous interception and detection of Hertzian waves of a designated radio frequency or frequencies, and

(2) Is substantially equivalent in frequency to the audio frequency or frequencies generated by detection of the intercepted Hertzian waves.

(k) *Calling.* Transmission from a station solely to secure the attention of another station, or other stations, for a particular purpose.

(l) *Working.* Radiocommunication carried on, for a purpose other than calling, by any station or stations using telegraphy, telephony, or facsimile.

SEC. 8.7 *Technical*—(a) *Radio frequency.* Any frequency between 10 kilocycles per second and 3,000,000 megacycles per second.

(b) *Audio frequency.* A frequency corresponding to the frequency of a normally audible sound wave, usually between 20 and 15,000 cycles per second.

(c) *Hertzian waves.* Electromagnetic waves of frequencies between 10 kc and 3,000,000 Mc.

(d) *Emission.* Any radiation of energy by means of Hertzian waves.

(e) *Spurious emission.* Any emission from a station at a frequency or frequencies outside an authorized frequency-band.

(f) *Telegraphy.* A system of telecommunication for the transmission of written matter by the use of a signal code.

(g) *Telephony.* A system of telecommunication set up for the transmission of speech, or in some cases, other sounds.

(h) *Facsimile.* A system of telecommunication for the transmission of fixed images with a view to their reception in a permanent form.

(i) *Carrier frequency.* The frequency of the carrier. (For the definition of "carrier", see § 2.1 of this subchapter.)

(j) *Authorized carrier frequency.* A specific carrier frequency authorized for use by a station from which the actual carrier frequency is permitted to deviate, solely because of frequency instability, by an amount not to exceed the frequency tolerance.

(k) *Frequency tolerance.* The extent to which a carrier frequency (or when a carrier is not present, a frequency coinciding with the center of an emission-bandwidth) is permitted by applicable regulations, or by the terms of a station authorization, to depart, solely because of frequency instability, from the authorized carrier frequency (or, when a carrier is not present, from the assigned frequency).

(l) *Frequency-band.* A continuous range of frequencies extending between two designated limiting frequencies.

(m) *Bandwidth.* The number of cycles or kilocycles per second expressing the difference between the limiting frequencies of a frequency-band.

(n) *Radio-channel.* A frequency-band, sufficient in width to permit its use for radiocommunication, comprised of the emission-bandwidth, the interference guard bands, and the frequency tolerance.

(o) *Emission-bandwidth.* The band of frequencies comprising 99 percent of the total radiated power extended to include any discrete frequency on which the power is at least 0.25 percent of the total radiated power. (This definition coincides with the definition of "Bandwidth Occupied by an Emission", which appears as paragraph 58 of the International Radio Regulations of Atlantic City, 1947. The emission-bandwidth is dependent upon the class of emission and the speed of signalling.)

(p) *Interference guard bands.* The two frequency-bands additional to, and on either side of, the authorized frequency-band, which may be provided to minimize the possibility of interference between different radio-channels.

(q) *Authorized emission-bandwidth.* A specific emission-bandwidth authorized for use by a station.

(r) *Authorized frequency-band.* A frequency-band authorized for use by a station.

(s) *Assigned frequency.* The frequency coinciding with the center of the frequency-band in which the station is authorized to work; this frequency does not necessarily correspond to any frequency in an emission. (This definition coincides with the definition of "Frequency Assigned to a Station" which appears as paragraph 57 of the International Radio Regulations of Atlantic City, 1947.)

(t) *Frequency assignment.* The specific frequency or frequencies authorized for the emission(s) of a particular station; expressed for each radio-channel by:

(1) The authorized carrier frequency the frequency tolerance, and the authorized emission-bandwidth in relation to the authorized carrier frequency,

(2) The authorized emission-bandwidth in reference to a specific assigned frequency (when a carrier does not exist), or

(3) The authorized frequency-band (when a carrier does not exist.)

(u) *Modulation.* The process of producing a wave some characteristic of which varies as a function of the instantaneous value of another wave, called the modulating wave.

(v) *Modulation factor.* (1) In an amplitude-modulated wave, the ratio of half the difference between the maximum and minimum amplitudes to the average amplitude.

(2) In a frequency-modulated wave, the ratio of the actual frequency swing to the frequency swing defined as 100 percent modulation.

(w) *Percentage modulation.* The modulation factor expressed in percent.

(x) *Amplitude modulation (AM).* Modulation in which the amplitude of a wave is the characteristic subject to variation.

(y) *Frequency modulation (FM)*. Modulation in which the instantaneous frequency of a sine-wave carrier is caused to depart from the carrier frequency by an amount proportional to the instantaneous value of the modulating wave.

(z) *Frequency deviation*. In frequency modulation, the peak difference between the instantaneous frequency of the modulated wave and the carrier frequency.

(aa) *Frequency swing*. In frequency modulation, the peak difference between the maximum and the minimum values of the instantaneous frequency.

(bb) *Deviation ratio*. In frequency modulation, for a sinusoidal modulating wave, the ratio of the maximum frequency deviation to the maximum frequency of the modulating wave.

(cc) *Antenna (aerial)*. A means of radiating or intercepting Hertzian waves.

(dd) *Artificial antenna (dummy antenna)*. A device which has the equivalent impedance characteristics of an antenna and the necessary power-handling capabilities, but which does not radiate or intercept Hertzian waves.

(ee) *Last radio stage*. In an electron-tube radio transmitter, the radio-frequency oscillator or power amplifier stage which supplies all radio-frequency power to the antenna, either directly or through the medium of a transmission line.

(ff) *Plate (anode) input power*. The electrical power delivered to the plate (anode) of an electron tube by the source of supply; this power being the product of the indicated anode voltage and the indicated anode current.

(gg) *Antenna power*. The power supplied by a particular radio transmitter to the antenna used in connection with that transmitter, at a radio frequency or frequencies within an authorized frequency-band.

(hh) *Radiated power*. Energy, in the form of Hertzian waves, radiated from an antenna.

(ii) *Authorized transmitter-power*. The power of a particular transmitter as designated in the respective station license or, in lieu thereof, the power designated in the applicable rule(s) or regulation(s). Unless specifically expressed otherwise, this power is the total plate input power to all electron tubes in the last radio stage of the transmitter which are used to supply radio-frequency power to the antenna, without modulation present in the case of a transmitter used for telephony by means of class A3 emission.

(jj) *Crystal oscillator*. A generator of alternating-current energy, the frequency of which is determined by properties of a piezoelectric crystal.

(kk) *Telephone receivers*. Whenever use of the following terms occurs in reference to "watch" as defined in § 8.6 (j), such use of these terms shall be construed as follows:

(1) *Telephone receiver*. Any instrument used to convert energy consisting of electric waves at audio frequency into energy consisting of substantially equivalent sound waves.

(2) *Hand receiver*. A telephone receiver capable of being held to the ear by the hand and normally used in that manner.

(3) *Head receiver*. A telephone receiver capable of being held to the ear by an attached headband or other device and normally used in that manner.

(4) *Loudspeaker*. A telephone receiver capable of effectively radiating acoustic power for reception by ear at a distance and normally used for that purpose.

(ll) *Energize*. The term "energize", as applied in this part to transmitters,

receivers, and other component equipment of ship radio installations required for safety purposes, means to supply with power as necessary to provide normal and effective operation of such equipment.

* * * * *

SEC. 8.115 *Retention of radio station logs.* (a) All station logs which are required under those provisions of this part pertaining to the particular classes of stations subject to this part shall be retained by the licensee for a period of one year from date of entry and for such additional periods as required by the following subparagraphs:

(1) Station logs involving communications incident to a distress or disaster shall be retained by the station licensee for a period of 3 years from date of entry;

(2) Station logs which include entries of communications incident to or involved in an investigation by the Commission and concerning which the station licensee has been notified shall be retained by the station licensee until such licensee is specifically authorized in writing by the Commission to destroy them;

(3) Station logs incident to or involved in any claim or complaint of which the station licensee has notice shall be retained by such licensee until such claim or complaint has been fully satisfied or until the same has been barred by statute limiting the time for the filing of suits upon such claims.

NOTE: See Parts 45 and 46 of this chapter concerning preservation of records of common carriers.

(b) Station logs shall be made available to an authorized representative of the Commission upon request.

(c) Ship station logs shall be fully completed at the end of each voyage and before the operator(s) (or other person(s) responsible under the applicable provisions of this part) leave the ship. The radio log currently in use shall be kept by the licensed operator(s) of the station or as otherwise authorized by the applicable provisions of this part, and during use shall be located in the principal radio operating room of the vessel. At the conclusion of each ocean voyage terminating at a port of the United States (includes Hawaii, Alaska, Puerto Rico, and Virgin Islands), the original radio log (or a duplicate thereof²) dating from the last departure of the vessel from a United States port shall be retained under proper custody on board the vessel for a sufficient period of time (not more than 24 hours) to be available for inspection by duly authorized representatives of the Commission. After retention on board the vessel as herein stipulated, the original log (and the duplicate log if provided²) may be filed at an established shore office of the station licensee, and shall be retained as stipulated by paragraph (a) of this section.

(d) Logs of ships of the United States containing entries required to be made by reason of the Great Lakes Agreement or § 8.368 (c) of this part shall be kept at the principal radiotelephone operating location while the vessel is being navigated. All entries in their original form required by said agreement or § 8.368 (c) shall be retained on board the vessel for a period of not less than one month from the date of entry. After retention on board the vessel as herein stipulated, the entries shall be filed at a place where they will be readily available to an authorized representative of the Commission upon request, and shall be retained as stipulated by paragraph (a) of this section.

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SEC. 8.151 *Authorized operator required.* (a) Except as otherwise provided in § 8.155, the actual operation of all transmitting apparatus in any radio station in the maritime mobile or maritime radiolocation service on board a ship of the United States shall be carried on only by a person holding an operator license issued by the Commission in accordance with Part 13 of this chapter.

(b) When the station is a public ship station used for telephony, the person actually operating the station shall, if authorized by the station licensee or the master (acting in this respect as the station licensee's agent), and subject to the priority of communication set forth in § 8.177, permit any person to speak over the station microphone: *Provided*, That such person actually operating the station shall continue to exercise his control so as to insure the continued proper operation of the station.

(c) When the station is a limited ship station used for telephony, the person actually operating the station may, if authorized by the station licensee or the master (acting in this respect as the station licensee's agent), and subject to the priority of communication's set forth in § 8.177, permit any person to speak over the station microphone: *Provided*, That such person actually operating the station shall continue to exercise his control so as to insure the continued proper operation of the station.

(d) For the purpose of paragraphs (b) and (c) of this section, any microphone, without regard to its location on board ship, may be construed to be the station microphone when it is electrically connected to the modulating system of the radiotelephone transmitting apparatus.

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SEC. 8.155 *Waivers of operator license—*(a) *For VHF telephony.* Subject to the conditions hereinafter stated, the provisions contained in section 318 of the Communications Act are waived, insofar as such provisions require any person to hold an operator's license in order to operate, during the course of normal rendition of service, any ship station (including developmental ship stations) or marine-utility station on board ship, in the maritime mobile service, when such station is authorized to use telephony only and further is authorized to be operated exclusively on one or more radio-channels above 30 Mc; *Provided*:

(1) The person who operates the transmitting equipment is the station licensee or is authorized by the station licensee to do so, and the use of the station during such operation is subject to the lawful direction and authority of the person who, at the time, occupies the position of the master of the ship on which the station is located;

(2) The station uses one or more of the following classes of emission only: A3 or F3 for telephony; and on the same radio-channels as are authorized for telephony A0, A2, F0, F2 solely for transmitting by automatic means attention-signals, signals for actuating selective-calling devices, for brief testing of the authorized apparatus, or station identification, or signals in an emergency involving safety;

(3) The station is authorized to use transmitting equipment only of a type which is acceptable to the Commission for operation in this service by unlicensed persons in accordance with this paragraph;

(4) The transmitting equipment operated by an unlicensed person in accordance with this paragraph is not required on board the ship for safety purposes by any statutory provisions or by any international agreement or treaty in force;

(5) All transmitter adjustments or tests during or coincident with the installation, servicing, or maintenance of the station that may affect its proper operation shall be made by or under the immediate supervision and responsibility of a person holding an operator license of the proper class for this purpose as prescribed in Part 13 of this chapter who shall be responsible for the proper functioning of the station equipment;

(6) Subsequent to any transmitter adjustments made in accordance with subparagraph (5) of this paragraph, and at all other times, the station licensee shall be responsible for determining that the transmitting equipment continues to meet the conditions established by the Commission relative to acceptance of the particular type of equipment for the purpose of operation by unlicensed persons;

(7) The station licensee or the person(s) authorized by the licensee to operate the station shall, in lieu of a licensed operator, comply with the provisions of § 8.154 as though he were a licensed operator;

(8) Nothing contained in this paragraph shall be construed to change or diminish in any respect the responsibility of the station licensee for having and maintaining control of the station or for proper functioning and operation of the station in accordance with law;

(9) No unlicensed person, authorized as provided by this paragraph to operate a station, may lawfully perform any act in relation to such station that he could not lawfully perform if he were acting under the authority of a radio operator license issued in his behalf by the Commission.

(b) *For ship-radar.* (1) No radio operator license is required for the operation on board ship, during the course of normal rendition of service, of ship-radar stations licensed in the radiolocation service (Ship-radar stations heretofore licensed in the ship service are construed to be licensed in the maritime radio-location service (including the maritime radionavigation service).) *Provided*, That the following conditions are met or provided for by the licensee of the station:

(i) The radar equipment shall employ as its frequency determining element a non-tunable, pulse-type magnetron;

(ii) The radar equipment shall be capable of being operated during the course of normal rendition of service in accordance with the radio law and the rules and regulations of the Commission by means of exclusively external controls, and

(iii) Operation during the course of normal rendition of service pursuant to this subparagraph (1), must be performed exclusively by the master of the radar-equipped ship or by one or more other persons responsible to him and authorized by him to do so.

(2) All adjustments or tests during or coincident with the installation, servicing, or maintenance of the equipment while it is radiating energy must be performed by or under the immediate supervision and responsibility of a person holding a first or second class commercial radio operator license, radiotelephone or radiotelegraph, containing a ship-radar endorsement, who shall be responsible for the proper functioning of the equipment in accordance with the radio law and the Commission's rules and regulations and for the avoidance and prevention of harmful interference from improper transmitter external effects: *Provided, however*, That nothing in this subparagraph shall be construed to prevent persons not holding such licenses or not holding such licenses so endorsed from making replacements of fuses or of receiving-tubes.

(3) Nothing in this subparagraph shall be construed to change or diminish in any respect the responsibility of any ship radar station licensee for having and maintaining control over the station licensed to him, or for the proper functioning and operation of such station in accordance with the terms of the station license.

SEC. 8.156 *Posting of operator license.* When a licensed operator is required for the operation of a station subject to this part, the original license of each such operator while he is employed or designated as radio operator of the station shall be posted in a conspicuous place at the principal location on board ship at which the station is operated: *Provided*, That in the case of stations of a portable nature, including marine-utility stations, or in the case where the operator holds a restricted radiotelephone operator permit, the operator may in lieu of posting have on his person either his required operator license or a duly issued verification card (FCC Form 758-F) attesting to the existence of that license.

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SEC. 8.177 *Order of priority of communications.* (a) The order of priority of *radiotelegraph* communications in the maritime mobile service on any frequency used for this service shall be as follows:

(1) Distress calls (including the international distress signal for radiotelegraphy), international automatic-alarm signals for distress purposes,¹

¹The international auto-alarm signal intended for use primarily in radiotelegraphy consists of a series of twelve dashes sent in one minute, the duration of each dash being four seconds and the duration of the interval between two consecutive dashes being one second.

distress messages, and distress traffic.

(2) Communications preceded by the international radiotelegraph urgency signal.

(3) Communications preceded by the international radiotelegraph safety signal.

(4) Communications relative to radio direction-finding bearings.

(5) Communications relative to the navigation and safe movement of aircraft.

(6) Communications relative to the navigation, movements, and needs of ships; including weather observation messages destined for an official meteorological service.

(7) Government communications for which priority right has been claimed.

(8) Service communications relating to the working of the radio-communication service or to communications previously transmitted.

(9) All other communications.

(b) The order of priority of *radiotelephone* communications in the maritime mobile service on any frequency used for this service shall be as follows:

(1) Distress calls (including the international distress signals for radiotelephony and radiotelegraphy), distress messages and distress traffic.

(2) Communications preceded by the international radiotelephone urgency signal, or known to the station licensee or his agent to consist of one or more urgent messages concerning the safety of a ship, aircraft, or other mobile unit or of some person on board or within sight of the ship, aircraft, or mobile unit.

(3) Communications preceded by the international radiotelephone safety signal, or known to the station licensee or his agent to consist of one or more messages concerning the safety of navigation or important meteorological warnings.

(4) Communications known by the station licensee or his agent to consist of one or more messages relative to the navigation movements, and needs of ships; including weather observation messages destined for an official meteorological service.

(5) Government communications for which priority right has been claimed.

(6) All other communications.

* * * * *

SEC. 8.184 *Maintenance of station log.* (a) Each station on board ship subject to this part which is required, under the provisions of this part pertaining to the particular class of station, to keep a radio station log, shall in addition, comply with the applicable provisions of paragraphs (b) and (c) of this section; the station licensee and the licensed radio operator (when a licensed radio operator is required) in charge of the station shall be responsible for compliance with this section.

(b) The log shall be kept in an orderly manner, in useable form, and in such detail that the information required for the particular class of station concerned is readily available. Key letters or abbreviations may be used if their proper meaning or explanation is contained elsewhere in the same log.

(c) The station log or any portion thereof shall not be erased, obliterated, or wilfully destroyed within the period of retention required by § 8.115. However, during this period any necessary correction may be made of such log but only by the person originating the entry and that person shall strike out the erroneous portion, initial the correction made, and indicate the date of correction.

* * * * *

SEC. 8.206 *Procedure in use of auto-alarm.* (a) Paragraphs (b) and (c) of this section shall apply to the use of an auto-alarm which is provided for the purpose of compliance with Part II of Title III of the Communications Act or the radio provisions of the Safety Convention on a ship compulsorily fitted with a radiotelegraph installation under that act or under the radio provisions of that convention.

(b) While the ship is being navigated outside a harbor or port, the auto-alarm shall be tested at least once every 24 hours by means of the testing device supplied as part of the alarm, the timing of the dashes to be made by reference to the second hand of the ship station clock. A test also shall be made to determine that the auto-alarm mechanism is operated in a normal manner by signals from other stations which are received on the frequency 500 kc. A statement that the foregoing requirement has been fulfilled must be inserted in the radio station log daily.

(c) The qualified operator, when going off watch, shall report to the officer on watch on the bridge whether or not the auto-alarm has been placed in use and adjusted for effective operation as prescribed in § 8.205 (a).

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SEC. 8.223. *Watch on 2182 kc.* (a) Each ship station on board a ship navigating the Great Lakes and licensed to transmit by telephony on one or more frequencies within the band 1600 to 3500 kc shall, during its hours of service for telephony, maintain an efficient watch for the reception of class A3 emission on the radio-channel of which 2182 kc is the assigned frequency, whenever the station is not being used for transmission on that channel or for communication on other radio-channels.

(b) Except for stations on board vessels required by law to be fitted with radiotelegraph equipment, each ship station, (in addition to those ship stations specified in paragraph (a) of this section) licensed to transmit by telephony on one or more frequencies within the band 1600 to 3500 kc shall, during its hours of service for telephony, maintain an efficient watch for the reception of class A3 emission on the radio-channel of which 2182 kc is the assigned frequency, whenever such station is not being used for transmission on that channel or for communication on other radio-channels. When the ship station is in Region 1 or 3, such watch shall, insofar as is possible, be maintained at least twice each hour for three minutes commencing at x h 00 and x h 30, Greenwich mean time (G. M. T.).

* * * * *
 SEC. 8.330 *Station records.* (a) (1) Each ship station authorized to use telegraphy on frequencies within the band 90 to 535 kc shall maintain an accurate radiotelegraph log. The first page of each portion of the log covering each voyage shall consist of a "title page" which, upon completion of all entries for the particular voyage, shall contain the following information:

- (i) Name of ship and call letters of ship station;
- (ii) Period of time covered by such portion of the log;
- (iii) Number of pages constituting such portion of the log;
- (iv) A statement as to whether or not such portion of the log contains distress entries; if so, the pages containing such entries shall be designated;
- (v) Operator's signature, mailing address, and radio operator license data (number, class, and date of issuance).

In addition the log shall be maintained as follows:

(2) (i) Each sheet of the log shall be numbered in sequence, for each voyage, and shall include the name of the vessel, official call letters of the ship station and the name of the operator on watch.

(ii) The entry "on watch" shall be made by the operator beginning a watch, followed by his signature. The entry "off watch" shall be made by the operator being relieved or terminating a watch, followed by his signature. All log entries shall be currently completed at the end of each watch by the operator responsible for the entries. The use of initials or signs is not authorized in lieu of the operator's signature.

(3) During the period a watch is maintained by an operator, all calls transmitted to or from the ship station and all replies transmitted or received shall be entered, stating the time and frequencies, and the call letters of the station communicated with or heard. (If desired, the names of the stations or ships also may be entered.) In addition, a notation of any messages exchanged shall be entered stating the time, the frequency in kilocycles, and the call letters of the station(s) heard, or communicated with. (If desired, the names of the stations or ships also may be entered.) In so far as possible, a positive entry with respect to reception on 500 kc shall be made at least once in each 15 minutes. The entries required by subparagraph (5) of this paragraph shall be acceptable as positive entries; *Provided*, Operating conditions are such as to prevent additional entries being made.

(4) The date and time of each occurrence or incident required to be entered in the log shall be shown opposite the entry and the time shall be expressed in Greenwich mean time (GMT),¹ except that in the Great Lakes region the

¹For example, 8:01 p. m. eastern standard time should be entered as 0101 GMT; 8:30 a. m. eastern standard time should be entered as 1330 GMT; 7:45 p. m. eastern standard time should be entered at 0045 GMT.

time shall be expressed in eastern standard time (e. s. t.) (counted from 00:00 to 24:00 o'clock, beginning at midnight). The first entry in each hour shall consist of four figures; additional entries in the same hour may be expressed in two figures by omitting the hour designation. The abbreviation "GMT" (e. s. t. in the Great Lakes region) shall be marked at the head of the column in which the time is entered.

(5) During the period a watch is maintained by an operator, an entry shall be made twice per hour stating whether or not the international silent period was observed. In addition, entries shall be made indicating any signals or communications heard on 500 kilocycles during this period. If no signals are heard on 500 kc, an entry to that effect shall be made. The use of rubber stamps for making entries to show observation of the silent period is not authorized.

(6) All distress calls, automatic-alarm signals, urgent and safety signals made or intercepted, the complete text, if possible, of distress messages and distress communications, and any incidents or occurrences which may appear to be of importance to safety of life or property at sea, shall be entered, together with the time of such observation or occurrence, and the position of the ship or other mobile unit in need of assistance, if it can be determined.

(7) Whenever harmful interference is experienced, an entry shall be made to that effect, stating the source of the interference, if known.

(8) The approximate geographical location of the ship, preferably the noon position, shall be entered each day of each voyage, either in terms of latitude and longitude, or as the distance in nautical miles and the direction from a known fixed point. For this purpose, the master of the ship shall furnish this information to the radio operator. The position report so furnished shall correspond to any entry of the same position made in other official records of the ship.

(9) An entry shall be made of the date and time of departure and arrival of the vessel at each port, including in each entry the name of the port.

(10) A daily entry shall be made regarding comparison of the radio station clock with standard time, including an indication of any errors observed and corrections made. For this purpose, authentic radio time signals received from land or fixed stations shall be acceptable as standard time.

(11) All test transmissions shall be entered, together with the time of such transmissions and the approximate geographical location of the vessel without regard to whether two-way communication with any other station is established.

(12) Any failure of equipment to operate as required, any failure of power supply, any inability to obtain sufficient power to charge storage batteries or to properly operate the radio installation and any incidents tending to unduly delay communications shall be entered.

(b) In addition to the radio log requirements stipulated in paragraph (a) of this section, the radio log of each ship station authorized to use telegraphy on frequencies within the band 90 to 535 kc, shall, when the ship is required by law and regulations to keep a radiotelegraph watch on 500 kc for safety purposes by means of a qualified operator, comply also with the following provisions:

(1) Entries shall be made of the results of tests of the emergency installation including transmitter antenna current, hydrometer readings of lead-acid storage batteries, voltage readings of other types of batteries, and quantity of fuel available for engine generators.

(2) An entry shall be made each time the emergency power supply is used (when the vessel is in the open sea) to carry on communication (other than a watch for safety purposes), stating the approximate period of time of such use.

(3) Results of inspections and tests of lifeboat radio equipment, when installed in compliance with requirements of law, prior to departure of the vessel from a harbor or port and the results of weekly inspections of such lifeboat equipment shall be entered.

(4) On a cargo vessel equipped with an auto-alarm, the entry "auto-alarm on", "sensitivity set at (The actual setting of the sensitivity control at the time the auto-alarm is placed in operation should be designated)", and the entry "auto-alarm off", respectively, shall be made whenever the operator places the auto-alarm in and out of operation. Results of the required auto-alarm tests shall be entered daily, including the sensitivity-control setting and the minimum number of 4-second dashes from the testing device which were necessary to properly operate the alarm.

(5) On a cargo vessel equipped with an auto-alarm, an entry shall be made in the radio station log whenever the visual indicator installed on the bridge (to indicate when the alarm becomes inoperative due to prolonged atmospheric or other interference), remains actuated for a continuous period of 5 minutes. A statement shall be included giving particulars as to the time the operator was called to make the necessary repairs or adjustments; any reason for the failure; the names of any parts removed, added, or substituted; repairs effected; and the time the alarm was restored to proper operating conditions.

(6) On a cargo vessel equipped with an auto-alarm, an entry shall be made in the radio station log whenever the auto-alarm becomes inoperative due to causes not indicated by the audible warning or the visual indicator, or whenever the audible warning is actuated. The entry shall include a statement showing the time the operator was called to make any necessary repairs or adjustments, the reason for the audible alarm being actuated or failing to be actuated, any parts removed, added, or substituted; repairs effected; and the time the auto-alarm was restored to proper operating condition.

(c) Each ship station authorized to use telegraphy, on frequencies above 550 kc exclusively (except ship stations on the Great Lakes and on board vessels navigated solely on inland waters of the United States), shall maintain an accurate radiotelegraph log as prescribed in paragraph (a) of this section: *Provided*, That paragraph (a) (3) and (5) of this section shall, in this case, not be applicable.

(d) Each ship station on the Great Lakes and on board a vessel navigated solely on inland waters of the United States which is authorized to use telegraphy, on frequencies above 550 kc exclusively, shall maintain an accurate radiotelegraph log as follows:

(1) Each sheet of the log shall be numbered in sequence and shall include the name of the vessel, official call letters of the ship station and the signature of the licensed operator in attendance at the time communication is effected.

(2) An entry shall be made for each complete exchange of communications with any station, stating the approximate geographical location of the vessel, the call letters or the name of the station communicated with, the time of the communication, the nature of the messages or signals exchanged, and designation of the transmitting frequencies.

(3) All test transmissions shall be entered, including designation of the

transmitting frequency, together with the time of commencement and completion of such transmissions and the approximate geographical location of the vessel, without regard to whether two-way communication with any other station is established.

(4) All distress calls, urgent and safety signals made or intercepted; the complete text, if possible, of distress messages and distress communication; and any incidents or occurrences which may appear to be of importance to safety of life or property shall be entered, together with the time of such observation of concurrence, designation of the frequency on which such transmissions were received, and the position of the ship or other mobile unit in need of assistance, if it can be determined.

(5) Any failure of equipment to operate as required, any failure of power supply, any inability to obtain power to charge storage batteries or to properly operate the radio installation and any incidents tending to unduly delay communication shall be entered.

(6) The date and time of making an entry shall be shown opposite the entry and the time shall be expressed as follows:

(i) For vessels navigated on the Great Lakes:

Eastern standard time (e. s. t.) (counted from 00:00 to 24:00 o'clock beginning at midnight).³ The first entry in each hour shall consist of four figures; additional entries in the same hour may be expressed in two figures by omitting the hour designation. The abbreviation "e. s. t." shall be marked at the head of the column in which the time is entered.

(ii) For vessels navigated on inland waters of the United States, other than the Great Lakes:

Local standard time (e. s. t., c. s. t., etc.) (counted from 00:00 to 24:00 o'clock, beginning at midnight).³ The first entry in each hour shall consist of four figures; additional entries in the same hour may be expressed in two figures by omitting the hour designation. The abbreviation "e. s. t." or "c. s. t.", etc., shall be marked at the head of the column in which the time is entered. However, this provision shall not prohibit the use of time entries expressed in GMT (and so indicated) in lieu of local standard time.

(e) In all ship stations authorized to transmit on frequencies within the band 405 to 535 kc, a written record shall be maintained of the adjustments of the transmitting and receiving equipment for operation on the assigned frequencies 410 kc or 500 kc and at least one authorized working frequency within this band. This record shall be posted at all times in a conspicuous place on or near the particular equipment involved.

(f) The ship radiotelegraph log currently in use shall be kept by the licensed operator(s) of the station and while in use it shall be located in the main radiotelegraph operating room of the ship. At the conclusion of each voyage terminating at a port of the United States, the original station log or a duplicate thereof dating from the last departure of the ship from a United States port shall be retained under proper custody on board the ship for a sufficient period of time but not necessarily in excess of 24 hours, to be available for inspection by a duly authorized representative(s) of the Commission. Thereafter the original log, and the duplicate log, if provided, may be filed at an established shore office of the ship station licensee, and shall be retained as stipulated by § 8.115.

* * * * *
³For example, 7:01 p. m. eastern standard time would be entered as 1901 e. s. t.; 7:30 a. m. eastern standard time would be entered as 0730 e. s. t.; 6:45 p. m. eastern standard time would be entered as 1845 e. s. t.

SEC. 8.352 *Frequencies for use in distress.* (a) The frequency 2182 kc is the international radiotelephone distress frequency for the maritime mobile service. Subject to the provisions of paragraph (b) of this section, it may be used for this purpose by ship or aircraft stations employing telephony in the band 1605 to 2850 kc when requesting assistance from the maritime services. It may be used, preferably with class A3 emission, for the distress call and distress traffic.

(b) Until such time as the frequency 2182 kc becomes guarded effectively for distress calls in United States areas other than the Great Lakes region, ship stations using telephony in event of distress only may call stations of the United States Coast Guard on the Government frequency 2670 kc. Transmission on the Government frequency 2670 kc for any purpose other than distress is strictly forbidden. In the Great Lakes region, the distress frequency 2182 kc is to be used at all times for radiotelephone distress calls and traffic.

NOTE: In the Great Lakes region, the frequency 2182 kc has been in use as the general radio-telephone calling frequency for several years, and its use in time of distress in that area has proven effective.

SEC. 8.353 *Frequencies for calling.*

(a) The international general radiotelephone calling frequency for the maritime mobile service is 2182 kc. It may be used as a carrier frequency for this purpose by ship stations and aircraft stations operating in the maritime mobile service:

(1) In addition this frequency may be used for transmission of:

(i) The international urgency signal, and very urgent messages (preceded by this signal) concerning the safety of a ship, aircraft, or other vehicle, or the safety of some person on board or within sight of such ship, aircraft, or vehicle.

(ii) The international safety signal, and messages (preceded by this signal) concerning the safety of navigation or giving important meteorological warnings.

(iii) Brief radio operating signals.

(iv) Brief test signals in accordance with the provisions of § 8.365, as may be necessary to determine whether the radio transmitting equipment of the station is in good working condition on this frequency.

(2) When using this frequency for purposes other than distress calls and distress traffic, and urgency and safety signals and messages, the mean antenna power of the unmodulated carrier wave shall not exceed 100 watts.

NOTE: As prescribed in paragraph 2, Article 3, of the Inter-American Radio Agreement, Washington, 1949, Article 1, paragraph 63 of the International Radio Regulations, Atlantic City, 1947, states as follows: "Mean power of a radio transmitter: The power supplied to the antenna during normal operation, averaged over a time sufficiently long compared to the period corresponding to the lowest frequency encountered in actual modulation." (In general, a time of one-tenth second, during which the mean power is a maximum, will be selected.)

(b) The frequency 156.8 Mc is the international radiotelephone frequency for calling, safety, intership, and harbor control purposes, for the maritime mobile service using frequencies within the band 156.25 Mc to 162.05 Mc. Use of this frequency by ship stations of the United States, however, is subject to the provisions of § 8.359 (c).

(c) In addition to the radio-channels of which the carrier frequencies are specifically authorized in this section for "calling", the radio-channels authorized in this subpart for "working" may be used for call and reply also:

Provided, Interference is not caused to any communication in progress on the particular working channel.

* * * * *

SEC. 8.364 Identification of station. (a) All radiotelephone emission of a ship station or a marine-utility station on board a ship shall be clearly identified by transmission therefrom in the English language of the official call sign assigned to that station by the Commission; provided that, in lieu of identification of the station by voice, the official call sign may be clearly transmitted by tone-modulated telegraphy in the International Morse Code either by a duly licensed radiotelegraph operator or by means of an automatic device approved for this purpose by the Commission. This identification shall be made:

(1) At the beginning and upon completion of each communication with any other station;

(2) At the beginning and upon conclusion of each transmission made for any other purpose; and

(3) At intervals not exceeding 15 minutes whenever transmission is sustained for a period exceeding 15 minutes.

(b) When an official call sign is not assigned by the Commission to a ship station using telephony, the complete name of the ship on which the station is located and the name of the licensee shall be transmitted by voice in the English language for the purpose of station identification.

(c) The provisions of paragraphs (a) and (b) of this section shall apply also to ship stations of portable nature when using telephony and operated on board ship pursuant to §§ 8.40 and 8.71.

* * * * *

SEC. 8.366 General radiotelephone operating procedure—(a) Limitations on calling. (1) Except when transmitting a general call to all stations within range for announcing or preceding the transmission of distress, urgency, or safety messages, a ship station shall call the particular station(s) with which it intends to communicate.

(2) Calling a particular station, either by voice or by automatic means, shall not continue for a period of more than thirty seconds in each instance. If the called station is not heard to reply, that station shall not again be called until after an interval of one minute. In the event of an emergency involving safety, the provisions of this subparagraph shall not apply.

(3) The use of selective-calling on the radio-channel of which either 2182 kc or 156.8 Mc is the authorized carrier frequency is prohibited.

(b) *Use of calling frequency required.* (1) Except when other operating procedure is used to expedite safety communication or is established in advance by and between the stations concerned, ship stations in the Great Lakes area, before transmitting on the intership radio-channel of which 2003 kc is the authorized carrier frequency, shall first establish communication with each other by initially calling and answering on the calling channel of which 2182 kc is the authorized carrier frequency.

(2) Except when other operating procedure is used to expedite safety communication or is established in advance by and between the stations concerned, ship stations, before transmitting on the intership radio-channel of which 2638, 2738, or 2830 kc is the authorized carrier frequency, shall first establish communication with each other by initially calling and answering on the calling channel of which 2182 kc is the authorized carrier frequency.

(3) Except when other operating procedure is used to expedite safety communication or is established in advance by and between the stations concerned, the radio-channel of which 156.8 Mc is the authorized carrier frequency shall be used for call and reply by ship stations and marine-utility stations on board ship before establishing ship-to-ship communication on the radio-channel of which the authorized carrier frequency is, in all areas, 156.3 Mc; in the Great Lakes area 156.7 Mc or 157.0 Mc; and on the Mississippi River and tributaries and the Gulf of Mexico Intracoastal Waterway 157.0 Mc: *Provided*, That this requirement shall not apply to marine-utility stations or other stations of portable nature which are not capable of a plate input power in excess of three watts and are not capable of being readily adjusted for operation on more than one radio-channel.

(c) *Calling coast stations.* (1) Use of the carrier frequency 2182 kc by ship stations for calling coast stations, and for replying to calls from such stations is authorized; however, such calls and replies shall, in general, be made on a ship-shore radio-channel authorized primarily for working.

(2) Use of the carrier frequency 156.8 Mc by ship stations and marine-utility stations on board ship for calling coast stations and marine-utility stations on shore, and for replying to calls from such stations is authorized; however, such calls and replies shall, in general, be made on a ship-shore radio-channel authorized primarily for working.

(d) *Time limitation on calling frequencies and adjacent working frequencies.* (1) Transmission by ship stations on the calling channel of which 2182 kc or 156.8 Mc is the authorized carrier frequency (including calls, answers, operating signals, and conversation pertaining to safety) shall be kept to a minimum and in general any one exchange of communications shall not exceed 3 minutes in duration. In the event of distress or other emergency, this time limitation shall not apply.

(2) Transmission by ship stations, when in Region I, is prohibited on any frequency (including 2182 kc) in the band 2167–2197 kc during the two three-minute periods in each hour which commence at xh00 and xh30, Greenwich mean time (G. m. t.); *Provided*, That this requirement is not applicable to the transmission of distress signals, distress traffic, urgency and safety signals, and messages preceded by the urgency or safety signal.

(e) *Change to working frequency.* After establishing communication with another station by call and reply on the calling channel of which 2182 kc or 156.8 Mc is the authorized carrier frequency, stations on board ship shall change to an authorized working channel for the transmission of messages which, under the provisions of this subpart, cannot be transmitted on the respective calling channels.

(f) *Shared use of 2003, 2638 and 2738 kc.* (1) In regions of heavy radio traffic, any one exchange of communications between any two mobile stations on the radio-channel of which 2003, 2638, 2738, or 2830 kc is the authorized carrier frequency, or between a ship station and a limited coast station on the 2638, 2738, or 2830 kc channel, shall not exceed 5 minutes in duration after the two stations have established contact by calling and answering. Subsequent to such exchange of communications, the 2003, 2638, 2738, or 2830 kc channel shall not be used again for communication between the same two stations until 5 minutes have elapsed: *Provided*, That this requirement shall in no way limit or delay the transmission of distress or emergency communications.

(2) All transmission on the radio-channels of which 2003, 2638, 2738 and

2830 kc are the authorized carrier frequencies by two or more stations, engaged in any one exchange of signals or communications with each other, shall take place on only one of these channels. For this purpose, the stations involved shall transmit and receive on the same channel: *Provided*, That this requirement is waived in the event of emergency when by reason of interference or limitation of equipment this method of single-channel communication cannot be used.

(g) *Authorized use of 2003, 2638, 2738 and 2830 kc.* The radio channel of which 2003, 2638, 2738, and 2830 kc are the authorized carrier frequencies, shall be used by mobile stations particularly in accordance with the provisions of §§ 8.176, 8.177 (b), and 8.358. Communications which appear to be for a solely personal or social purpose, not relating in any way to safety or to a maritime purpose, may be construed by the Commission, with respect to the authorized use of these radio channels, to be superfluous communication as defined in § 8.6 (b) and as prohibited under the provisions of § 8.178.

(2) Ship stations licensed to transmit on the radio-channel of which 2638 kc is the authorized carrier frequency, shall, when on inland waters of the United States, restrict the use of this channel to a necessary minimum.

(h) *Limitation on business and operational traffic.* All ship-to-ship communication and communication with limited coast stations and marine-utility stations on shore engaged in by ship stations and marine-utility stations on board ship shall be limited, on radio-channels above 30 Mc, to the minimum practicable transmission time. In the conduct of ship shore communication (other than distress), stations on board ship shall comply with instructions given by the limited coast station or marine-utility station on shore, with which they are communicating in all matters relative to operating practices and procedures and to the suspension of transmission in order to minimize interference.

* * * * *

SEC. 8.368 *Station records.* (a) Ship stations using telephony shall maintain an accurate radio telephone log during their hours of service, as hereinafter specified:

(1) Each sheet of the log shall be numbered in sequence and shall include the name of the vessel, official call sign of the ship station, and the signature of the licensed operator (or other person in accordance with § 8.155) who is responsible for operation of the radiotelephone transmitting apparatus. The use of initials or signs in lieu of the operator's signature is not authorized.

(2) Except as provided otherwise in subparagraph (3) of this paragraph, the date and time of making each entry shall be shown opposite the entry and the time shall be expressed in Greenwich mean time (G. m. t.) as follows: The first entry in each hour shall consist of four figures; additional entries in the same hour may be expressed in two figures by omitting the hour designation. The abbreviation "G. m. t." shall be marked at the head of the column in which the time is entered.

(3) As an alternative to the use of Greenwich mean time in making entries as specified in subparagraph (2) of this paragraph, ship stations on board vessels not engaged on international voyages or while navigated on the Great Lakes or inland waters of the United States, may express the time of each entry in local standard time (e. s. t., c. s. t., etc., counted from 0000 to 2400 o'clock, beginning at midnight), with the appropriate abbreviation "e. s. t." "c. s. t.," etc., entered at the head of the column in which time is entered: *Provided*, That in the Great Lakes area, eastern standard time (e. s. t.) ex-

clusively may be used as the only alternative to Greenwich mean time. The first entry in each hour shall consist of four figures; additional entries in the same hour may be expressed in two figures by omitting the hour designation.

NOTE: For example, 7.01 p. m. eastern standard time would be entered as 1901 e. s. t.: 7:80 a. m. eastern standard time would be entered as 0730 e. s. t.: 7:45 p. m. eastern standard time would be entered as 1945 e. s. t.

(4) Except when transmission occurs on a frequency above 30 Mc and the ship station is on inland waters of the United States other than in the Great Lakes area, all radiotelephone distress, urgency or safety signals and communications made or intercepted; a summary, if possible of such communications; and any information which may appear to be of importance to maritime safety shall be entered, together with the time of such observation or occurrence, identification of the radio-channel(s) on which such signals or messages were transmitted or received, and the position of any ship, or other mobile unit in need of assistance, if this can be determined. In addition, the ship's own position and the distance from the distressed ship or other mobile unit, if obtainable, shall be entered. These entries shall be made by a licensed operator or by a member of the crew who is designated and authorized by the master to do so; the signature of the person(s) making the entries shall appear in the log and shall be properly related to each particular entry for this purpose.

(5) With respect to ship stations which, by reason of the provisions of § 8.223, are required to maintain a watch on the radio-channel designated for radiotelephone calling and distress (assigned frequency 2182 kc), entries shall be made showing each time this watch is begun, suspended, or concluded; without any requirement, however, of making entries solely to show interruption of this watch due to authorized communication with other stations. The required entries shall be made by a licensed operator or by a member of the crew who is designated and authorized by the master to do so; the signature of each person making these entries and each person who actually maintains such watch shall appear in the log and shall be properly related to each particular entry for this purpose.

(6) A summary of communications exchanged between the ship station and mobile stations or land stations (except public coast stations in the United States) shall be entered when:

(i) Communication with a foreign station occurs; or

(ii) Transmission occurs on a radio-channel below 30 Mc; or

(iii) Transmission occurs on a frequency above 30 Mc and the ship station is within the territorial waters of a foreign country (except in the Great Lakes area) or is at sea within less than 150 nautical miles of a foreign country; or

(iv) The entries prescribed in this subparagraph shall be made by a licensed operator or by a member of the crew who is designated and authorized by the master to do so; the signature of the person(s) making the entries shall appear in the log and shall be properly related to each particular entry for this purpose.

(7) An entry shall be made giving pertinent details of all installations, service, or maintenance work performed which may affect the proper operation of the station. The entry shall be made, signed and dated by the responsible licensed operator who supervised or performed the work, and unless such operator is regularly employed on a full-time basis at the station and his

operator license is properly posted, such entry shall include his mail address and the class, serial number, and expiration date of his operator license.

(b) Marine-utility stations on board ship shall maintain an accurate radiotelephone log during their hours of service as follows:

(1) Each sheet of the log shall be numbered in sequence, shall include the general geographic area of navigation of the vessel upon which the station is operated, the name of the vessel, official call sign of the marine-utility station and the signature of the licensed operator (or other person in accordance with § 8.155) who is responsible for operation of the marine-utility station (the use of initials or signs in lieu of signatures is not authorized).

(2) Appropriate entries shall be made in the log giving pertinent details of all installations service, or maintenance work performed which may affect the proper operation of the station. The entry shall be made, signed and dated by the responsible licensed operator who supervised or performed the work, and unless such operator is regularly employed on a full time basis at the station and his operator license is properly posted, shall also include his mail address and the class, serial number, and expiration date of his license.

(c) With respect to ship stations of the United States subject to the Great Lakes Agreement, entries required by paragraph (a) of this section shall be made by an officer or crew member on board who has been certified as required by Article 7 of the Agreement, or by a person on duty listening as required by Article 7 of the Agreement, or by a licensed or certificated deck officer. The log shall include the name (and title if held) of the person making an entry properly related to each entry. Entries shall be made as soon as practicable after the observed occurrence, and the time thereof shall be specified in eastern standard time. The station log required by paragraph (a) shall include the following additional entries:

(1) The official number of the vessel;

(2) The name and radio certificate number of each officer and crew member assigned to the vessel who has been certified as required by Article 7 of the Great Lakes Agreement and designated by the Master to operate the radiotelephone installation;

(3) A record of charging of any storage batteries which are necessary for the proper operation of the required radiotelephone installation;

(4) A daily record of the results of the determination of the operating condition of the radiotelephone installation required by § 8.541.

* * * * *

SEC. 8.404 *Assignable frequencies above 2400 Mc.* (a) The following frequency-bands are authorized for use by ship-radiolocation stations (including ship-radar stations) in the maritime radionavigation service (the associated transmitting frequencies of U. S. Government radar beacons (racons) are, respectively, as follows: 3256, 5450, and 9310 megacycles); the maximum power shall be designated in each instrument of authorization: *Provided*, That for stations other than ship-radar stations, the class of emission, the frequency tolerance, and the bandwidth occupied by the emission shall be designated in each instrument of authorization.

3000 Mc to 3246 Mc

5460 Mc to 5650 Mc

9320 Mc to 9500 Mc

(b) The following frequency-bands are authorized for use by ship-radiolocation stations in the maritime radiolocation service; the class of emission, the

frequency tolerance, the bandwidth occupied by the emission, and the maximum power shall be designated in each instrument of authorization:

(1) 2450 to 2500 Mc for purposes other than radionavigation or safety, on the condition that harmful interference shall not be caused to the fixed and mobile services, on the condition that no protection shall be given from interference caused by emission from industrial, scientific, or medical equipment.

- (2) 3000 Mc to 3246 Mc
5460 Mc to 5650 Mc
9320 Mc to 9500 Mc

The use of frequencies within these bands for radiolocation, other than radionavigation, shall not cause harmful interference to the radionavigation service.

§ 8.405 *Special provisions applicable to ship-radar stations.* (a) Every ship-radar station licensed, prior to the effective date of this section, in the former "ship service" shall, subsequent to the effective date of this section, be regarded as licensed in the maritime radionavigation service and the use and operation of such stations shall be governed accordingly.

(b) Each ship-radar station installation the manufacture of which was completed on or after 1947 shall be furnished with a durable name plate with the manufacturer's name, transmitter model number; and month and year of completion of manufacture permanently inscribed thereon. Such name plate shall be affixed to the indicator housing at the principal radar operating position or to some other component of the radar installation which is readily accessible for inspection.

(c) Each ship-radar station license issued shall be subject to the condition that the station licensee, in relation to the proper operation of the station in accordance with the radio law, and rules and regulations of the Commission, will be represented on board the radar-equipped vessel by the person who at any given time occupies the position of master.

(d) The following provisions shall apply to ship-radar stations:

(1) The station licensee of each ship-radar station shall provide and require to be kept at the station a permanent installation and maintenance record. Entries in this record shall be made by or under the personal direction of the responsible installation, service, or maintenance operator concerned in each particular instance, but the station licensee shall have joint responsibility with the responsible operator concerned for the faithful and accurate making of such entries as are required by this paragraph.

(2) Each entry in this record shall be personally signed by the responsible operator concerned.

(3) The following entries shall be made in this record:

(i) The date and place of initial installation.
(ii) Any necessary steps taken to remedy any interference found to exist at the time of such installation.

(iii) The nature of any complaint (including interference to radio communication) arising subsequent to initial installation, and the date thereof.

(iv) The reason for the trouble leading to the complaint, including the name of any component or component part which failed or was misadjusted.

(v) Remedial measures taken, and date thereof.

(vi) The name, license number, and date of the ship-radar operator endorsement on the first or second class radio operator license of the responsible operator performing or immediately supervising the installation, servicing, or maintenance.

(e) Until the Commission shall otherwise provide, the ship-radar station licensee, by such arrangement as may be necessary with the ship master, operating agency, or ship owner, shall, upon specific request made by the Commission, be responsible for the submission of such reports as are requested by the Commission to show the value and practical performance of the ship-radar station. For assistance in preparing these reports, daily records, when the radar installation is tested or used, should, when practicable, be kept showing at least the following:

- (1) Approximate number of hours of use while the ship is in operation;
- (2) Number of service failures, and duration, nature, and cause of each failure if known;
- (3) Performance under local weather conditions which are unfavorable for marine navigation; and
- (4) Unusual incidents, including, among others, cases in which radar may have aided or hindered safe operation of the ship.

(f) In addition to the installation and maintenance record required by paragraphs (d) and (e) of this section, the following documents shall be available for reference on board each radar-equipped vessel whose ship-radar station is licensed by the Commission:

- (1) Part 8 of this chapter.
- (2) At least one set of instructions from the respective manufacturer relative to the use and operation of the particular type of ship-radar installation.
- (g) No provisions of this part shall require any ship-radar station to transmit any signal(s) intended solely for the purpose of identifying that station.

* * * * *

SEC. 8.503 *Requirements of main installation.* (a) All main installations on board vessels subject to Title III, Part II of the Communications Act shall comply with the following conditions, in addition to all other requirements:

(1) The main antenna shall be as efficient as is practicable under the prevailing physical limitations and shall be adequately installed and protected so as to insure proper operation, and so as not to endanger the ship and the required radio installation. For the purpose of insuring adequate protection against failure of the main antenna installation when severe mechanical stress is suddenly applied, an approved "safety link" shall be provided as a component of this installation.

NOTE: A safety link may be described as a device which, under heavy stress, will operate to greatly reduce such stress without breakage of the antenna, the halyards, or any other antenna-supporting elements.

(2) The main transmitter shall be of the electron-tube type and shall be capable of meeting the requirements of § 8.552.

NOTE: Upon proper application and satisfactory demonstration being made, the Commission for the purpose of this regulation will consider approval of transmitters other than those of the electron-tube type, except transmitters employing class B emission.

(3) The main receiver shall be capable of efficiently receiving radiotelegraph signals, classes A1 and A2 emission, on all frequencies within the bands 100 to 200 kilocycles and 350 to 515 kilocycles, and in addition class B emission within the band 485 to 515 kilocycles. In addition, it shall be fitted with a head receiver capable of effective operation at every audio frequency from 200 to 3000 cycles per second, inclusive. Where a loudspeaker is additionally provided for use in accordance with the provisions of § 8.204, such device also shall be capable of effective operation at every audio frequency from 200 to 3000 cycles per second, inclusive.

(4) There shall be readily available for use at all times under normal load conditions, when the vessel is leaving or attempting to leave a harbor or port for a voyage in the open sea, while being navigated in the open sea outside a harbor port, and when required during inspection of the ship radio station by an authorized representative of the Commission, a main power supply for the main radio installation capable of supplying electrical power sufficient to energize simultaneously and efficiently the main transmitter at its required antenna power (the antenna power specified in § 8.552) and the main receiver; and at the same time to charge, at the required rate(s), all storage batteries used as the emergency power supply, and any other storage batteries which are charged by connection to this radio room main power supply. Under this load condition and at all times herein specified, the potential(s) of the main power supply at the radio room terminals shall not deviate from its rated electrical potential(s) by more than 10 percent on vessels completed on or after July 1, 1941, nor by more than 15 percent on vessels completed before that date.

(5) For the purpose of determining the potential(s) of the main power supply of the main transmitter at its radio room terminals, a suitable voltmeter or voltmeters of approved accuracy shall be permanently installed in the main radio operating room.

SEC. 8.504 *Requirements of emergency or reserve installation.* (a) All emergency or reserve installations on board vessels subject to Title III, Part II of the Communications Act shall comply with the following conditions, in addition to all other requirements:

(1) The emergency installation shall be capable of being placed in operation (by a qualified operator who is on duty at the operating location) within a maximum time of 1 minute after the need arises for its use.

(2) The emergency antenna shall be as efficient as is practicable under the prevailing physical limitations and shall be adequately installed and protected so as to insure proper operation in time of an emergency, and so as not to endanger the ship and the required radio installation.

(3) The emergency transmitter shall be of the electron-tube type and shall be capable of meeting the requirements of § 8.553.

(4) The emergency receiver shall be capable of efficiently receiving radiotelegraph signals, classes A1 and A2 emission, on all frequencies within the band 350 to 515 kilocycles, and class B emission on all frequencies within the band 485 to 515 kilocycles. In addition, it shall be fitted with a head receiver capable of effective operation at every audio frequency from 200 to 3000 cycles per second, inclusive. Where a loudspeaker is additionally provided for use in accordance with the provisions of § 8.204, such device also shall be capable of effective operation at every audio frequency from 200 to 3000 cycles per second, inclusive.

(5) There shall be readily available for use at all times under normal load conditions, when the vessel is leaving or attempting to leave a harbor or port for a voyage in the open sea, while being navigated in the open sea outside a harbor or port, and when required during inspection of the ship radio station by an authorized representative of the Commission, an emergency power supply for the emergency installation (independent of the propelling power of the ship, and any other electrical system; and independent of the main power supply where a separate main and emergency or reserve installation is provided for the purpose of compliance with paragraph (a) of section 354 of the Communications Act) capable of supplying electrical power sufficient to energize simultaneously and efficiently the emergency transmitter at its required

antenna power (the antenna power specified in § 8.553) and the emergency receiver. Such emergency power supply shall be maintained in readiness to operate effectively and shall have a reserve capacity of at least 6 continuous hours at all times while the vessel is navigated outside a harbor or port and whenever the vessel leaves or attempts to leave a harbor or port of the United States for a voyage in the open sea.

(6) There shall be provided emergency electric lights of not less than 10 watts per unit, capable of being energized solely by the radio installation emergency power supply and connected thereto through individual fuses. These electric lights shall be capable of operation independent of any other electrical system and shall be arranged so as to provide satisfactory illumination of the main and emergency radio operating controls and radio station clock. The emergency lighting electrical circuits shall be arranged so as to avoid the application of excessive voltage to the emergency lights during the charging of any emergency batteries. The provisions of this subparagraph or of § 8.8 (j) shall not preclude the use of any other power supply for energizing these lights solely as an additional provision.

(7) All emergency power supply circuits shall be appropriately fused to afford adequate protection from serious overloads or short-circuits.

(8) No electrical load circuits except those of the emergency installation (includes the required radio station emergency light(s)) shall be connected to the emergency power supply: *Provided*, That an approved automatic-alarm-signal keying device, or the audible warning apparatus associated with an approved auto-alarm receiver, or both, may be connected to that part of the emergency power supply furnishing power to the emergency transmitter: *Provided further*, That the reserve capacity of the emergency power supply shall include the additional capacity required to energize, in a normal manner and to a normal extent, any keying device or audible warning apparatus that may be connected as herein authorized, including sufficient capacity to energize any keying device continuously for a period of one hour.

(9) The emergency power supply shall be located as near to the emergency transmitter and receiver as is practicable; *Provided*, That the location of such power supply complies with all applicable rules and regulations of the United States Coast Guard.

(10) The cooling system of all internal-combustion engines used as part of the emergency power supply shall be adequately protected or treated to prevent freezing or overheating consistent with the season and route to be traveled by the particular vessel involved.

(b) (1) The shipowner, operating company, or station licensee, if directed by the Commission or its authorized representative, shall prove by demonstration prescribed in subparagraphs (2), (3), (4) and (5) of this paragraph or by such other means as may be deemed necessary, that the emergency installation satisfies the 6-hour operating requirement of law.

(2) When the emergency power supply, on board a vessel required by law to be equipped with a radio installation, consists of or includes a storage battery, proof of the ability of such battery power supply to operate continuously and effectively over a prescribed period of time is authorized to be established by a discharge test over such prescribed period of time, when supplying power at the voltage required for normal and effective operation, to an electrical load as prescribed by subparagraph (4) of this paragraph.

(3) When the emergency power supply, on board a vessel required by law to be equipped with a radio installation, consists of or includes an engine-driven generator, proof of the adequacy of the engine fuel supply to operate

the unit continuously and effectively over a prescribed period of time may be established by using as a basis the fuel consumption during a continuous period of 1 hour when supplying power, at the voltage required for normal and effective operation, to an electrical load as prescribed by subparagraph (4) of this paragraph.

(4) The electrical load to be supplied by an emergency power supply for the purpose of establishing proof of required capacity shall be computed as the sum of all electrical loads presented by all other apparatus of the ship's radio installation which are connected to the emergency power supply under test. Allowances for intermittent use of such apparatus shall be made only in accordance with the following:

(i) The current supplied to the emergency transmitters may be computed as the current supplied when the transmitter is partially energized with the radiotelegraph key open plus one-fourth the difference between the current supplied when such key is open and the current supplied when such key is closed.

(ii) The current drawn by the automatic-alarm-signal keying device specified in paragraph (a) (8) of this section (if such device is connected to the emergency power supply) may be computed as one-sixth of the current supplied when this device is properly energized.

(iii) The current drawn by an audible warning apparatus associated with an approved auto-alarm receiver specified in paragraph (a) (8) of this section may be considered as negligible.

(5) At the conclusion of the tests specified in subparagraphs (2) and (3) of this paragraph, no part of the emergency source of power shall have an excessive temperature rise, nor shall the specific gravity or voltage of the storage battery be below the 90 percent discharge point as determined from information (such as voltage curves or specific gravity tables) supplied by the manufacturer for the type of battery involved.

SEC. 8.505 *Tests of emergency installation.* (a) On vessels required by law to be equipped with an emergency or reserve installation, the condition of this installation shall be determined by test and actual operation prior to the vessel's departure from each port (but not necessarily more than once each day) and on each day the vessel is outside a harbor or port. It is recognized that in some cases, tank vessels cannot meet this requirement when in port because of the hazardous nature of the cargo being handled. When storage batteries are used as an emergency power supply or are used for the purpose of starting an emergency engine-driven generator, tests shall be made of the charging circuits for polarity and correct charging rate. Hydrometer readings of the electrolyte of a pilot cell and such other cells as are necessary to determine the state of charge of an emergency lead-acid storage battery and voltage readings under normal load as are necessary to determine the state of charge of emergency storage batteries of other types shall be taken. When an engine-driven generator is used as an emergency power supply, a check shall be made of the quantity of fuel in the supply tank.

(b) When an automatic-alarm-signal keying device is installed in accordance with § 8.508, this device shall be operated to determine that it is in efficient operating condition prior to the vessel's departure from each port (but not necessarily more than once each day) and on each day the vessel is outside a harbor or port. To avoid the actual transmission of auto-alarm signals during such test operation, the radiotelegraph transmitter(s) to which this device is connected shall not be energized.

* * * * *

SEC. 8.511 *Installation of auto-alarm.* (a) A vessel shall be considered as fitted with an auto-alarm in accordance with the requirements of Title III, Part II of the Communications Act and the radio provisions of the Safety Convention when the auto-alarm is a type approved by the Commission as prescribed by § 8.510 and the auto-alarm installation on board such vessel complies with the conditions prescribed in the following paragraphs of this section.

(b) Each auto-alarm of a type approved by the Commission when first installed on board a vessel of the United States, shall bear an identifying serial number. Two or more principal components of one complete installation shall bear the same number. After the initial installation, if any principal component is entirely replaced, the substitute unit shall bear the serial number of the initial unit but must be identified in addition as a replacement. For this purpose the principal components of the following types of auto-alarms (approved prior to the effective date of § 8.554) are designated as follows:

(1) Radiomarine Corporation of America Models AR-8600 and AR-8600-X auto-alarms. One combined receiver and selector unit, without regard to container; one control and terminal box.

(2) Radiomarine Corporation of America Model AR-8601 auto-alarm. One combined receiver and selector unit, without regard to container; one control and terminal unit.

(3) Mackay Radio and Telegraph Company auto-alarms, Types 101-A and 101-B manufactured by Federal Telegraph Company. One selector unit without regard to container; one receiver unit, without regard to container.

(4) Mackay Radio and Telegraph Company auto-alarm, Type 5001-A. One combined receiver and selector unit, without regard to container.

(c) The auto-alarm shall be located in the main radiotelegraph operating room and shall be adequately installed and protected so as to insure proper operation. Means shall be provided for placing the entire system in or out of operation from the main radiotelegraph operating room. A simple change-over switch shall be provided to (1) disconnect the main antenna from all other equipment and connect it to the auto-alarm receiver and place the auto-alarm system in effective operating condition and conversely (2) de-energize the auto-alarm system and reconnect the main antenna to other equipment. In addition, suitable means of determining the supply voltages are within the limits required for proper operation of the autocalarm system shall be provided.

(d) Approved apparatus shall be provided for giving an audible warning in the main radiotelegraph operating room, in the radio operator's cabin, and on the navigating bridge. This apparatus shall operate continuously after the auto-alarm has been actuated by an alarm signal or by failure of the auto-alarm system, until manually stopped. Only one switch for stopping the audible warning apparatus from functioning is authorized and this shall be located in the main radiotelegraph operating room and shall be capable of manual operation only.

(e) Failure of the auto-alarm (if of a type approved prior to the effective date of § 8.554) to function normally because of prolonged atmospherics (static) or other prolonged interference, or both, shall operate a visual indicator on the bridge. The type and method of installation of such visual indicator shall comply with requirements of the United States Coast Guard.

(f) When an auto-alarm is dependent for effective operation upon a power supply having a voltage within definite upper and lower limits, such auto-alarm shall be fitted with an auxiliary device which (1) will energize the audible alarms if and when this power supply fails or its voltage exceeds the limits specified by the Commission for the particular type of alarm involved; or (2)

will automatically connect the auto-alarm to an auxiliary power supply, the voltage of which is within the specified limits.

(g) The testing device (see § 8.206 relative to required testing of the auto-alarm) of the auto-alarm shall be adjusted to produce a test signal of the correct value. This adjustment shall be considered satisfactory when it becomes necessary to turn the sensitivity control from its position of lowest sensitivity (zero dial position) to its position of approximately one-third maximum sensitivity before the alarm can be actuated.

* * * * *

SEC. 8.513 *Interior communication system.* Pursuant to paragraph (g) of section 354 of the Communications Act, an efficient interior communication system shall be provided between the bridge of a ship and the radio room, in all cases where the radio room does not adjoin or open onto the navigating bridge structure; further, an efficient interior communication system shall be provided between the bridge and the location of the direction-finding apparatus whenever the latter is not located on the bridge or within any compartment adjoining or opening onto the navigating bridge structure. When the operating position of the emergency radio installation is not located in the compartment normally used for operating the main radio installation, an efficient interior communication system shall be separately provided between the bridge and each of these radio operating positions.

* * * * *

SEC. 8.515 *Radio station clock.* The radio station clock required by § 8.114, when installed on board a vessel subject to Title III, Part II of the Communications Act, shall in addition to the requirements of § 8.114, have a sweep second hand and an hour dial not less than 5 inches in diameter, and shall be capable of operation for at least 8 days on one winding: *Provided*, That deviations from the requirements may be authorized by the Commission if such deviation does not adversely affect the reliability of the clock or the ability of the ship radio operator to transmit properly timed auto-alarm signals. A request for approval of any deviation from these requirements must be accompanied by a sample of the proposed clock face.

* * * * *

SEC. 8.602 *Reports of infringements of the International Radio Regulations.* In the event that infringement of the International Radio Regulations by a foreign station is detected, report thereof may be made by the submission to the Commission of a form similar to that set forth in appendix 2 of the International Radio Regulations.

PART 9—AVIATION SERVICES

SEC. 9.10 *Definition of terms.* For the purpose of this part the following definitions are applicable:

(a) *Aviation services.* Aviation services are primarily for the safe, expeditious and economical operation of aircraft. They include the aeronautical fixed service, aeronautical mobile service, aeronautical radionavigation service, and secondarily, the handling of public correspondence to and from aircraft.

(b) *Fixed service.* A service of radio communication between specified fixed points.

(c) *Aeronautical fixed service.* A fixed service intended for the transmission of information relating to air navigation preparation for and safety of flight.

(d) *Fixed station.* A station in the fixed service.

(1) *Operational fixed station.* A fixed station, not open to public correspondence, operated by and for the sole use of those agencies operating their own radiocommunication facilities in the Public Safety, Industrial, Land Transportation, Marine, or Aviation Service.

(e) *Aeronautical fixed station.* A station in the aeronautical fixed service.

(f) *Mobile service.* A service of radiocommunication between mobile and land stations, or between mobile stations.

(g) *Mobile station.* A station in a mobile service intended to be used while in motion or during halts at unspecified points.

(h) *Land station.* A station in the mobile service not intended for operation while in motion.

(i) *Aeronautical mobile service.* A mobile service between aircraft stations and aeronautical stations, or between aircraft stations.

(j) *Aircraft station.* A mobile station installed on board any type of aircraft and continuously subject to human control.

(1) *Aircarrier aircraft station.* An aircraft station aboard an aircraft engaged in, or essential to, transportation of passengers or cargo for hire. For the purpose of these rules with the exception of § 9.1002, an aircraft weighing less than 10,000 lbs. may be considered, at the option of the applicant, as a private aircraft even though actually engaged in air carrier operations. The election by the applicant will determine the application form to be used, the equipment and frequencies to be employed and the regulations applicable to the aircraft radio station.

(2) *Private aircraft station.* An aircraft station on board an aircraft not operated as an air carrier.

(3) *Flight test aircraft station.* An aircraft station aboard an aircraft used for the transmission of essential communications in connection with the tests of aircraft or major components of aircraft.

(4) *Flying school aircraft station.* An aircraft station aboard an aircraft used for communications pertaining to instructions to students or pilots while actually operating aircraft.

(k) *Aeronautical station.* A land station in the aeronautical mobile service, carrying on a service with aircraft stations. In certain instances an aeronautical station may be placed on board a ship.

(1) *Aeronautical enroute station.* An aeronautical station carrying on a service with aircraft stations, but which may also carry on a limited communication service with other aeronautical enroute stations.

(2) *Aeronautical advisory station.* An aeronautical station used for advisory and civil defense communications with private aircraft stations.

(3) *Airdrome control station.* An aeronautical station providing communication between an airdrome control tower and aircraft.

(4) *Flight test station.* An aeronautical station used for the transmission of essential communication in connection with the testing of aircraft or major components of aircraft.

(5) *Flying school station.* An aeronautical station used for radiocommunication pertaining to instructions to students or pilots while actually operating aircraft.

(6) *Aeronautical metropolitan station.* An aeronautical station used for communications with aircraft, including helicopters, operating between a main air terminal of a metropolitan area and subordinate landing areas.

(1) *Radionavigation service.* A radio location service involving the use of radionavigation.

(m) *Radionavigation*. Radiolocation intended solely for the determination of position or direction or for obstruction warning, in navigation.

(n) *Radiolocation service*. A service involving the use of radionavigation.

(o) *Radiolocation*. Determination of a position or of a direction by means of the constant velocity or rectilinear propagation properties of Hertzian waves.

(p) *Aeronautical radionavigation service*. A radionavigation service intended for the benefit of aircraft.

(q) *Radionavigation station*. A station in the radionavigation service.

(1) *Aeronautical marker beacon station*. A radionavigation land station in the aeronautical radionavigation service which provides a signal to designate a small area above the station.

(2) *Radiobeacon station*. A radionavigation station the emissions of which are intended to enable a mobile station to determine its bearing or its direction in relation to the radiobeacon station.

(3) *Altimeter station*. A radio navigation mobile station, in the aeronautical radionavigation service, the emissions of which are intended to determine the altitude of the aircraft, aboard which the altimeter station is located, above the earth's surface.

(4) *Localizer station*. A radionavigation land station in the aeronautical radionavigation service which provides signals for the lateral guidance of aircraft with respect to a runway center line.

(5) *Omni directional range station*. A radionavigation land station in the aeronautical radionavigation service providing direct indication of the bearing (omni bearing) of that station from an aircraft.

(6) *Radio range station*. A radionavigation land station in the aeronautical radionavigation service providing radial equisignal zones.

(7) *Surveillance radar station*. A radionavigation land station in the aeronautical radionavigation service employing radar to display the presence of aircraft within its range.

(8) *Glide path station*. A directional radio beacon associated with an instrument landing system which provides guidance in the vertical plane to an aircraft for the purpose of approach in landing.

(r) *Aeronautical utility land station*. A land station located at airdrome control towers and used for control of ground vehicles and aircraft on the ground at airdromes.

(s) *Aeronautical utility mobile station*. A mobile station used for communication, at airdromes, with the aeronautical utility land station, ground vehicles, and aircraft on the ground.

(t) *Civil Air Patrol Land Station*. A land station used exclusively for communications of the Civil Air Patrol.

(u) *Civil Air Patrol Mobile Station*. A mobile station used exclusively for communications of the Civil Air Patrol.

(v) *Ground radio station*. Any radio station on the ground equipped or engaged in radio communication or radio transmission of energy.

(w) *Aeronautical public communication service*. A communication service carried on between aircraft and land radio stations for the purpose of providing a public communication service for persons aboard aircraft.

(x) *Aeronautical public service station*. A radio station, ground or aircraft, operated in the aeronautical public communication service.

(y) *Telemetry*. Telemetry is the automatic transmission of instrument readings.

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SEC. 9.156 *Correction of log.* No log or portion thereof shall be erased, obliterated, or willfully destroyed within the required retention period. Any necessary correction may be made only by the person originating the entry who shall indicate the erroneous portion, initial the correction made, and indicate the date of correction.

* * * * *

SEC. 9.191 *Station identification*—(a) Telephony (1) Air carrier aircraft: In lieu of radio station call letters, the official aircraft registration number or company flight identification may be used, provided, adequate records are maintained by the air carrier to permit ready identification of individual aircraft. (2) Private aircraft: In lieu of radio station call letters, only the official aircraft registration number may be used. (3) When use is made of the aircraft registration number, the full number must be given upon initial call of each continuous series of communications. In other communications in each series, the last three characters may be used, provided, the practice is first inaugurated by the ground station operator. (4) An aeronautical public service aircraft station may use the identification of the aircraft station with which it is associated or an assigned telephone number, provided that, adequate records are maintained to permit ready identification of the aircraft station. (5) A ground station in the aviation services may use in lieu of the assigned radio call letters the name of the city, area, or airdrome which it serves, together with such additional identification as may be required.

(b) *Telegraphy.* In radiotelegraphy the complete radio station call letters shall be used at the beginning and termination of each contact. After communication has been established, continuous two-way communication may be conducted without further identification or call-up (if no mistake in identity is liable to occur) until the termination of the contact. Aeronautical enroute stations utilizing automatic keying shall transmit call letters at the end of each sequence of communications and, in any event, at least once each hour during periods of transmission.

SEC. 9.192 *Availability for inspections.* All classes of stations in the aviation services and the maintenance records of said stations shall be made available for inspection upon request of an authorized representative of the Commission made to the licensee or to his representative.

* * * * *

SEC. 9.311 *Scope of service.* Communications by an aircraft station in the aeronautical mobile service shall be limited to the necessities of safe aircraft operation. Normally contacts with an airdrome control station shall not be attempted unless the aircraft is within the area served by the station.

SEC. 9.312 *Frequencies available.*³ The following frequencies are available to aircraft stations in the aeronautical mobile service:

(a) 375 kilocycles: International direction-finding frequency for use outside the continental United States.

(b) 457 kilocycles: Working frequency exclusively for aircraft on sea flights desiring an intermediate frequency.

(c) 500 kilocycles: International calling and distress frequency for ships and aircraft over the seas.⁴

³Although present channel spacing in the very high frequency bands is 200 kilocycles, it is expected that this spacing will eventually be reduced to 100 kilocycles. Design of VHF equipment for future use should be made with this in mind.

⁴Transmission on these frequencies with the exception of urgent and safety messages and signals must cease twice each hour, for 3 minutes beginning at x:15 and x:45 o'clock GCT.

(d) 6210 kilocycles: International aircraft calling and working frequency.

(e) 8364 kilocycles: Frequency for use by lifeboats, liferafts and other survival craft for search and rescue communications with stations of the maritime mobile service.

(f) 121.7 and 121.9 megacycles: Airport utility frequencies.

(g) 121.5 megacycles: This frequency is a universal simplex channel for emergency and distress communications. It will provide a means of calling and working between the various services in connection with search and rescue operations, an emergency means for direction finding purposes and a means for establishing air to ground contact with lost aircraft. This frequency will not be assigned to aircraft unless there are also assigned and available for use other frequencies to accommodate the normal communication needs of the aircraft.

(h)

118.1 A	119.9	123.7	125.5
118.3	120.1	123.9	125.7
118.5	120.3 B	124.1	125.9
118.7	120.5	124.3	126.1 E
118.9	120.7	124.5	126.3 E
119.1	120.9	124.7	126.5
119.3	121.1	124.9	126.7 F
119.5	121.3 C	125.1	
119.7	121.7 D	125.3	

These frequencies are available for air traffic control operations.

A—Primarily for international operations.

B—Primarily for communications with Air Route Traffic Control Centers.

C—For communication with low activity airdrome control stations.

D—Available on a secondary basis to its primary use as an airport utility frequency.

E—Available on a non-interference basis to government use of 126.18 Mc.

F—For communication with Interstate Airway Communication Stations.

(i) Miscellaneous maritime frequencies. Calling and working frequencies of ship stations may also be assigned to aircraft stations for the purpose of communicating with coastal stations, or ship stations, available for A1, A2, and A3 emission in conformity with Part 8 of this chapter, Rules Governing Ship Service, provided the Commission is satisfied in each case that undue interference will not be caused to the service of ship or coastal stations.

(j) Other frequencies which may be required for overseas and foreign operation may also be made available upon the showing that a need exists therefor.

(k) In addition to the frequencies specifically designated in this part, a licensee, when operating an aircraft station outside the United States as defined in the Communications Act of 1934, as amended, may use such frequencies as may be required to maintain communications by the authority having jurisdiction over the ground stations with which it is desired to maintain communication.

* * * * *

SEC. 9.321 *Frequencies available.*³ The following frequencies, in addition to those listed in § 9.312 are available to air carrier aircraft stations:

³Although present channel spacing in the very high frequency bands is 200 kilocycles, it is expected that this spacing will eventually be reduced to 100 kilocycles. Design of VHF equipment for future use should be made with this in mind.

(a) 3117.5 kilocycles: National calling and working frequency for air carrier aircraft.

(b)

<i>Mc.</i>	<i>Mc.</i>	<i>Mc.</i>
125.7	126.1	126.5
125.9	126.3	

These frequencies are available for communication to airdrome control stations.

(c) 126.7 megacycles: Air carrier aircraft to airway communication stations.

(d) The aeronautical frequencies listed under § 9.432 are also available to air carrier aircraft upon showing that agreements have been made with the licensee of appropriate ground stations.

(e) 3023.5^a kilocycles (or 3105 kc. until March 15, 1954): Available to air carrier aircraft only where service on the appropriate very high frequency is not available or where service is suspended due to equipment failure.

* * * * *

PART 10—PUBLIC SAFETY RADIO SERVICES

SEC. 10.105 *Modulation requirements.* (a) When amplitude modulation is used for telephony, the modulation percentage shall be sufficient to provide efficient communication and shall be normally maintained above 70 percent on peaks, but shall not exceed 100 percent on negative peaks.

(b) When phase or frequency modulation is used for telephony, the deviation arising from modulation shall not exceed plus or minus 15 kc from the unmodulated carrier.

(c) Each transmitter first authorized or installed after July 1, 1950, shall be provided with a device which will automatically prevent modulation in excess of that specified in paragraphs (a) and (b) of this section which may be caused by greater than normal audio level: *Provided, however,* That this requirement shall not be applicable to transmitters authorized to operate as mobile stations with a maximum plate power input to the final radio frequency stage of 3 watts or less.

* * * * *

SEC. 10.108 *Transmitter measurements.* (a) The licensee of each station shall employ a suitable procedure to determine that the carrier frequency of each transmitter, authorized to operate with a plate input power to the final radio frequency stage in excess of 3 watts, is maintained within the tolerance prescribed in this part. This determination shall be made, and the results thereof entered in the station records, in accordance with the following:

- (1) When the transmitter is initially installed;
- (2) When any change is made in the transmitter which may affect the carrier frequency or the stability thereof;
- (3) At intervals not to exceed 6 months, for transmitters employing crystal-controlled oscillators;
- (4) At intervals not to exceed one month, for transmitters not employing crystal-controlled oscillators.

(b) The licensee of each station shall employ a suitable procedure to determine that the plate power input to the final radio frequency stage of each base station or fixed station transmitter, authorized to operate with a plate input

^aAircraft radio station licensees presently authorized to operate on the frequency 3105 kc. may in addition thereto operate on the frequency 3023.5 kc. in accordance with § 9.321 (e) or § 9.331 (a) during the term of their current licenses without the frequency 3023.5 kc. showing on such licenses.

power to the final radio frequency stage in excess of 3 watts, does not exceed the maximum figure specified on the current station authorization. When the transmitter is so constructed that a direct measurement of plate current in the final radio frequency stage is not practicable, the plate input power may be determined from a measurement of the cathode current in the final radio frequency stage. When the plate input to the final radio frequency stage is determined from a measurement of the cathode current, the required entry shall indicate clearly the quantities that were measured, the measured values thereof, and the method of determining the plate power input from the measured values. This determination shall be made, and the results thereof entered in the station records, in accordance with the following:

- (1) When the transmitter is initially installed;
- (2) When any change is made in the transmitter which may increase the transmitter power input;
- (3) At intervals not to exceed 6 months.

(c) The licensee of each station shall employ a suitable procedure to determine that the modulation of each transmitter, authorized to operate with a plate input power to the final radio frequency stage in excess of 3 watts, does not exceed the limits specified in this part. This determination shall be made and the results thereof entered in the station records, in accordance with the following:

- (1) When the transmitter is initially installed;
- (2) When any change is made in the transmitter which may affect the modulation characteristics;
- (3) At intervals not to exceed 6 months.

(d) The determinations required by paragraphs (a), (b) and (c) of this section may, at the option of the licensee, be made by any qualified engineering measurement service, in which case, the required record entries shall show the name and address of the engineering measurement service as well as the name of the person making the measurements.

(e) In the case of mobile transmitters, the determinations required by paragraphs (a) and (c) of this section may be made at a test or service bench; provided the measurements are made under load conditions equivalent to actual operating conditions, and provided further, that after installation the transmitter is given a routine check to determine that it is capable of being satisfactorily received by an appropriate receiver.

* * * * *

SEC. 10.152 *Station identification.* (a) The required identification for stations in these services shall be the assigned call signal.

(b) Nothing in this section shall be construed as prohibiting the transmission of additional station or unit identifiers which may be necessary for systems operation: *Provided, however,* Such additional identifiers shall not be composed of letters or letters and digits arranged in a manner which could be confused with an assigned radio station call signal.

(c) Except as indicated in paragraphs (d), (e) and (f) of this section, each station in the services shall transmit the required identification at the end of each transmission or exchange of transmissions, or once each 30 minutes of the operating period, as the licensee may prefer.

(d) A mobile station authorized to the licensee of the associated base station and which transmits only on the transmitting frequency of the associated base station is not required to transmit any identification.

(e) A mobile station which is either separately licensed to a different licensee,

transmits on any frequency other than the transmitting frequency of the associated base station, or which has no associated base station shall transmit the required identification at the end of each transmission or exchange of transmissions, or once each 30 minutes of the operating period, as the licensee may prefer. Where election is made to transmit the required identification at thirty-minute intervals, a single mobile unit in each general geographic area may be assigned the responsibility for such transmission and thereby eliminate any necessity for every unit of the mobile station to transmit the required identification. For the purpose of this paragraph, the term "each general geographic area" means an area not smaller than a single city or county and not larger than a single district of a State where the district is administratively established for the service in which the radio system operates.

(f) Stations which are entirely automatic in their operation will be considered for exemption from the requirements of paragraph (c) of this section.

* * * * *

PART 13—COMMERCIAL RADIO OPERATORS

SEC. 13.6 *Operator license, posting of.* The original license of each station operator shall be posted at the place where he is on duty, except as otherwise provided in this part or in the rules governing the class of station concerned.

* * * * *

SEC. 13.11 *Procedure—(a) General.* Applications shall be governed by applicable rules in force on the date when application is filed (see § 13.28). The application in the prescribed form and including all required subsidiary forms and documents, properly completed and signed, shall be submitted in person or by mail to the office at which the applicant desires his application to be considered and acted upon, which office will make the final arrangements for conducting any required examination. If the application is for renewal of license, it may be filed at any time during the final year of the license term or during a one year period of grace after the date of expiration of the license sought to be renewed. During this one-year period of grace an expired license is not valid. A renewed license issued upon the basis of an application filed during the grace period will be dated currently and will not be backdated to the date of expiration of the license being renewed. A renewal application shall be accompanied by the license sought to be renewed. If the prescribed service requirements for renewal without examination (see § 13.28) are fulfilled, the renewed license may be issued by mail. If the service record on the reverse side of the license does not fully describe or cover the service desired by the applicant to be considered in connection with license renewal (as might occur in the case of service rendered at U. S. government stations), the renewal application shall be supported by documentary evidence describing in detail the service performed and showing that the applicant actually performed such service in a satisfactory manner.

(b) *Restricted radiotelephone operator permit.* No oral or written examination is required for this permit. If the application is properly completed and signed, and if the applicant is found to be qualified, the permit may be issued forthwith by personal delivery to the applicant or by mail.

SEC. 13.12 *Special provisions, radiotelegraph first class.* An applicant for the radiotelegraph first-class operator license must be at least 21 years of age at the time the license is issued and shall have had an aggregate of 1 year of satisfactory service as a radiotelegraph operator manipulating the key

of a manually operated radiotelegraph station on board a ship or in a manually operated coastal telegraph station.

* * * * *

SCOPE OF AUTHORITY

SEC. 13.61 Operating authority. The various classes of commercial radio operator licenses issued by the Commission authorize the holders thereof to operate radio stations, except amateur, as follows (See also § 13.62 (c) for additional operating authority with respect to standard and FM broadcast stations):

(a) *Radiotelegraph first-class operator license.* Any station except:

(1) Stations transmitting television, or

(2) Any of the various classes of broadcast stations other than remote pickup and ST broadcast stations, or

(3) On a cargo vessel (other than a vessel operated exclusively on the Great Lakes) required by treaty or statute to be equipped with a radiotelegraph installation, the holder of this class of license may not act as chief or sole operator until he has had at least 6 months satisfactory service in the aggregate as a qualified radiotelegraph operator in a station on board a ship or ships of the United States.

(4) On an aircraft employing radiotelegraphy, the holder of this class of license may not operate the radiotelegraph station during the course of normal rendition of service unless he has satisfactorily completed a supplementary examination qualifying him for that duty, or unless he has served satisfactorily as chief or sole radio operator on an aircraft employing radiotelegraphy prior to February 15, 1950. The supplementary examination shall consist of:

(i) Written examination element: 7.

(5) At a ship radar station licensed in the Ship Service, the holder of this class of license may not supervise or be responsible for the performance of any adjustments or tests during or coincident with the installation, servicing or maintenance of the radar equipment while it is radiating energy unless he has satisfactorily completed a supplementary examination qualifying him for that duty and received a ship radar endorsement on his license certifying to that fact: *Provided*, That nothing in this subparagraph shall be construed to prevent persons holding licenses not so endorsed from making replacements of fuses or of receiving-type tubes. The supplementary examination shall consist of:

(i) Written examination element: 8.

(b) *Radiotelegraph second-class operator license.* Any station except:

(1) Stations transmitting television, or

(2) Any of the various classes of broadcast stations other than remote pickup and ST broadcast stations, or

(3) On a passenger vessel (a ship shall be considered a passenger ship if it carries or is licensed or certificated to carry more than 12 passengers; a cargo ship means any ship not a passenger ship) required by treaty or statute to maintain a continuous radio watch by operators or on a vessel having continuous hours of service for public correspondence, the holder of this class of license may not act as chief operator, or

(4) On a vessel (other than a vessel operated exclusively on the Great Lakes) required by treaty or statute to be equipped with a radiotelegraph installation, the holder of this class of license may not act as chief or sole operator until he has had at least 6 months' satisfactory service in the aggregate.

gate as a qualified radiotelegraph operator in a station on board a ship or ships of the United States.

(5) On an aircraft employing radiotelegraphy, the holder of this class of license may not operate the radiotelegraph station during the course of normal rendition of service unless he is at least eighteen (18) years of age and has satisfactorily completed a supplementary examination qualifying him for that duty, or unless he has served satisfactorily as chief or sole radio operator on an aircraft employing radiotelegraphy prior to February 15, 1950. The supplementary examination shall consist of:

(i) Transmitting and receiving code test at twenty-five (25) words per minute plain language and twenty (20) code groups per minute.

(ii) Written examination element: 7.

(6) At a ship radar station licensed in the Ship Service, the holder of this class of license may not supervise or be responsible for the performance of any adjustments or tests during or coincident with the installation, servicing or maintenance of the radar equipment while it is radiating energy unless he has satisfactorily completed a supplementary examination qualifying him for that duty and received a ship radar endorsement on his license certifying to that fact: *Provided*, That nothing in this subparagraph shall be construed to prevent persons holding licenses not so endorsed from making replacements of fuses or of receiving-type tubes. The supplementary examination shall consist of:

(i) Written examination element: 8.

(c) *Temporary limited radiotelegraph second-class operator license*. Any ship station or ship radar station, subject to the following conditions and limitations:

(1) On a passenger vessel required by treaty or statute to maintain a continuous radio watch by operators or on a vessel having continuous hours of service for public correspondence, the holder of this class of license may not act as chief operator.

(2) On a vessel (other than a vessel operated exclusively on the Great Lakes) required by treaty or statute to be equipped with a radiotelegraph installation, the holder of this class of license may not act as chief or sole operator until he has had at least 6 months' satisfactory service in the aggregate as a qualified radiotelegraph operator in a station on board a ship or ships of the United States.

(3) At a ship radar station licensed in the Ship Service, the holder of this class of license may not supervise or be responsible for the performance of any adjustments or tests during or coincident with the installation, servicing or maintenance of the radar equipment while it is radiating energy unless he has satisfactorily completed a supplementary examination (with the passing grade normally required) qualifying him for that duty and received a ship radar endorsement on his license certifying to that fact: *Provided*, That nothing in this subparagraph shall be construed to prevent persons holding licenses not so endorsed from making replacements of fuses or of receiving-type tubes. The supplementary examination shall consist of:

(i) Written examination element: 8.

(d) *Radiotelegraph third class operator permit*. Any station except:

(1) Stations transmitting television, or

(2) Any of the various classes of broadcast stations other than non-commercial educational FM broadcast stations using transmitters with power ratings of 10 watts or less, remote pickup broadcast stations and ST broadcast stations, or

(3) Coastal telephone stations (other than when transmitting manual radiotelegraphy for identification or for testing) at which the power in the antenna of the unmodulated carrier wave is authorized to exceed 250 watts, or

(4) Coastal harbor telephone stations (other than in the Territory of Alaska and other than when transmitting manual radiotelegraphy for identification or for testing) at which the power in the antenna of the unmodulated carrier wave is authorized to exceed 250 watts, or

(5) Ship stations or aircraft stations other than those at which the installation is used solely for telephony and at which the power in the antenna of the unmodulated carrier wave is not authorized to exceed 250 watts, or

(6) Ship telegraph, coastal telegraph or marine-relay stations open to public correspondence, or

(7) Radiotelegraph stations on board a vessel required by treaty or statute to be equipped with a radio installation, or

(8) Aircraft stations while employing radiotelegraphy:

Provided, That (1) such operator is prohibited from making any adjustments that may result in improper transmitter operation, and (2) the equipment is so designed that the stability of the frequencies of the transmitter is maintained by the transmitter itself within the limits of tolerance specified by the station license, and none of the operations necessary to be performed during the course of normal rendition of the service of the station may cause off-frequency operation or result in any unauthorized radiation, and (3) any needed adjustments of the transmitter that may affect the proper operation of the station are regularly made by or under the immediate supervision and responsibility of a person holding a first- or second-class commercial radio operator license, either radiotelephone or radiotelegraph as may be appropriate for the class of station involved (as determined by the scope of the authority of the respective licenses as set forth in paragraphs (a), (b), (c), (e) and (f) of this section and § 13.62), who shall be responsible for the proper functioning of the station equipment, and (4) in the case of ship radiotelephone or aircraft radiotelephone stations when the power in the antenna of the unmodulated carrier wave is authorized to exceed 100 watts, any needed adjustments of the transmitter that may affect the proper operation of the station are made only by or under the immediate supervision and responsibility of an operator holding a first- or second-class radiotelegraph license, who shall be responsible for the proper functioning of the station equipment.

NOTE: The scope of authority of restricted radiotelegraph operator permits valid as of September 1, 1950, shall, until the expiration of their current terms, remain unaffected by the amendment of paragraph (c) of this section set forth in the Commission's order dated June 27, 1950, and effective September 1, 1950; and at the expiration of their current terms, such permits may, in accordance with the provisions of § 13.28, be renewed only as radiotelegraph third class operator permits.

(e) *Radiotelephone first-class operator license.* Any station except:

(1) Stations transmitting telegraphy by any type of the Morse Code, or
 (2) Ship stations licensed to use telephony and power in excess of 100 watts for communication with coastal telephone stations.

(3) At a ship radar station licensed in the Ship Service, the holder of this class of license may not supervise or be responsible for the performance of any adjustments or tests during or coincident with the installation, servicing or maintenance of the radar equipment while it is radiating energy unless he has satisfactorily completed a supplementary examination qualifying him for that duty and received a ship radar endorsement on his license certifying to that fact: *Provided*, That nothing in this subparagraph shall be construed

to prevent persons holding licenses not so endorsed from making replacements of fuses or of receiving-type tubes. The supplementary examination shall consist of:

- (i) Written examination element: 8.
- (f) *Radiotelephone second-class operator license*. Any station except:
 - (1) Stations transmitting telegraphy by any type of the Morse Code, or
 - (2) Standard broadcast stations, or
 - (3) International broadcast stations, or
 - (4) FM broadcast stations, or
 - (5) Non-commercial educational FM broadcast stations with transmitter power rating in excess of 1 kilowatt, or
 - (6) Television broadcast stations licensed for commercial operation, or
 - (7) Ship stations licensed to use telephony and power in excess of 100 watts for communication with coastal telephone stations.

(8) At a ship radar station licensed in the Ship Service, the holder of this class of license may not supervise or be responsible for the performance of any adjustments or tests during or coincident with the installation, servicing or maintenance of the radar equipment while it is radiating energy unless he has satisfactorily completed a supplementary examination qualifying him for that duty and received a ship radar endorsement on his license certifying to that fact: *Provided*, That nothing in this subparagraph shall be construed to prevent persons holding licenses not so endorsed from making replacements of fuses or of receiving-type tubes. The supplementary examination shall consist of:

- (i) Written examination element: 8.
- (g) *Radiotelephone third-class operator permit*. Any station except:
 - (1) Stations transmitting television, or
 - (2) Stations transmitting telegraphy by any type of the Morse code, or
 - (3) Any of the various classes of broadcast stations other than non-commercial educational FM broadcast stations using transmitters with power ratings of 10 watts or less, remote pickup broadcast stations and ST broadcast stations, or
 - (4) Coastal telephone stations at which the power in the antenna of the unmodulated carrier wave is authorized to exceed 250 watts, or
 - (5) Coastal harbor telephone stations, other than in the Territory of Alaska, at which the power in the antenna of the unmodulated carrier wave is authorized to exceed 250 watts, or

(6) Ship stations or aircraft stations other than those at which the installation is used solely for telephony and at which the power in the antenna of the unmodulated carrier wave is not authorized to exceed 250 watts:

Provided, That (1) such operator is prohibited from making any adjustments that may result in improper transmitter operation, and (2) the equipment is so designed that the stability of the frequencies of the transmitter is maintained by the transmitter itself within the limits of tolerance specified by the station license, and none of the operations necessary to be performed during the course of normal rendition of the service of the station may cause off-frequency operation or result in any unauthorized radiation, and (3) any needed adjustments of the transmitter that may affect the proper operation of the station are regularly made by or under the immediate supervision and responsibility of a person holding a first- or second-class commercial radio operator license, either radiotelephone or radiotelegraph as may be appropriate for the class of station involved (as determined by the scope of the authority of the respective licenses as set forth in paragraphs (a), (b), (c), (e), and

(f) of this section and § 13.62), who shall be responsible for the proper functioning of the station equipment, and (4) in the case of ship radiotelephone or aircraft radiotelephone stations when the power in the antenna of the unmodulated carrier wave is authorized to exceed 100 watts, any needed adjustments of the transmitter that may affect the proper operation of the station are made only by or under the immediate supervision and responsibility of an operator holding a first- or second-class radiotelegraph license, who shall be responsible for the proper functioning of the station equipment.

(h) *Restricted radiotelephone operator permit.* Any station except:

(1) Stations transmitting television, or

(2) Stations transmitting telegraphy by any type of the Morse Code, or

(3) Any of the various classes of broadcast stations other than remote pickup, broadcast STL, and FM intercity relay stations, or

(4) Ship stations licensed to use telephony for communication with Class I coast stations on frequencies between 4000 kc and 30 Mc, or

(5) Radio stations provided on board vessels for safety purposes pursuant to statute or treaty, or

(6) Coast stations other than in the territory of Alaska while employing a frequency below 30 Mc, or

(7) Coast stations at which the power in the antenna of the unmodulated carrier wave is authorized to exceed 250 watts;

(8) At a ship radar station the holder of this class of license may not supervise or be responsible for the performance of any adjustments or tests during or coincident with the installation, servicing or maintenance of the radar equipment while it is radiating energy: *Provided*, That nothing in this subparagraph shall be construed to prevent any person holding such a license from making replacement of fuses or of receiving type tubes:

Provided, That, with respect to any station which the holder of this class of license may operate, such operator is prohibited from making any adjustments that may result in improper transmitter operation, and the equipment is so designed that the stability of the frequencies of the transmitter is maintained by the transmitter itself within the limits of tolerance specified by the station license, and none of the operations necessary to be performed during the course of normal rendition of the service of the station may cause off-frequency operation or result in any unauthorized radiation, and any needed adjustments of the transmitter that may affect the proper operation of the station are regularly made by or under the immediate supervision and responsibility of a person holding a first- or second-class commercial radio operator license, either radiotelephone or radiotelegraph, who shall be responsible for the proper functioning of the station equipment.

MISCELLANEOUS

SEC. 13.71 *Issue of duplicate or replacement licenses.* (a) An operator whose license, permit or authorization has been lost, mutilated or destroyed shall immediately notify the Commission. A properly executed application for duplicate should be submitted to the office of issue, embodying a statement of the circumstances involved in the loss, mutilation or destruction of the license or permit for which a duplicate is desired. If the license or permit has been lost, the applicant must state that reasonable search has been made for it, and further, that in the event it be found either the original or the duplicate will be returned for cancellation. The applicant should also submit documentary evidence of the service that has been obtained under the original license or permit, or a statement under oath or affirmation embodying that information.

(b) The holder of any license, permit or authorization whose name is legally changed may make application for replacement document to indicate the new legal name, by submitting a properly executed application to the office of issue, accompanied by the license, permit or authorization affected and by documentary evidence of the legality of the name change.

SEC. 13.72 *Exhibiting signed copy of application.* When a duplicate or replacement operator license or permit has been requested, or request has been made for renewal upon service or for an endorsement or a verification card, the operator shall exhibit in lieu of the original document a signed copy of the application which has been submitted by him.

* * * * *

SEC. 13.74 *Posting requirements for operator.* (a) Performing duties other than, or in addition to, service or maintenance, at two or more stations. The holder of any class of radio operator license or permit of the diploma form (as distinguished from the card form) who performs any radio operating duties, as contrasted with but not necessarily exclusive of service or maintenance duties, at two or more stations at which posting of his license or permit is required shall post at one such station his operator license or permit and shall post at all other such stations a duly issued, verified statement (Form 759).

(b) Performing service or maintenance duties at one or more stations. The holder of a radiotelephone or radiotelegraph first- or second-class radio operator license who performs, or supervises, and is responsible for service or maintenance work on any transmitter of any station for which a station license is required, shall post his license at the transmitter involved whenever the transmitter is in actual operation while service or maintenance work is being performed: *Provided*, That in lieu of posting his license, he may have on his person either his license or a verification card (Form 758-F): *And provided further*, That if he performs operating duties in addition to service or maintenance duties he shall, in lieu of complying with the foregoing provisions of this paragraph, comply with the posting requirements applicable to persons performing such operating duties, as set forth in paragraph (a) of this section, and in the rules and regulations applicable to each service.

SEC. 13.75 *Record of service and maintenance duties performed.* In every case where a station log or service and maintenance records are required to be kept and where service or maintenance duties are performed which may affect the proper operation of a station, the responsible operator shall sign and date an entry in the log of the station concerned, or in the station maintenance records if no log is required, giving:

(a) Pertinent details of all service and maintenance work performed by him or under his supervision;

(b) His name and address; and

(c) The class, serial number and expiration date of his license:

Provided, That the responsible operator shall not be subject to requirements of paragraphs (b) and (c) of this section in relation to a station, or stations of one licensee at a single location, at which he is regularly employed as an operator on a full time basis and at which his license is properly posted.

* * * * *

PART 17—CONSTRUCTION, MARKING AND LIGHTING OF ANTENNA STRUCTURES

SEC. 17.37 *Inspection of tower lights and associated control equipment.* The licensee of any radio station which has an antenna structure requiring

illumination pursuant to the provisions of section 303 (q) of the Communications Act of 1934, as amended, as outlined elsewhere in this part:

(a) (1) Shall make an observation of the tower lights at least once each 24 hours either visually or by observing an automatic and properly maintained indicator designed to register any failure of such lights, to insure that all such lights are functioning properly as required; or alternatively;

(2) Shall provide and properly maintain an automatic alarm system designed to detect any failure of such lights and to provide indication of such failure to the licensee.

(b) Shall report immediately by telephone or telegraph to the nearest Airways Communication Station or office of Civil Aeronautics Administration any observed or otherwise known failure of a code or rotating beacon light or top light not corrected within thirty minutes, regardless of the cause of such failure. Further notification by telephone or telegraph shall be given immediately upon resumption of the required illumination.

(c) Shall inspect at intervals not to exceed 3 months all automatic or mechanical control devices, indicators and alarm systems associated with the tower lighting to insure that such apparatus is functioning properly.

SEC. 17.38 *Recording of tower light inspections in the station record.* The licensee of any radio station which has an antenna structure requiring illumination shall make the following entries in the station record of the inspections required by § 17.37:

(a) The time the tower lights are turned on and off each day if manually controlled;

(b) The time the daily check of proper operation of the tower lights was made, if automatic alarm system is not provided;

(c) In the event of any observed or otherwise known failure of a tower light;

(1) Nature of such failure.

(2) Date and time the failure was observed, or otherwise noted.

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

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

(5) Date and time notice was given to the Airways Communication Station (Civil Aeronautics Administration) that the required illumination was resumed.

(d) Upon completion of the periodic inspection required at least once each three months:

(1) The date of the inspection and the condition of all tower lights and associated tower lighting control devices, indicators and alarm systems.

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

* * * * *

**EXTRACTS FROM STANDARDS OF GOOD ENGINEERING PRACTICE
CONCERNING STANDARD BROADCAST STATIONS**

S.G.E.P.—AM-12—CONSTRUCTION AND SAFETY OF LIFE REQUIREMENTS

A. Design. The general design of standard broadcast transmitting equipment (main studio microphone (including telephone lines, if used, as to performance only) to antenna output) shall be in accordance with the following

specifications. For the points not specifically covered below, the principles set out shall be followed: The equipment shall be so designed that:

* * * * *

(2) The equipment is capable of satisfactory operation at the authorized operating power or the proposed operating power with modulation of at least 85 to 95 percent with no more distortion than given in (3) below.

(3) The total audio frequency distortion from microphone terminals, including microphone amplifier, to antenna output does not exceed 5 percent harmonics (voltage measurements of arithmetical sum or r. s. s.) when modulated from 0 to 84 percent, and not over 7.5 percent harmonics (voltage measurements of arithmetical sum or r. s. s.) when modulating 85 percent to 95 percent (distortion shall be measured with modulating frequencies of 50, 100, 400, 1000, 5000 and 7500 cycles up to tenth harmonic or 16,000 cycles, or any intermediate frequency that readings on these frequencies indicate is desirable).

* * * * *

(9) The transmitter is equipped with automatic frequency control equipment capable of maintaining the operating frequency within the limit specified by section 3.59.

(a) The maximum temperature variation at the crystal from the normal operating temperature shall not be greater than:

1. Plus or minus 0.1° C. when an X or Y cut crystal is employed, or
2. Plus or minus 1.0° C. when low temperature coefficient crystal is employed.

* * * * *

E. *Spare tubes.* A spare tube of every type employed in the transmitter and frequency and modulation monitors shall be kept on hand. When more than one tube of any type are employed, the following table determines the number of spares of that type required:

Number of each type employed	Spares required
1 or 2	1
3 to 5	2
6 to 8	3
9 or more	4

S.G.E.P.—AM-13—INDICATING INSTRUMENTS PURSUANT TO SECTION 3.58

A. Instruments indicating the plate current or plate voltage of the last radio stage (linear scale instruments), shall meet the following specifications:

* * * * *

(2) Accuracy shall be at least 2 percent of the full scale reading.

* * * * *

(5) Full scale reading shall not be greater than five times the minimum normal indication.

B. Instruments indicating the antenna current shall meet the following specifications:

(1) Instruments having logarithmic or square law scales.

* * * * *

(c) No scale division above one-third full scale reading (in amperes) shall be greater than one-thirtieth of the full scale reading. (Example: An ammeter meeting requirement (a) above having full scale reading of 6 amperes is acceptable for reading currents from 2 to 6 amperes, provided no scale division

between 2 and 6 amperes is greater than one-thirtieth of 6 amperes, 0.2 ampere.)

* * * * *

(3) Remote reading antenna ammeters may be employed and the indications logged as the antenna current in accordance with the following:

* * * * *

(f) Calibration shall be checked against the regular meter at least once a week.

S.G.E.P.—FM-1—DEFINITIONS

* * * * *

D. *Center frequency.* The term "center frequency" means:

(1) The average frequency of the emitted wave when modulated by a sinusoidal signal.

(2) The frequency of the emitted wave without modulation.

E. *Frequency swing.* The term "frequency swing" means the instantaneous departure of the frequency of the emitted wave from the center frequency resulting from modulation.

F. *FM broadcast channel.* The term "FM broadcast channel" means a band of frequencies 200 kilocycles wide and is designated by its center frequency. Channels for FM broadcast stations begin at 88.1 megacycles and continue in successive steps of 200 kilocycles to and including 107.9 megacycles.

* * * * *

J. *Percentage modulation.* The term "percentage modulation" as applied to frequency modulation means the ratio of the actual frequency swing to the frequency swing defined as 100 percent modulation, expressed in percentage. For FM broadcast stations a frequency swing of ± 75 kilocycles is defined as 100 percent modulation.

S. G. E. P.—FM-9—INDICATING INSTRUMENTS PURSUANT TO § 3.258

The following requirements and specifications shall apply to indicating instruments used by FM broadcast stations:

A. Instruments indicating the plate current or plate voltage of the last radio stage (linear scale instruments) shall meet the following specifications:

(1) Length of scale shall be not less than 2-3/10 inches.

(2) Accuracy shall be at least 2 percent of the full scale reading.

(3) Scale shall have at least 40 divisions.

(4) Full scale reading shall not be greater than five times the minimum normal indication.

APPENDIX II

TABLE 1.—*Abbreviations available for all services*

Abbreviations	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 station is . . . nautical miles (<i>or</i> . . . kilometres).
QRC	By what private enterprise (<i>or</i> State administration) are the accounts for charges for your station settled?	The accounts for charges of my station are settled by the private enterprise . . . (<i>or</i> 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 . . . hrs.
QRF	Are you returning to . . . (place)?	I am returning to . . . place <i>or</i> Return to . . . (place).
QRG	Will you tell me my exact frequency (<i>or</i> that of . . .)?	Your exact frequency (<i>or</i> that of . . .) is . . . kc/s (<i>or</i> 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 (<i>or</i> those of . . .)?	The readability of your signals (<i>or</i> 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 (<i>or</i> 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.
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).

TABLE 1.—Abbreviations available for all services—Continued

Abbreviations	Question	Answer or advice
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 No. . . . (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? (See art. 33 sec. V).	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)].
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 . . .).

TABLE 1.—Abbreviations available for all services—Continued

Abbreviations	Question	Answer or advice
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 . . . 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).
QTA	Shall I cancel telegram number . . . as if it had not been sent?	Cancel telegram No. . . . 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? <i>or</i> What is my TRUE bearing from . . . (call sign)? <i>or</i>	Your TRUE bearing from me is . . . degrees (at . . . hours) <i>or</i> Your TRUE bearing from . . . (call sign) was . . . degrees (at . . . hours) <i>or</i>
QTF	What is the TRUE bearing of . . . (call sign) from . . . (call sign)?	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? (See appendix 15.)	The position of your station according to the bearings taken by the direction finding stations which I control was . . . latitude . . . longitude, class . . . at . . . hours. (See appendix 15.)

TABLE 1.—Abbreviations available for all services—Continued

Abbreviations	Question	Answer or advice
QTG	Will you send two dashes of 10 seconds each followed by your call sign (repeated . . . times) [on . . . kc/s (or Mc/s)]? <i>or</i>	I am going to send two dashes of 10 seconds each followed by my call sign (repeated . . . times) [on . . . kc/s (or Mc/s)] <i>or</i>
	Will you request . . . to send two dashes of 10 seconds followed by his call sign (repeated . . . times) on . . . kc/s (or Mc/s)?	I have requested . . . to send two dashes of 10 seconds followed by his call sign (repeated . . . times) on . . . kc/s (or Mc/s).
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)? <i>or</i>	I have left dock (or port) <i>or</i>
	Are you airborne?	I am airborne.
QTP	Are you going to enter dock (or port)? <i>or</i>	I am going to enter dock (or port) <i>or</i>
	Are you going to alight (or land)?	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.

TABLE 1.—Abbreviations available for all services—Continued

Abbreviations	Question	Answer or advice
QTV	Shall I stand guard for you on the frequency of . . . kc/s (<i>or</i> Mc/s) (from . . . to . . . hours)?	Stand guard for me on the frequency of . . . kc/s (<i>or</i> Mc/s) (from . . . to . . . hours).
QTX	Will you keep your station open for further communication with me until further notice (<i>or</i> until . . . hours)?	I will keep my station open for further communication with you until further notice (<i>or</i> 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 (<i>or</i> other indication) of the last message you received from me [<i>or</i> from . . . (call sign)]?	The number (<i>or</i> other indication) of the last message I received from you [<i>or</i> 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 (<i>or</i> land)?	I am forced to alight (<i>or</i> land) immediately. <i>or</i> I shall be forced to alight (<i>or</i> land) at . . . (position <i>or</i> 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.
QUJ	Will you indicate the TRUE course for me to steer toward you (<i>or</i> . . .) with no wind?	The TRUE course for you to steer toward me (<i>or</i> . . .) with no wind is . . . degrees at . . . hours.
QUK	Can you tell me the condition of the sea observed at . . . (place <i>or</i> coordinates)?	The sea at . . . (place <i>or</i> coordinates) is . . .
QUL	Can you tell me the swell observed at . . . (place <i>or</i> coordinates)?	The swell at . . . (place <i>or</i> coordinates) is . . .
QUM	Is the distress traffic ended?	The distress traffic is ended.

TABLE 1.—Abbreviations available for all services—Continued

Abbreviations	Question	Answer or advice
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.
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 . . .).

TABLE 1.—Abbreviations available for all services—Continued

Abbreviations	Question	Answer or advice
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.)

TABLE 2.—Abbreviations available for aeronautical services

Signal	Question	Answer or advice
QAB	May I have clearance (for . . .) from . . . (<i>place and/or control</i>) to . . . (<i>place and/or control</i>) at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>)?	You are cleared (<i>or</i> . . . is cleared) by . . . from . . . (<i>place and/or control</i>) to . . . (<i>place and/or control</i>) at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>).
QAF	Will you advise me when you are (were) at (over) . . . (<i>place</i>)?	I am (was) at (over) . . . (<i>place</i>) at . . . hours [at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>)].
QAG		Arrange your flight in order to arrive over . . . (<i>place</i>) at . . . hours. <i>or</i> I am arranging my flight in order to arrive over . . . (<i>place</i>) at . . . hours.
QAH	What is your height above . . . (<i>datum</i>)?	I am at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). <i>Note.</i> —An aircraft is permitted to reply to QAH IMI by using any of the answer forms of signals QBF, QBG, QBH, QBK, QBN or QBP. <i>In such cases the signal QAH is omitted from the reply.</i> <i>or</i> Arrange your flight so as to reach . . . (<i>figures and units</i>) height above . . . (<i>datum</i>) at . . . (<i>hour or place</i>).
QAK	Is there any risk of collision?	There is risk of collision. <i>Note.</i> —This signal should be followed by appropriate Q signals or ICAO approved abbreviations giving instructions for avoiding collision.
QAL	Are you going to land at . . . (<i>place</i>)? <i>or</i>	I am going to land at . . . (<i>place</i>). <i>or</i> (You may) land at . . . (<i>place</i>). <i>or</i>
	Has aircraft landed at . . . (<i>place</i>)? [See also signal QTP.]	Aircraft . . . landed at . . . (<i>place</i>). [See also signal QTP.]
QAM	What is the latest available meteorological observation for . . . (<i>place</i>)?	Meteorological observation made at . . . (<i>place</i>) at . . . hours was as follows . . . <i>Note.</i> —The information may be given in Q Code form or the AERO form of the International Code. When in Q Code, the information is to be given in the following sequence of Q signal answer (<i>or</i> advice) forms:

Signal	Question	Answer or advice
		<p>QAN, QBA, QNY, QBB, QNH and/or QFE and, if necessary, QMU, QNT, QBJ.</p> <p><i>It is not normally necessary to precede the QAN, QBA, QNY and QBB information by these Q signals but this may be done if considered desirable.</i></p> <p><i>When in the AERO form of International Code, the abbreviation AERO is to precede the information.</i></p>
QAN	What is the surface wind direction and speed at . . . (place)?	<p>The surface wind direction and speed at . . . (place) at . . . hours is . . . (direction) . . . (speed figures and units).</p> <p><i>Note.—Unless otherwise indicated in the question, answer (or advice), surface wind direction is given in degrees relative to MAGNETIC North.</i></p>
QAO	What is the wind direction in degrees TRUE and speed at . . . (position or zone/s) at each of the . . . (figures) . . . (units) levels above . . . (datum)?	<p>The wind direction and speed at . . . (position or zone/s) at the following heights above . . . (datum) is:</p> <p>. . . (vertical distance in figures units)</p> <p>. . . degrees TRUE . . . (speed in figures and units)</p> <p>. . . (vertical distance in figures and units)</p> <p>. . . degrees TRUE . . . (speed in figures and units).</p>
QAP	Shall I listen for you (or for . . .) on . . . kc/s. (. . . Mc/s.)? <i>Note.—If the frequency is given in megacycles, the abbreviation MC is to be used.</i> [See also signal QSX.]	<p>Listen for me (or for . . .) on . . . kc/s. (. . . Mc/s.).</p> <p><i>Note.—If the frequency is given in megacycles, the abbreviation MC is to be used.</i> [See also signal QSX.]</p>
QAA	Am I near a prohibited area (or . . . prohibited area)?	<p>You are . . .</p> <p>(1) near (2) flying over a prohibited area (or . . . prohibited area).</p>
QAR	May I stop listening on the watch frequency for . . . minutes?	You may stop listening on the watch frequency for . . . minutes.
QAU		I am about to jettison fuel.
QAV	Are you able to home on your DF equipment?	I am homing on my DF equipment on . . . station.
QAW		I am about to carry out overshoot procedure.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QAY	Will you advise me when you pass (passed) . . . (place) bearing 090 (270) degrees relative to your heading?	I passed . . . (place) bearing . . . degrees relative to my heading at . . . hours.
QAZ	Are you experiencing communication difficulties through flying in a storm?	I am experiencing communication difficulties through flying in a storm. <i>Note.—Attention is invited to the possible supplementary use of signals QAR, QBE, QCS, QRM, QRN, QRX, QSZ or the signal CL to amplify the meaning associated with signal QAZ.</i>
QBA	What is the horizontal visibility at . . . (place)?	The horizontal visibility at . . . (place) at . . . hours is . . . (distance figures and units).
QBB	What is the amount, the type and height above official aerodrome elevation of the cloud base of the significant cloud [at . . . (place)]?	The amount, the type and height above official aerodrome elevation of the cloud base of the significant cloud at . . . (place) at . . . hours is . . . eighths (. . . type) at . . . (figures and units) height above official aerodrome elevation and . . . eighths (. . . type) at . . . (figures and units) height above official aerodrome elevation.
	<i>Note.—The significant cloud layers are:</i>	
	(i) the lowest layer of cloud below 6 000 metres (approx. 20 000 feet) covering more than half the sky;	
	(ii) the lowest layer of cloud, if any, below the layer given in i) preceding;	
	(iii) if no layer of cloud below 6 000 metres (approx. 20 000 feet) covers more than half the sky, the significant cloud layer is the lowest layer of cloud below 6 000 metres.	
QBC	Report meteorological conditions as observed from your aircraft [at . . . (position or zone)] [(at . . . hours)]	The meteorological conditions as observed from my aircraft at . . . (position or zone) at . . . hours at . . . (figures and units) height above . . . (datum) are . . . <i>Note.—The information may be given in Pomar or Q Code form. When given in Q Code, the following sequence of Q signal answer (or advice) forms is used: QMX, QNY, QAO, QDF, QMI, QFT and QNI.</i>
QBD	How much fuel have you remaining (expressed as hours and/or minutes of consumption)?	Fuel remaining is . . . (hours and/or minutes of consumption).
QBE		I am about to wind in my aerial.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QBF	Are you flying in cloud?	I am flying in cloud at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>) [and I am ascending (descending to . . . (<i>figures and units</i>) height above that datum].
QBG	Are you flying above cloud?	I am flying above cloud and at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). <i>or</i> Maintain a vertical distance of . . . (<i>figures and units</i>) above cloud, smoke, haze or fog levels.
QBH	Are you flying below cloud?	I am flying below cloud and at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). <i>or</i> Maintain a vertical distance of . . . (<i>figures and units</i>) below cloud.
QBI	Is flight under IFR compulsory at . . . (<i>place</i>) [or from . . . to . . . (<i>place</i>)]?	Flight under IFR is compulsory at . . . (<i>place</i>) [or from . . . to . . . (<i>place</i>)].
QBJ	What is the amount, type and height above . . . (<i>datum</i>) of the top of the cloud [at . . . (<i>position or zone</i>)]?	At . . . hours at . . . (<i>position or zone</i>) the top of the cloud is: amount . . . eighths (. . . type) at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>).
QBK	Are you flying with no cloud in your vicinity?	I am flying with no cloud in my vicinity and at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>).
QBM	Has . . . sent any message for me?	Here is the message sent by . . . at . . . hours.
QBN	Are you flying between two layers of cloud?	I am flying between two layers of cloud and at . . . <i>figures and units</i> height above . . . (<i>datum</i>).
QBO	What is the nearest aerodrome at which flight under VFR is permissible and which would be suitable for my landing?	Flying under VFR is permissible at . . . (<i>place</i>) which would be suitable for your landing.
QBP	Are you flying in and out of cloud?	I am flying in and out of cloud and at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>).
QBS		Ascend (<i>or</i> descend) to . . . (<i>figures and units</i>) height above . . . (<i>datum</i>) before encountering IFR weather conditions or if visibility falls below . . . (<i>figures and units of distance</i>) and advise.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QBT	How far, along the runway, from the approach end, can the observer at the runway threshold see the runway lights which will be in operation for my landing [at . . . (place)]?	At . . . hours, the observer at the threshold of runway number . . . could see the runway lights in operation for your landing [at . . . (place)] for a distance of . . . (figures and units) from the approach end. <i>Note.—If the station enquired of is not equipped to make the special observation requested, the reply to QBT IMI is given by the signal QNO.</i>
QBV	Have you reached the . . . (figures and units) height above . . . (datum) [or . . . (area or place)]?	I have reached the . . . (figures and units) height above . . . (datum) [or . . . (area or place)]. <i>or</i> Report reaching the . . . (figures and units) height above . . . (datum) [or . . . (area or place)].
QBX	Have you left the . . . (figures and units) height above . . . (datum) [or . . . (area or place)]?	I have left the . . . (figures and units) height above . . . (datum) [or . . . (area or place)]. <i>or</i> Report leaving the . . . (figures and units) height above . . . (datum) [or . . . (area or place)].
QBZ	Report your flying conditions in relation to clouds.	<i>The reply to QBZ IMI is given by the appropriate answer form of signals QBF, QBG, QBH, QBK, QBN and QBP.</i>
QCA	May I change from . . . (figures and units) to . . . (figures and units) height above . . . (datum)?	You may change from . . . (figures and units) to . . . (figures and units) height above . . . (datum). <i>or</i> I am changing from . . . (figures and units) to . . . (figures and units) height above . . . (datum).
QCB		Delay is being caused by . . . (1) your transmitting out of turn. (2) your slowness in answering. (3) lack of your reply to my . . .
QCE	When may I expect approach clearance?	Expect approach clearance at . . . hours. <i>or</i> No delay expected.
QCF		Delay indefinite. Expect approach clearance not later than . . . hours.
QCH	May I taxi to . . . (place)?	Cleared to taxi to . . . (place). [The place is given in plain language.]

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QCI		Make a 360-degree turn immediately (turning to the . . .).
		<i>or</i>
		I am making a 360-degree turn immediately (turning to the . . .).
QCS		My reception on . . . frequency has broken down.
QCX	What is your full call sign?	My full call sign is . . .
		<i>or</i>
		Use your full call sign until further notice.
QCY		I am working on trailing aerial.
		<i>or</i>
		Work on trailing aerial.
QDB	Have you sent message . . . to . . . ?	I have sent message . . . to . . .
QDF	What is your D-Value at . . . (position)?	My D-Value at . . . (position) at (figures and units) height above the 1013.2 millibars datum is . . . (D-Value figures and units) . . . * (specify plus or minus).
		<i>or</i>
	What is the D-Value at . . . (place or position) (at . . . hours) for the . . . millibar level?	The D-Value at . . . (place or position) at . . . hours for the . . . millibar level is . . . (D-Value figures and units) . . . * (specify plus or minus).
		<i>Note.</i> —When the true altitude (radio altitude) is higher than the standard pressure altitude PS (Plus) is used [conversely MS (Minus) is used].
QDL	Do you intend to ask me for a series of bearings?	I intend to ask you for a series of bearings.
QDP	Will you accept control (or responsibility) of (for) . . . now (or at . . . hours)?	I will accept control (or responsibility) of (for) . . . now (or at . . . hours).
QDT	Are you flying in VFR weather conditions?	I am flying in VFR weather conditions.
		<i>or</i>
		Fly at all times in VFR weather conditions.
QDV	Are you flying in a horizontal visibility of less than . . . (figures and units)?	I am flying in a horizontal visibility of less than . . . (figures and units) at . . . (figures and units) height above . . . (datum).
QEA	May I cross the runway ahead of me?	You may cross the runway ahead of you.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QEB	May I turn at the intersection?	Taxi as follows at the intersection ... (straight ahead DRT turn left LEFT turn right RITE).
QEC	May I make a 180-degree turn and return down the runway?	You may make a 180-degree turn and return down the runway.
QED	Shall I follow the pilot vehicle?	Follow the pilot vehicle.
QEF	Have I reached my parking area?	You have reached your parking area.
	<i>or</i>	<i>or</i>
	Have you reached your parking area?	I have reached my parking area.
QEG	May I leave the parking area?	You may leave the parking area.
	<i>or</i>	<i>or</i>
	Have you left the parking area?	I have left the parking area.
QEH	May I move to the holding position for runway number . . . ?	Cleared to the holding position for runway number . . .
	<i>or</i>	<i>or</i>
	Have you moved to the holding position for runway number . . . ?	I have moved to the holding position for runway number . . .
QEJ	May I assume position for take-off?	Cleared to hold at take-off position for runway number . . .
	<i>or</i>	<i>or</i>
	Have you assumed position for take-off?	I am assuming take-off position for runway number . . . and am holding.
QEK	Are you ready for immediate take-off?	I am ready for immediate take-off.
QEL	May I take-off (and make a . . . hand turn after take-off)?	You are cleared to take-off (turn as follows after take-off . . .).
QEM	What is the condition of the landing surface at . . . (place)?	The condition of the landing surface at . . . (place) is . . .
		<i>Note.—The information is given by sending appropriate NOTAM Code groups.</i>
QEN	Shall I hold my position?	Hold your position.
QEO	Shall I clear the runway (or landing area)?	Clear the runway (or landing area).
	<i>or</i>	<i>or</i>
	Have you cleared the runway (or landing area)?	I have cleared the runway (or landing area).
QES	Is a right-hand circuit in force at . . . (place)?	A right-hand circuit is in force at . . . (place).

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QFA	What is the meteorological forecast for . . . (<i>flight, route, section of route or zone</i>) for the period . . . hours until . . . hours?	The meteorological forecast for . . . (<i>flight, route, section of route or zone</i>) for the period . . . hours until . . . hours is . . . <i>Note.</i> —When the forecast is given in Q Code the following sequence of Q signal answer (or advice) forms is to be given: QAO, QMX, QMI, QNY, QBA, QMW, QFT and QNI.
QFB		The . . . (1) approach (2) runway (3) approach and runway lights are out of order.
QFC	What is the amount, the type and the height above . . . (<i>datum</i>) of the base of the cloud at . . . (<i>place, position or zone</i>)?	At . . . (<i>place, position or zone</i>) the base of the cloud is . . . eighths . . . type at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). <i>Note.</i> —If several cloud layers or masses are present, the lowest is reported first.
QFD	(1) Is the . . . visual beacon [at . . . (<i>place</i>)] in operation? (2) Will you switch on the . . . visual beacon [at . . . (<i>place</i>)]? (3) Will you extinguish the aerodrome visual beacon [at . . . (<i>place</i>)] until I have landed?	(1) The . . . visual beacon [at . . . (<i>place</i>)] is in operation. (2) I will extinguish the aerodrome visual beacon [at . . . (<i>place</i>)] until your landing is completed.
QFE	[At . . . (<i>place</i>)] what is the present atmospheric pressure at official aerodrome elevation?	At . . . (<i>place</i>) the atmospheric pressure at official aerodrome elevation is (<i>or was observed at . . . hours to be</i>) . . . tenths of millibars. [<i>Example: QFE KLGA 9787 (i.e., 978.7 millibars).</i>]
QFF	[At . . . (<i>place</i>)] what is the present atmospheric pressure converted to mean sea level in accordance with meteorological practice?	At . . . (<i>place</i>) the atmospheric pressure converted to mean sea level in accordance with meteorological practice is (<i>or was determined at . . . hours to be</i>) . . . tenths of millibars.
QFG	Am I over the aerodrome?	You are over the aerodrome.
QFH	May I descend below the clouds?	You may descend below the clouds.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QFI	Are the aerodrome lights lit?	The aerodrome lights are lit. <i>or</i> Please light the aerodrome lights.
QFL	Will you send up pyrotechnical lights?	I will send up pyrotechnical lights.
QFM	What height above . . . (<i>datum</i>) . . . (1) should I maintain? (2) are you maintaining? (3) do you intend cruising at?	(1) Maintain (<i>or fly at</i>) . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). (2) I am maintaining . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). (3) I intend cruising at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>).
QFO	May I land immediately?	You may land immediately.
QFP	Will you give me the latest information concerning . . . facility [at . . . (<i>place</i>)]?	The latest information concerning . . . facility [at . . . (<i>place</i>)] is as follows . . . <i>Note.</i> —The information is given by sending appropriate NOTAM Code groups.
QFQ	Are the approach and runway lights lit?	The approach and runway lights are lit. <i>or</i> Please light the approach and runway lights.
QFR	Does my landing gear appear damaged?	Your landing gear appears damaged.
QFS	Is the . . . radio facility at . . . (<i>place</i>) in operation?	The . . . radio facility at . . . (<i>place</i>) is in operation (<i>or will be in operation in . . . hours</i>). <i>or</i> Please have the . . . radio facility at . . . (<i>place</i>) put in operation.
QFT	Between what heights above . . . (<i>datum</i>) has ice formation been observed [at . . . (<i>position or zone</i>)]?	Ice formation has been observed at . . . (<i>position or zone</i>) in the type of . . . and with an accretion rate of . . . between . . . (<i>figures and units</i>) and . . . (<i>figures and units</i>) heights above . . . (<i>datum</i>).
QFU	What is the magnetic direction (<i>or number</i>) of the runway to be used?	The magnetic direction (<i>or number</i>) of the runway to be used is . . . <i>Note.</i> —The runway number is indicated by a two-figure group and the magnetic direction by a three-figure group.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QFV	Are the floodlights switched on?	The floodlights are switched on. <i>or</i> Please switch on the floodlights.
QFW	What is the length of the runway in use in . . . (<i>units</i>)?	The length of runway . . . now in use is . . . (<i>figures and units</i>).
QFX		I am working (<i>or am going to work</i>) on a fixed aerial. <i>or</i> Work on a fixed aerial.
QFY	Please report the present meteorological landing conditions [at . . . (<i>place</i>)].	The present meteorological landing conditions at . . . (<i>place</i>) are . . . <i>Note.—When given in Q Code the information is sent in the following sequence: QAN, QBA, QNY, QBB, QNH and/or QFE and, if necessary, QMU, QNT, QBJ. It is not normally necessary to precede the QAN, QBA, QNY and QBB information by these Q signals but this may be done if considered desirable.</i>
QFZ	What is the aerodrome meteorological forecast for . . . (<i>place</i>) for the period . . . hours until . . . hours?	The aerodrome meteorological forecast for . . . (<i>place</i>) for the period . . . hours until . . . hours is . . . <i>Note.—When given in Q Code the following sequence of Q signal answer (or advice) forms is to be used: QAN, QBA, QNY, QBB and, if necessary, QMU, QNT and QBJ.</i>
QGC		There are obstructions to the . . . of runway . . .
QGD	Are there on my track any obstructions whose elevation equals or exceeds my altitude?	There are obstructions on your track . . . (<i>figures and units</i>) height above . . . (<i>datum</i>).
QGE	What is my distance to your station (<i>or to . . .</i>)?	Your distance to my station (<i>or to . . .</i>) is . . . (<i>distance figures and units</i>). <i>Note.—This signal is normally used in conjunction with one of the signals QUX, QUV, QTE or QUJ.</i>
QGH	May I land using . . . (<i>procedure or facility</i>)?	You may land using . . . (<i>procedure or facility</i>).
QGK	What track should I make good?	Make good a track from . . . (<i>place</i>) on . . . degrees . . . (<i>true or magnetic</i>).
	<i>or</i>	<i>or</i>
	What track are you making good?	I am making good a track from . . . (<i>place</i>) on . . . degrees . . . (<i>true or magnetic</i>).
QGL	May I enter the . . . (<i>control area or zone</i>) at . . . (<i>place</i>)?	You may enter the . . . (<i>control area or zone</i>) at . . . (<i>place</i>).

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QGM		Leave the . . . (control area or zone).
QGN	May I be cleared to land [at . . . (place)]?	You are cleared to land [at . . . (place)].
QGO		Landing is prohibited at . . . (place).
QGP	What is my number for landing?	You are number . . . to land.
QGQ	May I hold at . . . (place)?	Hold at . . . (place) at . . . (figures and units) height above . . . (datum) and await orders.
QGT		Fly for . . . minutes on a heading that will enable you to maintain a track reciprocal to your present one.
QGU		Fly for . . . minutes on a magnetic heading of . . . degrees.
QGV	Do you see me?	I see you at . . . (cardinal or quadrantal point of direction).
	<i>or</i>	<i>or</i>
QGW	Can you see the aerodrome? Does my landing gear appear to be down and in place?	I can see the aerodrome. Your landing gear appears to be down and in place.
QGZ		Hold on . . . direction of . . . facility.
QHE	Will you inform me when you are on . . . leg of approach?	I am on . . . (1) crosswind leg (2) down-wind leg (3) base leg (4) final leg } of approach.
QHG	May I enter traffic circuit at . . . (figures and units) height above . . . (datum)?	Cleared to enter traffic circuit at . . . (figures and units) height above . . . (datum).
QHH	Are you making an emergency landing?	I am making an emergency landing. <i>or</i> Emergency landing being made at . . . (place). All aircraft below . . . (figures and units) height above . . . (datum) and within a distance of . . . (figures and units) leave . . . (place or headings).
QHI	Are you (or is . . .) (1) waterborne? (2) on land?	I am (or . . . is) (1) waterborne } (2) on land } at . . . hours.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QHQ	May I make a . . . approach [at . . . (<i>place</i>)]? <i>or</i> Are you making a . . . approach?	You may make a . . . approach [at . . . (<i>place</i>)]. <i>or</i> I am making a . . . approach.
QHZ	Shall I circle the aerodrome (<i>or go around</i>)?	Circle the aerodrome (<i>or go around</i>).
QIC	May I establish communication with . . . radio station on . . . kc/s. (<i>or</i> . . . Mc/s.) now (<i>or at</i> . . . hours)?	Establish communication with . . . radio station on . . . kc/s. (<i>or</i> . . . Mc/s.) now (<i>or at</i> . . . hours). <i>or</i> I will establish communication with . . . radio station on . . . kc/s. (<i>or</i> . . . Mc/s.) now (<i>or at</i> . . . hours).
QIF	What frequency is . . . using?	. . . is using . . . kc/s. (<i>or</i> . . . Mc/s.).
QJA	Is my . . . (1) tape (2) mark and space } re-	Your . . . (1) tape (2) mark and space } is re-
QJB	Will you use . . . (1) radio? (2) cable? (3) telegraph? (4) teletypewriter? (5) telephone? (6) receiver? (7) transmitter? (8) reperforator?	I will use . . . (1) radio. (2) cable. (3) telegraph. (4) teletypewriter. (5) telephone. (6) receiver. (7) transmitter. (8) reperforator.
QJC	Will you check your . . . (1) transmitter distributor? (2) auto-head? (3) perforator? (4) reperforator? (5) printer? (6) printer motor? (7) keyboard? (8) antenna system?	I will check my . . . (1) transmitter distributor. (2) auto-head. (3) perforator. (4) reperforator. (5) printer. (6) printer motor. (7) keyboard. (8) antenna system.
QJD	Am I transmitting . . . (1) in letters? (2) in figures?	You are transmitting . . . (1) in letters. (2) in figures.
QJE	Is my frequency shift . . . (1) too wide? (2) too narrow? (3) correct?	Your frequency shift is . . . (1) too wide. (2) too narrow (by . . . cycles). (3) correct.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QJF		My signal as checked by monitor . . . is satisfactory . . . (1) locally. (2) as radiated.
QJG	Shall I revert to automatic relay?	Revert to automatic relay.
QJH	Shall I run . . . (1) my test tape? (2) a test sentence?	Run . . . (1) your test tape. (2) a test sentence.
QJI	Will you transmit a continuous . . . (1) mark? (2) space?	I am transmitting a continuous . . . (1) mark. (2) space.
QJK	Are you receiving . . . (1) a continuous mark? (2) a continuous space? (3) a mark bias? (4) a space bias?	I am receiving . . . (1) a continuous mark. (2) a continuous space. (3) a mark bias. (4) a space bias.
QKA		I have effected rescue and am proceeding to . . . base [with . . . persons injured requiring ambulance].
QKC		The sea conditions (at . . . position) . . . (1) permit alighting but not take-off. (2) render alighting extremely hazardous.
QKN		Aircraft plotted (believed to be you) in position . . . on track . . . degrees at . . . hours.
QLB	Will you monitor . . . station and report regarding range, quality, etc.?	I have monitored . . . station and report (<i>briefly</i>) as follows . . .
QLH	Will you use simultaneous keying on . . . frequency and . . . frequency?	I will now key simultaneously on . . . frequency and . . . frequency.
QLV	Is the . . . radio facility still required?	The . . . radio facility is still required.
QMH		Shift to transmit and receive on . . . kc/s. (<i>or</i> . . . Mc/s.); if communication is not established within 5 minutes, revert to present frequency.

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QMI	Report the vertical distribution of cloud [at . . . (<i>position or zone</i>)] as observed from your aircraft.	The vertical distribution of cloud as observed from my aircraft at . . . hours at . . . (<i>position or zone</i>) is: lowest layer observed* . . . eighths (. . . type) with base of . . . (<i>figures and units</i>) and tops of . . . (<i>figures and units</i>) [*and similarly in sequence for each of the layers observed.] height above . . . (<i>datum</i>). <i>Example.</i> —QMI 1400 11 2 CU 1000 FT 2500 FT 6 SC 6000 FT 10000 FT 5 AC 13000 FT 14000 FT MER.
QMU	What is the surface temperature at . . . (<i>place</i>) and what is the dew point temperature at that place?	The surface temperature at . . . (<i>place</i>) at . . . hours is . . . degrees and the dew point temperature at that time and place is . . . degrees.
QMW	At . . . (<i>position or zone</i>) what is (are) the height(s) above . . . (<i>datum</i>) of the zero centigrade isotherm(s)?	At . . . (<i>position or zone</i>) the zero centigrade isotherm(s) is (are) at . . . (<i>figures and units</i>) height(s) above . . . (<i>datum</i>).
QMX	What is the air temperature [at . . . (<i>position or zone</i>)] (at . . . hours) at the . . . (<i>figures and units</i>) height above . . . (<i>datum</i>)?	At . . . (<i>position or zone</i>) at . . . hours the air temperature is . . . (<i>degrees and units</i>) at . . . (<i>figures and units</i>) height above . . . (<i>datum</i>). <i>Note.</i> —Aircraft reporting QMX information will transmit the temperature figures as corrected for airspeed.
QMZ	Have you any amendments to the flight forecast in respect of section of route yet to be traversed?	The following amendment(s) should be made to the flight forecast . . . [If no amendments, signal QMZ NIL.]
QNE	What indication will my altimeter give on landing at . . . (<i>place</i>) at . . . hours, my sub-scale being set to 1013.2 millibars (29.92 inches)?	On landing at . . . (<i>place</i>) at . . . hours, with your sub-scale being set to 1013.2 millibars (29.92 inches), your altimeter will indicate . . . (<i>figures and units</i>).

TABLE 2.—Abbreviations available for aeronautical services—Continued

Signal	Question	Answer or advice
QNH	What should I set on the sub-scale of my altimeter so that the instrument would indicate my elevation if I were on the ground at your station?	If you set the sub-scale of your altimeter to read . . . tenths of millibars (or hundredths of an inch*), the instrument would indicate your elevation if you were on the ground at my station at . . . hours. <i>*Note.—When the setting is given in hundredths of an inch the abbreviation INS is used to identify the units.</i>
QNI	Between what heights above . . . (datum) has turbulence been observed at . . . (position or zone)?	Turbulence has been observed at . . . (position or zone) with an intensity of . . . between . . . (figures and units) and . . . (figures and units) heights above . . . (datum).
QNO		I am not equipped to give the information (or provide the facility) requested.
QNR		I am approaching my point of no return.
QNT	What is the maximum gust speed of the surface wind at . . . (place)?	The maximum gust speed of the surface wind at . . . (place) at . . . hours is . . . (speed figures and units).
QNY	What is the present weather and the intensity thereof at . . . (place, position or zone)?	The present weather and intensity thereof at . . . (place, position or zone) at . . . hours is . . . (dust-storm, sandstorm, rain, snow, hail, thunderstorm, etc.). <i>Notes:</i> (a) If no phenomena as above, signal QNY NIL. (b) When present weather information is transmitted by a ground station, the information is to be given in accordance with the present weather table in the International AERO Form [Annex 3, Table 26]. (c) When present weather information is transmitted by an aircraft, the information is to be given in accordance with the present or past weather table [Annex 3, Table 22], or alternatively the appropriate answer (or advice) form of signals QBF, QBG, QBH, QBK, QBN, QBP.

TABLE 3.—Miscellaneous abbreviations and signals—(General)

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 (<i>or I repeat</i>) the figures in abbreviated form.
ADS	Address (used after a question mark to request a repetition).
AR	End of transmission (. — . — . to be sent as one signal).
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 (<i>or I confirm</i>).
CL	I am closing my station.
COL	Collate (<i>or I collate</i>).
CP	General call to two or more specified stations. (See art. 32.)
CQ	General call to all stations. (See art. 31.)
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 [<i>or at . . . (time)</i>].
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?
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 (<i>or Minutes</i>).

TABLE 3.—Miscellaneous abbreviations and signals—(General)—Continued

Abbreviation or signal	Definition
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 (<i>or</i> 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. (See 700.)
R	Received.
REF	Reference to . . . (<i>or</i> Refer to . . .).
RPT	Repeat (<i>or</i> I repeat) (<i>or</i> Repeat . . .).
RQ	Indication of a request.
SIG	Signature (used after a question mark to request a repetition).
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. (See 943.)
TU	Thank you.
TXT	Text (used after a question mark to request a repetition).
VA	End of work (. . . — — — to be sent as one signal).
W	Word(s) <i>or</i> [Group(s)].
WA	Word after . . . (Use 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. (See 934.)

TABLE 4.—Miscellaneous abbreviations and signals for aeronautical services

Abbreviation or signal	Meaning	Abbreviation or signal	Meaning
AC	Alto cumulus.	DCT	Direct (<i>in relation to flight plan clearances and type of approach</i>).
ACC	Area control.	DES	I am descending [to . . . (<i>figures and units</i>) height above . . . (<i>datum</i>)].
AD	Aerodrome.	DRT	Keep straight ahead.
ADZ	Advise.	DU	Position not guaranteed.
AERO	Aero form of the International Code.	E	East or Eastern longitude.
AGN	Again.	ERB	Landing off a runway is permitted.
AIR	Relative to air.	ETD	Estimated time of departure.
ANT	Before.	ETI	The information is estimated.
APP	Approach control.	FAH	Degrees Fahrenheit.
APR	After . . . (<i>time or place</i>).	FBL	Light (<i>used to qualify icing, turbulence, interference or static reports</i>).
ARFOT	Area forecast in units of English system.	FC	Flight control.
ARMET	Area forecast in units of Metric System.	FIR	Flight information region.
ARR	Arrive (<i>or arrival</i>).	FLT	Flight.
AS	Altostratus.	FNA	Final approach.
ASC	I am ascending [to . . . (<i>figures and units</i>) height above . . . (<i>datum</i>)].	FOT	Units of English system.
ATC	Air traffic control (<i>in general</i>).	FRCU	Fractocumulus.
ATP	At . . . (<i>time or place</i>).	FS	Fractostratus.
AWY	Airway.	FSL	Full stop landing.
BABS	Beam approach beacon system.	FT	Feet (<i>dimensional unit</i>).
BCST	Broadcast.	GCA	Ground controlled approach system.
BOH	Break-off height.	GEO	Geographic or true.
BRF	Short (<i>used to indicate the type of approach desired or required</i>).	GMT	Greenwich mean time.
BTN	Between.	GND	Relative to ground.
CB	Cumulonimbus.	HEL	Helicopter.
CC	Cirrocumulus.	HF	High frequency [3,000 to 30,000 kc/s.].
CEN	Degrees centigrade.	HR	Hours (<i>period of time</i>).
CI	Cirrus.	IAR	Intersection of air routes.
CLA	Clear type of ice formation.	ID	Identification.
CLR	Cleared to . . .		
CS	Cirrostratus.		
CTA	Control area.		
CTR	Control zone.		
CU	Cumulus.		

TABLE 4.—Miscellaneous abbreviations and signals for aeronautical services—Continued

Abbreviation or signal	Meaning	Abbreviation or signal	Meaning
IFR	Instrument flight rules.	MET	Meteorological.
ILS	Instrument landing system.	MF	Medium frequency [300 to 3000 kc/s.].
IMT	Immediately.	MKR	Marker radio beacon.
INA	Initial approach.	ML	Statute mile(s).
INF	Below . . .	MNTN	Maintain.
INP	If not possible.	MOD	Moderate (<i>used to qualify icing, turbulence, interference or static reports</i>).
INS	Inches (<i>dimensional unit</i>).	MPH	Statute miles per hour.
IR	Ice on runway.	MRG	Medium range.
IRL	Intersection of range legs.	MS	Minus.
IVB	If forward visibility is less than . . . (<i>figures and units</i>).	MSL	The indication of vertical distance is given as the reading, without correction for ambient temperature of a pressure altimeter set to QNH.
IVR	If forward flight visibility remains . . . (<i>figures and units</i>).	MTU	Metric units.
KC	Kilocycles per second.	MX	Mixed type of ice formation (<i>white and clear</i>).
KG	Kilogrammes.	N	North latitude. (<i>To be used only with figures indicating latitude, e.g. 4730N.</i>)
KM	Kilometres.		<i>Aeronautical Note.—In the maritime mobile service, the abbreviation N signifies No and is used in that service to give a negative sense to Q signals.</i>
KMH	Kilometres per hours.	NDB	Non-directional radiobeacon.
KT	Knots.	NE	North-East.
LB	Pounds (<i>weight</i>).	NM	Nautical mile(s).
LEFT	Left (<i>direction of turn</i>).	NML	Normal.
LF	Low frequency [30 to 300 kc/s.].	NO	No.
LNG	Long (<i>used to indicate type of approach desired or required</i>).	NR	Number.
LRG	Long range.	NS	Nimbostratus.
M	Metres.	NW	North-West.
MAG	Magnetic.	OPA	White type of ice formation.
MB	Millibars.		
MC	Megacycles per second.		
MER	The indication of vertical distance is given as TRUE height above mean sea level (<i>e.g. after applying the correction for ambient temperature to the altitude reading of a pressure altimeter set to QNH</i>).		

TABLE 4.—Miscellaneous abbreviations and signals for aeronautical services—
Continued

Abbreviation or signal	Meaning	Abbreviation or signal	Meaning
OPC	The control indicated is Operational Control.	SIA	Standard instrument approach.
ORD	Indication of an order.	SID	Standard instrument departure.
PLA	Practice low approach.	SKED	Schedule.
PP	Descent through cloud (procedure).	SLW	Slow.
PRES	The indication of vertical distance is (or is to be) replaced by the indication of the pressure, expressed in millibars, at the level and the position of the aircraft.	SOL	The indication of vertical distance is given as the reading, without correction for ambient temperature of a pressure altimeter set to QFE. (The abbreviation should only be used in the vicinity of the station which provided the QFE setting).
PREVU	The information refers to forecast and not to present conditions.		
PSGR	Passenger(s).	SRG	Short range.
PS	Plus.	ST	Stratus.
PTN	Procedure turn.	STA	Straight in approach.
QUAD	Quadrant.	STD	The indication of vertical distance is given as the reading, without correction for ambient temperature, of a pressure altimeter having the sub-scale set to 1013.2 millibars (29.92 inches).
RAD	The control referred to is Radio Control.		
RCA	Reach cruising altitude.		
RDO	Radio.		
REP	Reporting point.		
RITE	Right (direction of turn).	SUP	Above . . .
RNG	Radio range.	SW	South-West.
RNWY	Runway.		
ROFOT	Route forecast in units of English system.	TAFOT	Aerodrome forecast in units of English system.
ROMET	Route forecast in units of Metric system.	TAMET	Aerodrome forecast in units of Metric system.
RON	Receiving only.	TER	The indication of vertical distance is given as TRUE height above official aerodrome level (e.g. after applying the correction for ambient temperature to the vertical distance reading of a pressure altimeter set to QFE).
RP	Rapid.		
RTT	Radioteletypewriter.		
S	South or Southern latitude.		
SAP	As soon as possible.		
SC	Stratocumulus.		
SE	South-East.		
SEV	Severe.		

TABLE 4.—*Miscellaneous abbreviations and signals for aeronautical services—*
Continued

Abbreviation or signal	Meaning	Abbreviation or signal	Meaning
TFZ	Traffic zone.	VFR	Visual flight rules.
TGL	Touch and go landing.	VHF	Very high frequency [30,- 000 kc/s. to 300 Mc/s.].
TIL	Until.	VLR	Very long range.
TIP	Until past . . . (<i>place</i>).		
TO	To . . . (<i>place</i>).	VOR	VHF omnidirectional ra- dio range.
TRB	It is not necessary to keep to the runways and taxi- ways after landing.	VSA	By visual reference to the ground.
TT	Teletypewriter.		
TWR	Aerodrome control.	W	West or Western longi- tude.
UAB	Until advised by . . .	WX	Weather.
UFN	Until further notice.		
VAN	Runway control van.	XS	Atmospherics.
VIA	By way of . . .	YD	Yards.
VIO	Heavy (<i>used to qualify ic- ing, turbulence, inter- ference or static re- ports</i>).	YR	Your.

TABLE 5.—*Extracts from the Telegraph Regulations (Paris Revision, 1949) annexed to the International Telecommunication Convention (Atlantic City, 1947)*
 249 § 4. More Code Signals.

Spacing and length of signals:	
250	(a) A dash is equal to three dots;
251	(b) The space between the signals forming the same letter is equal to one dot;
252	(c) The space between two letters is equal to three dots;
253	(d) The space between two words is equal to seven dots.
*	*
*	*
*	*
*	*
*	*
*	*
255	LETTERS
a	— . —
b	—
c	—
d	—
e	—
é	—
f	—
g	—
h	—
i	—
j	—
k	—
l	—
m	—
n	—
o	—
p	—
q	—
r	—
s	—
t	—
u	—
v	—
w	—
x	—
y	—
z	—
256	FIGURES
1	—
2	—
3	—
4	—
5	—
6	—
7	—
8	—
9	—
0	—
*	*
*	*
*	*
*	*
*	*
*	*
259	SIGNS
Full stop (period)	----- [.] —
Comma	----- [,] — —
Colon	----- [:] — —
Question mark (note of interrogation) or request for repetition of a transmission not understood	----- [?] —
Apostrophe	----- ['] —
Hyphen or dash	----- [-] — —
Fraction bar	----- [/] — —
Brackets (parentheses) (before and after the words)	----- [()] — —
Inverted commas (quotation marks) (before and after the words)	----- [“ ”] —
Administrations and recognized private operating agencies using code converters may use the apostrophe twice, before and after the words, to signal inverted commas (quotation marks).	
Double hyphen	----- [=] — —
Understood	----- [] —
Error	----- [] —
Cross or signal for the end of a telegram or of transmission	----- [] —

TABLE 5.—*Extracts from the Telegraph Regulations (Paris Revision, 1949) annexed to the International Telecommunication Convention (Atlantic City, 1947)*
—Con.

SIGNS—continued							
259	Invitation to transmit ----- . . . Wait ----- End of work ----- Starting signal (to precede every transmission) ---- 						
260	The provisions regarding the transmission of fractional numbers which are applicable to instruments using International Telegraph Alphabet No. 1 (§ 2) shall also be applicable to instruments using the Morse code.						
261	A group consisting of figures and letters shall be transmitted without space between figures and letters.						
262	The following letters and signals may be used in relations between countries which accept them:						
	<table border="0" style="width: 100%;"> <tr> <td style="text-align: center;">ä</td> <td style="text-align: center;">ñ —</td> </tr> <tr> <td style="text-align: center;">á or å</td> <td style="text-align: center;">ö —</td> </tr> <tr> <td style="text-align: center;">ch —</td> <td style="text-align: center;">ü</td> </tr> </table>	ä	ñ —	á or å	ö —	ch —	ü
ä	ñ —						
á or å	ö —						
ch —	ü						
* * *	* * *						
221	A number which includes a fraction shall be transmitted with the fraction linked to the whole number by a single hyphen. <i>Examples:</i> 1-3/4 and not 13/4; 3/4-8 and not 3/48; 363-1/2 4 5642 and not 3631/2 4 5642.						

APPENDIX III

SUMMARY OF RADIOTELEPHONE OPERATING PRACTICE— ELEMENT II

A licensed radio operator should remember that the station he desires to operate should be licensed by the Federal Communications Commission. In order to prevent interference and to give others an opportunity to use the airways he should avoid unnecessary calls and communications by radio. He should remember that radio signals normally travel outward from the transmitting station in many directions and can be intercepted by unauthorized persons.

Before making a radio call, the operator should listen on the communications channel to insure that interference will not be caused to communications which may be already in progress. At all times in radio communications the operator should be courteous.

Station identification should be made clearly and distinctly so that unnecessary repetition of call letters or names is avoided and to enable monitoring stations to clearly identify all calls.

To prevent tampering, a radio transmitter should at all times be either attended by or supervised by a licensed operator or the transmitter should be made inaccessible to unauthorized persons.

A radio transmitter should not be on the air except when signals are being transmitted. The operator of a radiotelephone station should not press the push-to-talk button except when he intends to speak into the microphone. Radiation from a transmitter may cause interference even when voice is not transmitted.

When radio communications at a station are unreliable or disrupted due to static or fading, it is not a good practice for the operator to continuously call other stations in attempting to make contact because his calls may cause interference to other stations that are not experiencing static or fading.

A radiotelephone operator should make an effort to train his voice for most effective radiocommunication. His voice should be loud enough to be distinctly heard by the receiving operator and it should not be too loud since it may become distorted and difficult to understand at the receiving station. He should articulate his words and avoid speaking in a monotone as much as possible. The working distance range of the transmitter is affected to some extent by the loudness of the speaker's voice; if the voice is too low, the maximum distance range of the transmitter cannot be attained, and if the voice is too loud the distance range may be reduced to zero due to the signals becoming distorted beyond intelligibility.

It is important in radiotelephone communications that operators use familiar and well-known words and phrases in order to insure accuracy and save time from undue repetition of words. Some radio operating companies, services, networks, associations, etc., select and adopt standard procedure words and phrases for expediting and clarifying radiotelephone conversations. For example, in the aviation services, "Roger" means "I have received

all of your last transmission"; "Stand by" means "Wait for another call or further instruction"; "Out" means "This conversation is ended and no response is expected"; "Over" means "My transmission is ended, and I expect a response from you"; "Break" indicates a separation between portions of a message; "Say again" means "Repeat", and "words twice" is used to ask a station to send every phrase twice. The above procedure words are often used in other communication services.

Often in radiotelephone communications a "phonetic alphabet" or word list is useful in identifying letters or words that may sound like other letters or words of different meaning. For example "group" may sound like "scoop", or "bridge" may sound like "ridge". A phonetic alphabet or word list consists of a list of 26 words each word beginning with a different letter for identifying that particular letter. If the letters in "Group" are represented in a phonetic alphabet by George, Roger, Oboe, Uncle and Peter, the word "Group" is transmitted as "Group, G as in George, R as in Roger, O as in Oboe, U as in Uncle, P as in Peter".

In making a call by radio, the call sign or name of the called station is generally given not more than 3 times followed by the call sign, or in some services the name, of the calling station not more than 3 times.

In testing a radiotelephone transmitter the operator should clearly indicate that he is testing, and the station identification should clearly be given. Tests should be as brief as possible.

If a radio station is used only for occasional calls, it is a good practice to test the station regularly. Regular tests may reveal defects or faults which if corrected immediately may prevent delays when communications are necessary. Technical repairs or adjustment to radio telephone communication stations are made only by or under the immediate supervision and responsibility of operators holding first- or second-class licenses.

When a licensed operator in charge of a radiotelephone station permits another person to use the microphone and talk over the facilities of the station he should remember that he continues to bear responsibility for the proper operation of the station.

SUMMARY OF ELEMENT V

Radiotelegraph operating procedures and practices differ in many respects from that of radiotelephony. In radiotelephony, conversations are generally carried on in an informal manner similar to speaking on a wire telephone line while in radiotelegraphy, messages are generally formally written in advance of transmission. Generally the structure of a message consists of the preamble, the address, the text and the signature. The radio operator prepares the preamble, while the other parts are supplied by the sender of the message.

The preamble usually contains a prefix which indicates the type of message, charge rate classification and the priority. The preamble also contains the daily serial number of the message, word count or check, place of origin, time and date of filing and instructions for routing the message.

The address of the radiotelegram indicates to whom the message is to be delivered.

The text of the message contains the information that the sender wishes to convey to the recipient of the message. The signature gives the name of the person who filed the message.

Sometimes, for security reasons, radiotelegraph messages are written in code or cipher language. In code language the message is often sent in groups

of four or five numbers or letters of no apparent meaning, but which can be decoded by the recipient of the message. Cipher language is composed of figures, words, names or combinations of letters of no apparent meaning but which can be deciphered by the recipient of the message.

In radiotelegraphy as well as in radiotelephony, the calling station normally gives the call sign of the called station three times followed by the call sign of the calling station three times. For example, if KARC calls WDEF, the call would be made as:

WDEF WDEF WDEF DE KARC KARC KARC K

WDEF answers:

KARC KARC KARC DE WDEF WDEF WDEF R K

The international Morse code is used by most radiotelegraph stations. The code is transmitted either by hand or by automatic devices. When transmitted by hand, either a Morse hand key is used or a semiautomatic key or "bug" is used. Some stations use teletypewriter machines employing special telegraph signals.

When using hand or semiautomatic telegraph keys, the speed of transmission varies from approximately 10 to 40 words per minute, depending upon the proficiency of the operators.

Only radio stations that are licensed for public correspondence accept messages from the general public for transmission by radio. Most radio stations in the various services such as police, fire, forestry, aeronautical, highway maintenance, highway trucking, industrial, intercity bus, railroad and taxicab stations carry on nonpublic communications for their own service or business. Point-to-point and land mobile stations in the Public Radio-communication Services, a number of coast stations, most ship stations and some aircraft stations are open to public correspondence and make charges for the transmission of messages from the public in accordance with tariff regulations.

After listening for long periods to CW signals of constant tone, receiving operators may become fatigued. Often operators avoid this fatigue by changing the pitch of the signal by slightly retuning the receiver or by readjusting the BFO control.

Many radiotelegraph systems employ break-in operation wherein the receiving station can break-in on the transmitting station for the purpose of getting fill-ins or repeats of words missed. When break-in is employed, the transmitting operator is able to listen on the channel between dashes, dots or at anytime that his key is open.

In addition to the tuning control, most radiotelegraph receivers are equipped with a beat oscillator, selectivity control, RF gain control, audio gain control, antenna trimmer condenser and a crystal phasing control. Generally when radiotelegraph signals are being received the AVC is off and the sensitivity is adjusted with the RF gain control. Normally the RF gain control is adjusted to a point just below that at which the signals overload the receiver. The audio volume control is adjusted to the comfort of the receiving operator. In some receivers the RF and AF controls are combined into one control.

When interference and static is severe, the receiver is adjusted for sharp selectivity. The receiver is in sharpest selectivity when the crystal phasing switch is on.

Quite often a radio station can be heard on a radio receiver at frequencies other than the assigned frequency of the transmitting station. Sometimes the fault is due to improper operation of the transmitting station but in

many instances it is due to the inherent characteristics of the receiver. If the cause is within the receiver, the operator can do little about it except to be aware of the phenomena and perhaps by proper tuning of the receiver to avoid the effects. He will find that the desired station can be best received if he tunes in on the assigned frequency of the station rather than tuning in on an apparent frequency or image frequency on the receiver. The effect of receiving a signal on an "image" frequency may cause apparent interference to the desired signal and the operator should be aware of this condition in order that he may make necessary adjustments.

