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PRIVATE SERVICE SYSTEMS
10A ALERTING SYSTEM
SWITCHING CONTROL CIRCUIT

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit provides consoles and switching control equipment for 4-wire telegraph facilities equipped with line failure alarms that will enable North American Air Defense Command (NORAD) to instantly initiate an alert over dual and diverse facilities to all Regions and Sectors, and over single lines to all Site installations in its command. Facilities are provided to transmit, in addition to the alert signal, test alert and release signals for NORAD and the Region installations and appropriate acknowledgment signals from all locations.

2. GENERAL

2.01 The overall network consists of direct dual and diverse telegraph lines from the NORAD headquarters to each Region installation. Each Region in turn is connected via similar facilities to each Sector in its command. Each Sector is connected via a single line to each Site in its command. (See Fig. 1.)

2.02 As a convenience of description, when considering a Region location, NORAD will be referred to as the "upstream location," and the two lines between NORAD and the Region will be referred to as "upstream lines." All Sectors reporting to the Region will be referred to as "downstream locations," and the two lines connecting the Region to each Sector will be referred to as "downstream lines." At each Sector, the Region and its associated lines will be called "upstream" and each Site and its line will be called "downstream." Of course, the Site, being the last in the chain, will only have an "upstream" line to its associated Sector installation, and the NORAD installation, being the first in the chain, will only have "downstream" lines to each of its Region locations.

2.03 The telegraph lines are used to transmit and receive pulses at a rate of 10 pps, which are in the form of 2-out-of-5 pulse length code (PLC) words. The words are interpreted as signaling, control, and line continuity checking functions.

2.04 Five code words are used in this system, and are used to indicate the following functions:

(1) Alert - Originated by the Ballistic Missile Early Warning System (BMEWS) computer, NORAD, and Region locations to all installations in the defense area.

(2) Test Alert - Except for BMEWS, same as above. Also, an arrangement is provided to test alert individual Regions by NORAD or Sectors by Region.

(3) Release - Originated by NORAD or Region to all installations in its defended area. A Region cannot release if NORAD had initiated the alert or test alert.

(4) Manual Acknowledgment - Originated at Region, Sector, and Site locations to indicate to the higher level of authority that the alert or test alert signals have been received.

(5) Continuity - Originated by NORAD and repeated to all locations in the defense as check of the integrity of the line. Failure to receive a continuity word or any one of the other four words in a 20- to 30-second period will cause appropriate alarms to sound.

The alert and test alert signals are repeated three times, and receipt of two out of three words at the distant end will activiate the alert or test alert logic circuitry. This will cause appropriate signals to function at the receiving locations. In addition, the code words will be retransmitted to all downstream locations. The release and manual acknowledgment words are transmitted only once, and receipt of the word will activate the signals and retransmit the word downstream. The continuity word is transmitted once every 6 seconds and, upon receipt, is retransmitted both upstream and downstream. In the event of failure of an upstream line at a Region or Sector location, a continuity start pulse generator at the affected location will be activated and transmit new continuity check words downstream until such time as the upstream circuit is again operative.

2.05 When an alert or test alert signal is received and recognized at Region, Sector, and Site locations, the words, in addition to being retransmitted downstream, where applicable as described above, are also transmitted back upstream so that the upstream location will receive a signal in the form of a flashing lamp to inform the attendant at the upstream location that the signal has been received by the downstream location. This facility is referred to as an automatic acknowledgment signal. In the case of the release signal, the receipt of the signal back to the upstream location from the downstream location will release the circuitry associated with the automatic and manual acknowledgment signals.

2.06 As shown in Fig. 2, 3, 4, and 5, there are consoles for each of the four types of installations. Signals are initiated by the operation of the appropriate nonlocking keys and lamp signals indicate operated keys or receipt of signals. Circuitry is provided to test the switching equipment and associated PLC sending and receiving equipment locally at each location. Override circuits are provided which give priority to alert and test alert signals. The receipt of an

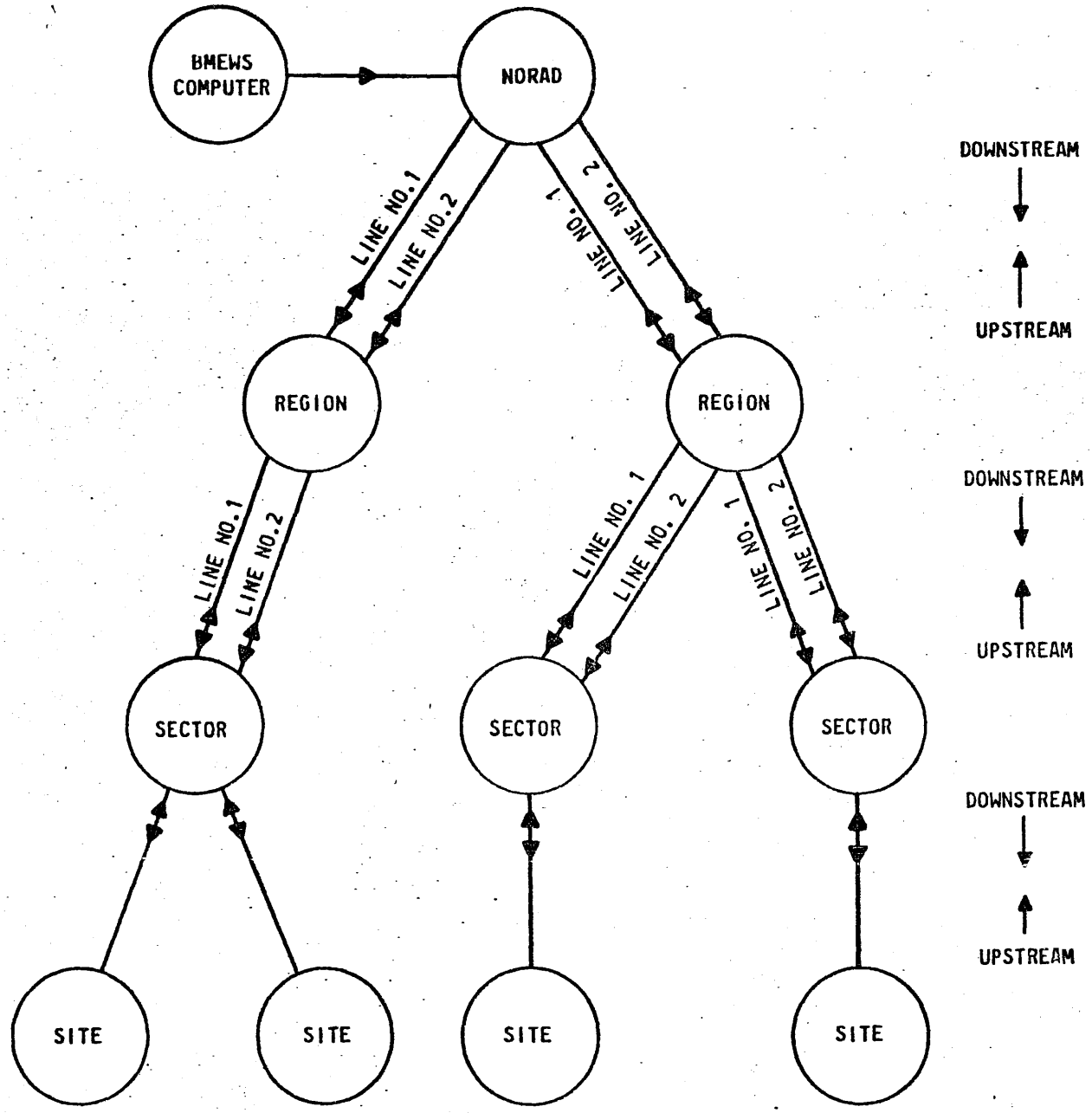


Fig. 1 - 10A Alerting System

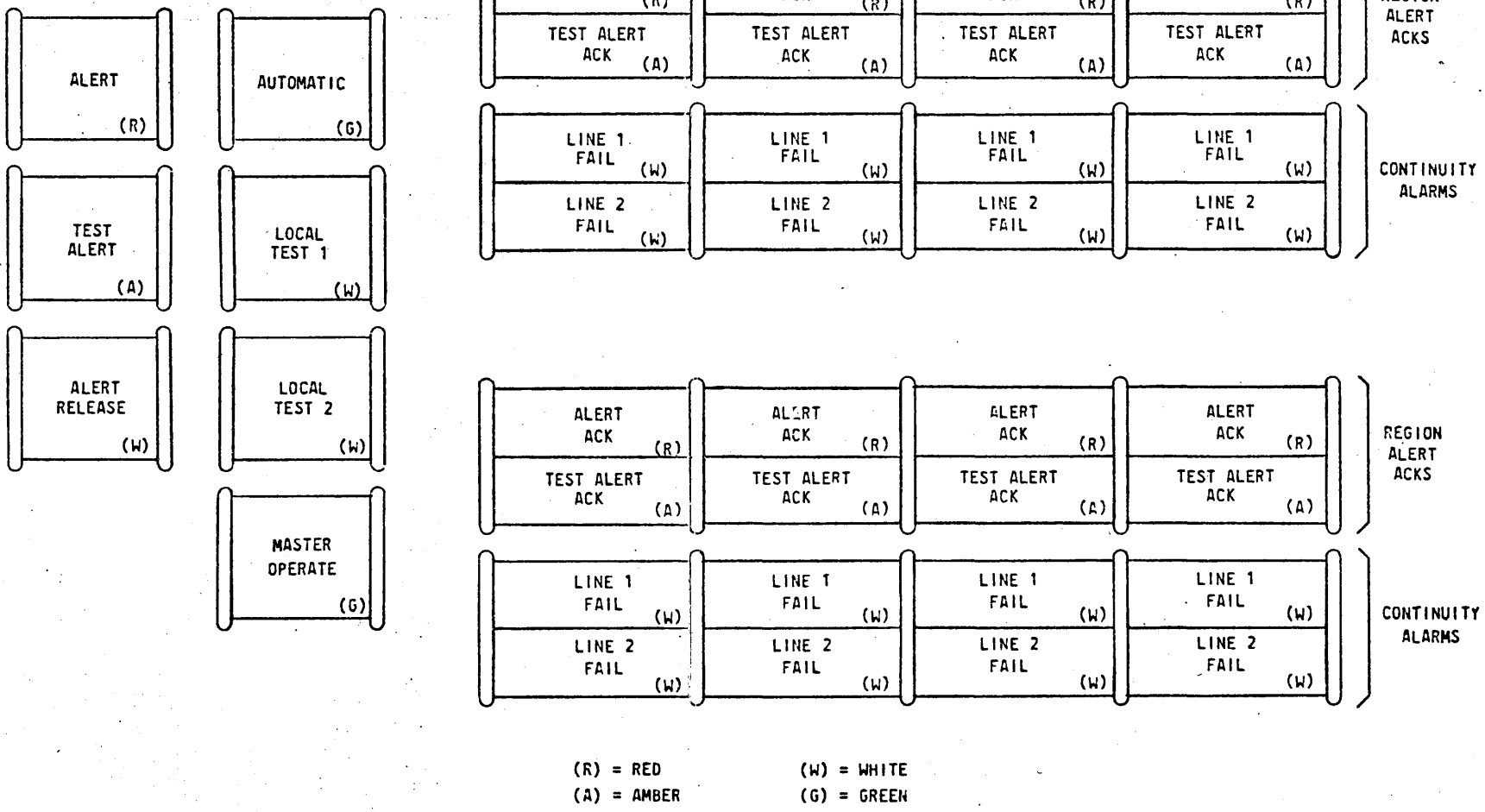


Fig. 2 - NORAD Controls

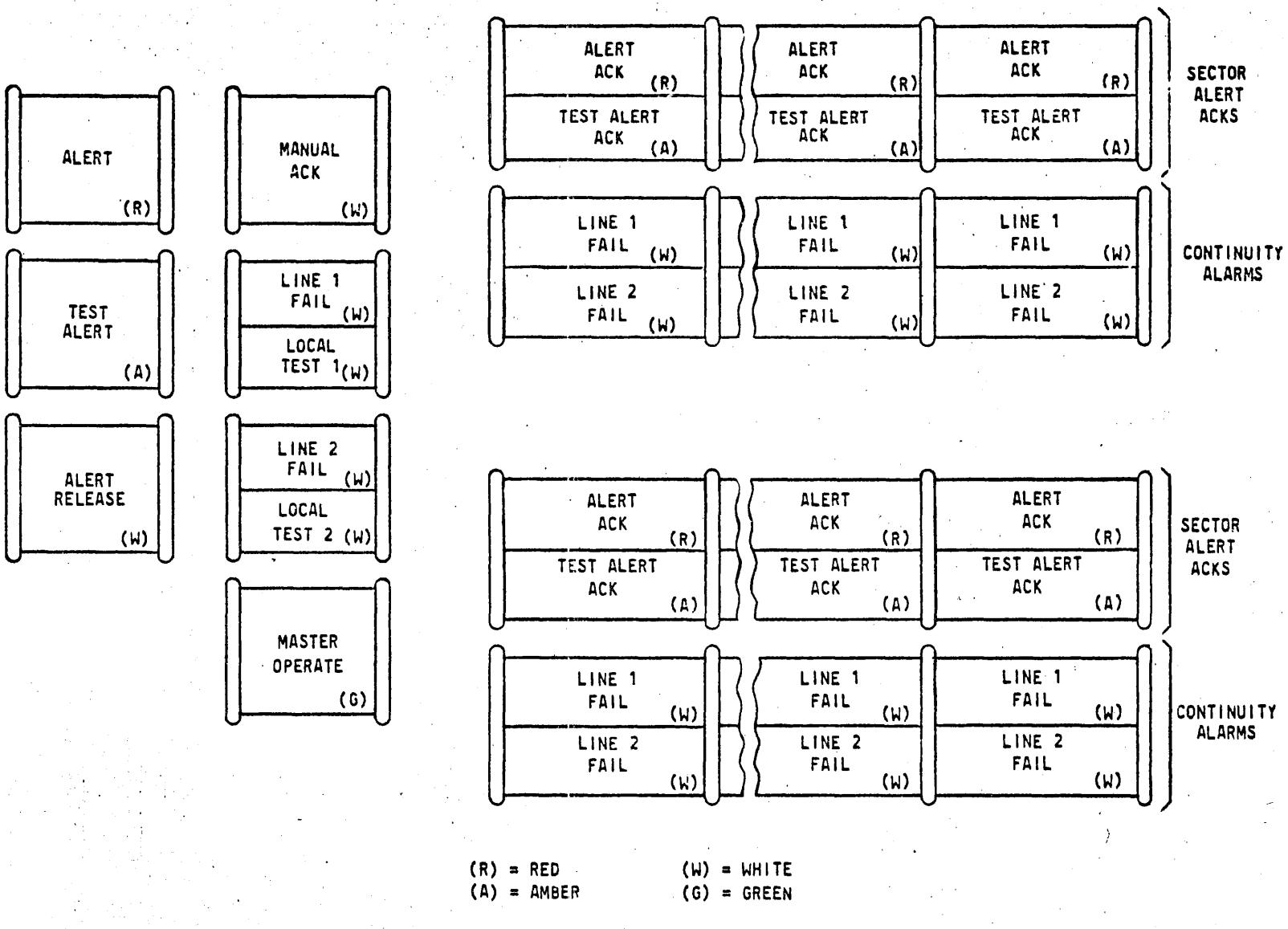
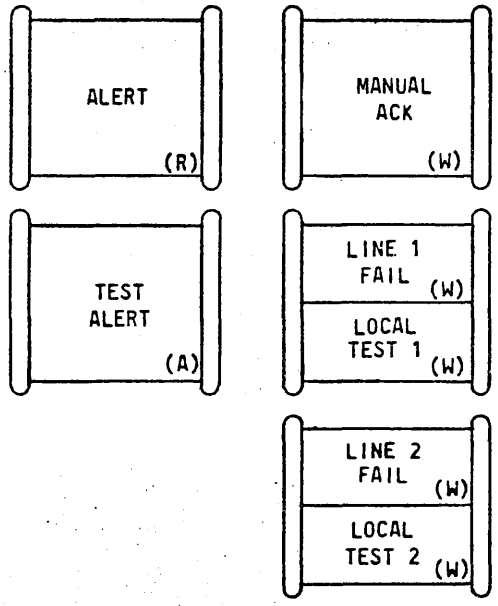
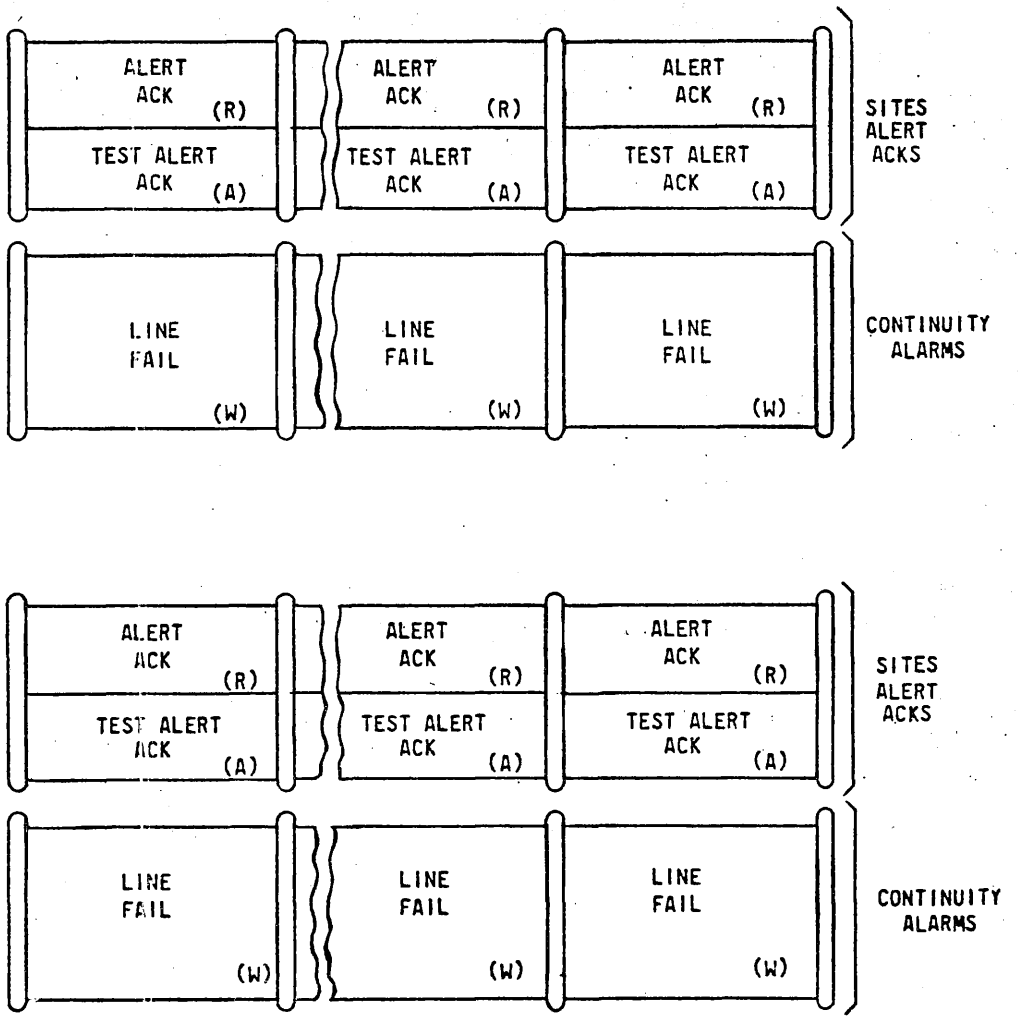
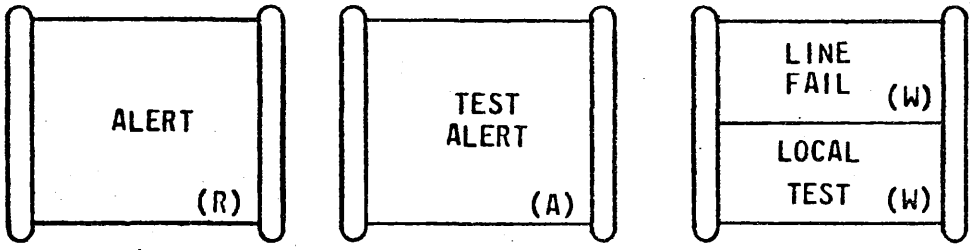


Fig. 3 - Region Controls





(R) = RED (W) = WHITE
(A) = AMBER



(R) = RED (W) = WHITE
(A) = AMBER

Fig. 5 - Site Controls

alert signal at any location will retire operated test alert circuits. The receipt of an alert signal at all locations, except Sites, will retire any operated local test circuit.

2.07 An alert initiated by NORAD will be described below. The other signals have a similar method of operation, except that only the alert and test alert require the transmitting of three words and receiving of at least two words.

2.08 Initiating an alert at NORAD by a 2-key operation will cause PLC sending equipment to transmit three alert code words downstream to all Regions. Receipt of the first code word by the PLC receiver at the Region will be registered in logic circuitry and a timed gate will be opened for a sufficient period to receive two additional code words. Upon receipt of the second recognizable word, the alert logic circuit will register the second word, and cause the following operations:

(a) Sounding of audible alarms and flashing lamps at the consoles.

(b) Transmission of three alert code words downstream to all Sectors in its defense.

(c) Transmission of three code words upstream to activate the automatic alert acknowledgment circuitry to function at the NORAD installation.

The acknowledgment signal will indicate to NORAD that the Region has received the alert signal. If at the time the alert signal was received the Region had been conducting a test alert or local test exercise, the alert signal would have overridden and retired the test. In addition, receipt of each code word would indicate to the continuity checking circuits that at least one recognizable word had been received, and that the integrity of the line was secure. Operation of the ALERT key at a Region will retire the audible signals, and change the flashing ALERT lamp to steady. Receipt of the 2-out-of-3 words at each Sector will cause logic circuitry, similar to that provided at the Region location, to function and transmit the three alert codes back up to Region and down to all Site locations in the command. Receipt of the 2-out-of-the-3 alert words at the Site will sound audible signals, flash the ALERT lamp, and retransmit the alert code words back to its Sector location to control the automatic acknowledgment lamps at the Sector console position. When the attendant at the Site control operates his ALERT key to silence the alert bell and retire the flashing lamp, the code sending equipment is conditioned to transmit the manual acknowledgment code word to the Sector location. At Sector, the manual acknowledgment code word is received and the flashing acknowledgment lamp is changed to a steady condition. As the Site locations acknowledge manually, all of the Site acknowledge lamps are changed to a steady condition. When all of the Sites reporting to the Sector have acknowledged, the attendant at the Sector console operates the MANUAL ACK key and the appropriate code word is transmitted upstream to its Region. In turn, when all of the Sectors have manually acknowledged to the Region, that location transmits the manual acknowledgment word upstream to the NORAD location. In this manner, each Sector and Region and the NORAD location know that all installations in their defense have received and acknowledged the alert.

2.09 The test alert signal is transmitted and received in a similar manner except that the TEST and TEST ACK lamps light; another difference is that circuitry is provided whereby the NORAD and the Region installations may individually test alert one or more of their downstream locations, or all downstream locations simultaneously.

2.10 Release signals are also transmitted and received in a similar manner as the alert signal, except that only one code word is used. Receipt of the release signal at a location releases all operated switching equipment controlled from upstream

signals and transmits the release signal upstream to release the acknowledgment switching equipment controlled from signals received from downstream.

2.11 In order to check the reliability of the code transmitting, code receiving, and logic circuitry used in the system, a local test circuit arrangement is provided. This circuit provides for:

(a) Disconnecting all lines, both upstream and downstream from the switching equipment.

(b) Exercising all transmitting, logic, and receiving equipment associated with the facility by locally transmitting three alert signals, ignoring the middle code word.

(c) Automatically returning the circuits to their normal condition in approximately 8 to 12 seconds.

2.12 A lamp filament check circuit is provided to enable the attendant to verify that all lamps are in good condition at any particular installations. Operation of the local TEST-LINE FAIL key will light all of the lamps at the consoles.

2.13 At NORAD, Region, and Sector locations two consoles are provided. The operating console is provided with keys and lamps, the monitor console is provided only with the lamps, but in other respects is the same as the operating console. Lamp power supplies, in the form of transformers, are provided to furnish power to lamps. The signals on power is ±28 volts ac and optional back-lighting power; ±10 volts ac is provided for use in dark environment locations. Direct current (24 volts dc) backup power switching facilities are provided on an optional basis. With this arrangement, relays, held operated by the ±28 volts ac power, will release, if the ac supply fails, and connect the lamp circuits to locally supplied 24-volt dc batteries.

2.14 An arrangement is provided at NORAD to connect this alert system to the BMEWS computer or to a similar computer system so that an alert can be initiated automatically by the machine. Operation of the AUTOMATIC key at the NORAD console connects this system to the computer, and a signal from the machine will originate an alert in a manner similar to that described above. Release of the alert must be initiated by the attendant at the NORAD console.

SECTION II - DETAILED DESCRIPTION

1. ORIGINATING AN ALERT

"NORAD" AND REGION

1.01 Operation of the ALERT key, FS1, operates the AL relay via the RR relay normal and Y, V, and 7 options. The AL relay operated (a) locks up to ground under control of the KT timer, FS38, option 13, (b) connects ground to the start lead of the KT timer, (c) opens the operate path of the TST relay to avoid originating both an alert and a test alert simultaneously, and (d) at Region location, operates the ALA relay. The ALA relay operated opens the operate path of the TW relay to disable the test alert logic when the region is in an alert mode.

1.02 Operation of the MASTER OPERATE key within 3 seconds will operate the MAS relay, FS4. The MAS relay operated will (a) operate the AUM relay to open the start lead of the KT timer, (b) operate the KD relay, FS4, (c) lock up under control of the RR relay, and (d) connect ground to the winding of the RR relay, FS39, via the KD relay operated. The RR relay which is a slow-operate type will operate in approximately 50 msec. When the RR relay operates, the MAS relay will lock up via the RR and KD relays operated to ground on the T1 and T2 leads of the code sending circuits. The RR relay operated will lock up to the MAS relay. If the MAS relay key is not operated within 3 seconds of the time the ALERT key has been operated, the KT timer will function and release the AL relay. This circuitry provides a 2-key operation, and guards against a false alert being originated by unintentional operation of the ALERT key.

1.03 In FS17, a ground is connected to the AL lead of the Code Register Circuit (line 1) during the operate time of the RR relay via the MAS relay operated, the RR and RLS relays normal, the AL relay operated (contact 10), V and X options, and the LF1 relay normal. The ground pulse is also connected to the Code Register Circuit (line 2) via the AL lead, AL relay (contact 11), V and X options, and the LF2 relay normal. The Code Register Circuit and code sending circuit will cause the SE1 and SE2 relays to function and follow the pulse-length code output pulses of the code sending circuits via the M4 lead, and the LF1, LF2, L1A, and L2A relays normal. The Code Register Circuit and sending circuit are arranged to send three PLC words automatically whenever a 50-msec ground is connected to the AL lead.

1.04 In FS20, the downstream line transmit circuit, pulsed operation of the SE1 (line 1) or SE2 (line 2) relay will, (a) with H option, operate and release the L1- and L2- relays of FS19 to open and close the telegraph line, (b) with S option, alternately connect +80 volts and ground to the O lead of all 43A1 or equivalent telegraph terminals, and (c) with R option will operate and release the M- relays of FS19 to connect -48 volts and ground alternately to the M lead of the DX signaling equipment. A separate group of M- relays or the L1- relays will be provided for dual facilities line 1 and another group of M- relays, or the L2- relays will be provided for dual facilities line 2. The functions of the COA, COB, CO-, and R relay contacts shown in FS20 are described in 4.06.

1.05 The three alert codes are transmitted downstream to all Regions, in the case of an alert originated at NORAD, and to all Sectors of its defense when the alert is originated at a Region. When the alert is originated at a Region, the alert codes are also transmitted upstream to NORAD to notify the console attendant, via a flashing acknowledgment lamp, that the Region has initiated an alert. In FS19, pulsed operation of the SE1, SE2, L1-, L2-, and M- relays as described above will open and close the telegraph loop, H option, connect +80 volts dc and ground to the 43A1 telegraph terminals of the upstream line, S option, or -48 volts dc and ground to the M lead of the DX signaling units, R option. In this case the circuit is via the CT1 and CT2 relays normal.

BMEWS

1.06 An arrangement is provided whereby the BMEWS, or similar computer associated with the defense system, can be connected into this circuit and, upon providing approximately a 2-second ground input signal, can originate an alert on this alerting system.

A. Automatic Key

1.07 In FS9, momentary operation of the AUTOMATIC nonlocking key applies ground to the windings of both relays, BMW and BMZ, through the break contact of continuity transfer 9 of the BMW relay. Only BMW operates, however, since relay BMZ is shunted down through its own back contact. After the AUTOMATIC key is released, BMW remains operated as a result of its locking path to ground and BMZ operates from the locking path of BMW since BMZ is no longer shunted down by the key ground. The BMW and BMZ relays are now operated and the BMEWS computer is connected to this system. In order to disconnect the computer, the AUTOMATIC key is operated a second time and key ground is connected via the M2 contact of the BMZ and shunts the BMW, releasing it. Relay BMZ remains operated since its operating path is transferred to the key lead by the action of the continuity transfer of the BMW relay. When the key is released, BMZ is released and the circuit returns to normal.

B. Originating Circuit

1.08 When the computer connects ground on the BM lead, the BM relay operates.

The BM relay will remain operated as long as ground is sustained on the BM lead, and applies ground to the winding of the BP relay via the BP thermistor. The BP thermistor delays the operation of the BP relay by approximately 300 to 600 msec. During this time, ground is connected to the receive alert logic circuitry, of FS13, option 8, via the BM relay operated, the BP relay released, and the BMZ relay operated to operate the OLB relay for approximately the heating time of the thermistor (300 to 600 msec), plus the release time of the OLB relay. Functions of the OLB relay are described in 11.09. The BP relay operated (a) shorts the BP thermistor to bypass the relay operating current and (b) connects ground to the winding of the BP1 relay via the BP1 thermistor and a break contact of the OLT relay. The OLT relay is a slave of the OLB relay and as soon as the OLB and OLT relays release, the thermistor will begin to heat. In approximately 300 to 600 msec, the BP1 relay will operate and short the BP1 thermistor. During the thermistor heating time, ground is connected via the BP and Z1 relays operated, the BP1 relay normal, and the BMZ relay operated to operate the CR relay of FS13. Functions of the CR relay are described in 2.05. The BM, BP, and BP1 relays will remain operated until the BMEWS computer removes ground from the BM lead.

2. RECEIVING AN ALERT

GENERAL

2.01 At Region and Sector locations the two lines from upstream are terminated in two separate interface circuits and each line is equipped with its own code receiver circuit and output switching equipment as shown in FS11. The pulses which constitute the alert PLC words are fed from each line to its own code receiver and output circuits. In order for an alert word to be recognized by the logic switching, outputs from both receiver circuits must be present. In the event that one of the upstream lines fails, the switching equipment will condition itself to accept the output from the receiver associated with the good line as an alert signal. Of course, 2-out-of-3 alert signals must be received in either case before the switching equipment will activate the audible and visual alert signals at the console. At Site locations only a single upstream line from the Sector is provided, so only one interface circuit (code receiver circuit and output switching circuit) is provided as shown in FS12.

2.02 When telegraph dc loop facilities are provided, options H and 15 are used. If the carrier facilities are collocated in the same location as this switching equipment, options S and 15 are used. If DX signaling facilities are provided, R option is used. When options H or S and 15 are provided, circuit opens and closures equivalent to the PLC words will pulse the RS relay, which in turn will drive the PF relay of the code receiver circuit via the M4 lead, FS11 and 12. When DX signaling is provided, ground pulses on the E lead will control the PF relays.

REGION AND SECTOR

A. Both Facilities Operative

2.03 In FS11, ground pulses equivalent to the PLC alert word on the E lead, R option, or from the RS relay, 15 option, are connected to the M4 lead of the code receiver circuits via normal contacts of the CT1 and LT1 relays for line 1 and the CT2 and LT2 relays for line 2. If the ground pulses constitute an alert word, the code receivers provide a ground pulse on the AL lead for approximately 200 msec.

2.04 The AL1 relay (line 1) and the AL2 relay (line 2) will operate for a period of approximately 0.5 second, because they are of the slow-release type having a release time of approximately 300 msec. The AL1 and AL2 relays operated operate the OK1 and OK2 relays, respectively, to register a continuity pulse. In addition, the ground (in FS13) is connected to the winding of the W1 and Z1 relays via 7M of the AL1 and 7M of the AL2 relays in series (X, Y option), a break contact of the Z1 relay, and a continuity contact of the W1 relay. The W1 relay will operate and lock up to ground via the make of the continuity transfer and a break of the ALT relay. The Z1 relay is shunted down and will not operate at this time. When the ground is removed from this output of the code receiver, FS11, the AL1 and AL2 relays will release and remove the shunt path from the winding of the Z1 relay allowing it to operate. The Z1 relay operated (a) transfers the input lead connected to 7M of the AL2 relay from the windings of the W1 and Z1 relays to the winding of the CR relay via M10 of the Z1 relay and break contacts of the LT1, LT2, ALT, OLT, and 2C relays, and (b) connects battery to the 12 lead of the AL timer to start that unit.

2.05 At this point in the sequence of operation, the alert logic has registered the first alert code word and has started the AL timer to provide a 5-second time gate, during which a second code word must be received or the T relay of the AL timer will operate, operating the ALT relay which in turn will release the W1 and Z1 relays. The timer circuitry provides a guard against random false outputs, occasioned by noise on the lines, from adding up and originating a false alert. When the code receiver, FS11, has received the second alert word, the AL1 and AL2 relays operate

and release as described above. The ground pulse operates the CR relay via make contacts of the AL1, AL2, and Z1 relays and break contacts of the LT1, LT2, ALT, OLT, and 2C relays. The CR relay operates the 2C relay and provides ground to the Code Register Circuit to send the three alert codes downstream to alert those locations and upstream to provide automatic acknowledgment signals. The 2C relay operated (a) opens the operate path of the CR relay to prevent further operation of the relay if the third code word is received, (b) locks up to the ALT relay normal, (c) operates the IM relay, and (d) operates the ALL relay via break contacts of the AL and OLT relays to the local test (LT) timer normal. The LT timer does not operate for this circuit function. The IM relay operated will open the control lead of the ALERT RELEASE key so that only NORAD can originate the release signal. The ALL relay operated (a) connects ground to operate the bells of FS10, (b) operates the AUM relay of FS38 to disable the KT timer, (c) connects ground to the windings of the A and B relays, FS35, via the AB resistor to start the flashing circuit, (d) disconnects back-lighting battery and connects flashing battery, FS25, to the ALERT lamps, and (e) releases the CR relay. The CR relay is locked up to the ALL relay normal in order to guarantee that the operated time of the CR relay is long enough to perform functions described in 2.08.

2.06 When the attendant at the operating console operates the ALERT key in response to the audible and visual signals, the AL relay, FS1, operates and locks up to the RLS relay normal and the KT timer, 13 option, or ground, Y option. As mentioned above, the KT timer has been disabled to avoid releasing the AL relay in 3 seconds. This would normally happen unless the MASTER OPERATE key, FS4, is operated after the AL key is operated for originating an alert as described in 1.02. In addition, the AL relay operated (a) releases the ALL relay, FS13, to retire incoming alert signals, (b) connects steady signal-on battery to the ALERT lamp, and (c) provides locking ground to the AUM relay.

B. One Facility Inoperative

2.07 If continuity on one of the upstream lines fails, the alert logic circuit, FS13, will accept 2-out-of-3 alert codes received by the receiver associated with the good line as a legitimate alert. In FS11, assume that upstream line 1 has failed. The CTA relay has operated as described in 8. When the code words are received by line 2, the AL2 relay operates and releases as described in 2.04. In FS13, the operation and release of the AL2 relay will cause the alert logic circuitry to function as described in 2.04 and 2.05. The ground pulses are connected to the W1, Z1, and CR relays via the CTB relay normal, CTA and AL2 relays operated, and the L1A and L2A relays normal.

C. Alert Override

2.08 Receipt of an alert at any location will override and release all previously originated or received signals. Operation of the CR relay, FS13, will operate the AR relay, FS18, and the RLS relay, FS3. Operation of the AR relay and the RLS relay and its associated RA relay will release all previously operated relays except for the alert logic relays of FS13. The CR relay also operates the 2C relay and the alert functions are the same as described in 2.03 through 3.06.

SITE

2.09 Operation of the alert receive circuitry at a Site installation is similar to that described in 2.04 and 2.05 except that only one line is terminated at these locations. Options 11 and Z are provided for the alert switching logic. Of course, option R for DX signaling or option 15 for carrier or telegraph loop termination will be provided, depending on the type of line facility at each location.

2.10 In FS12, ground pulses are connected to the code receiver circuit over the M4 lead via a break contact on the L1A relay via H, R, or S option. When the code receiver recognizes the ground pulses as the first PLC alert word, a ground of approximately 200 msec duration is applied to the AL lead. The ground pulse will (a) operate and release the CMA relay via the AL1 diode and (b) operate the W1 and Z1 relays of FS13 via the AL lead. The CMA relay operated indicates to the continuity circuitry, described in 8., that a legitimate code word has been received. Ground pulses from the code receiver indicating that the second or third code word has been received will operate the CR, 2C, and ALL relays as described in 2.05.

2.11 When the attendant at the control console operates the ALERT key, the AL relay operates to retire the incoming signals and also operates a relay in the Code Register Circuit. The Code Register Circuit and code sending circuit will transmit the manual acknowledgment word upstream to the Sector to inform that location that the Site has acknowledged the alert (see 3.04).

AT "NORAD" FROM BMEWS EQUIPMENT

2.12 When the alert is initiated by the BMEWS equipment and the AUTOMATIC key has been operated, two ground pulses, as shown in FS9 and described in 1.08, are received by the logic of FS13. The first ground pulse will operate the OLB relay via the BM and BMZ relays operated and BP relay released. Operation of the OLB relay will operate the OLA and OLT relays to provide an override of all features as described in 11.09. Operation of the OLT relay will operate the W1 relay via 1M of the OLT. The

end of the first ground pulse, when the BP relay operates and opens the operate ground of relay OLB via option 8, will release the OLT relay. The OLT relay released will allow the Z1 relay to operate via M4 of the W1 relay. The alert logic, FS13, has now received the equivalent of one alert code word, the W1 and Z1 relays are operated, and the timing gate (the AL timer) has begun its timing cycle. When the second pulse appears via the BP and BMZ relays operated, the BP1 relay released, and option 8, the CR relay will operate via the Z1 relay operated and the LT1, LT2, ALT, OLT, and 2C relays normal.

2.13 Functions of the CR relay and all subsequent relay operations for receiving an alert from BMEWS are the same as described in 2.05.

Caution: If at the time the alert is released, the incoming alert lamp and bell operate, but the acknowledgment lamps do not function, check to see if the 2C relay, FS13, is operated. If this condition exists, manually release the 2C relay and test the AL timer for proper operation.

3. ACKNOWLEDGMENT OF ALERT

GENERAL

3.01 Two separate acknowledgment signals are used in this system. The first is the automatic acknowledgment which provides a flashing lamp signal at the upstream console to indicate to the attendant that at least 2-out-of-the-3 code words have been received at the downstream location. The second is the manual acknowledgment signal which indicates, by changing the flashing lamp to steady, that all locations reporting to the downstream location have acknowledged receipt of the alert signals manually.

3.02 For example, the Region is the upstream location and one of its Sectors is the downstream location. Region has initiated an alert and three code words are transmitted to the Sector. When the Sector alert logic circuitry has received two of these words, it will originate three alert words downstream to its Sites and upstream to the Region. The Region acknowledgment circuitry will recognize any one of these words and flash an acknowledgment lamp at the Region console. At the Sector, a manual acknowledgment word is transmitted to the Region when all Sites reporting to the Sector have signaled the Sector that they have received the alert signal. Receipt of the manual acknowledgment code word at the Region will activate the manual acknowledgment circuitry and change the flashing acknowledgment lamp to steady.

AUTOMATIC

3.03 In FS18, receipt of an alert code word, via H, R, or S option by the code receiver circuits associated with the two downstream lines associated with that downstream location, will provide a ground pulse on the AL lead from each receiver operating the OK- relay associated with each line and the AA relay associated with that location. The operated AA relay (a) locks up to the AR relay normal, (b) provides ground to the AB resistor of FS35 to start the flashing circuit, (c) in FS32, disconnects back lighting voltage and connects flashing signal-on voltage to the ALERT ACK lamps, and (d) opens the operate path of the AT relay. The operation and release of the OK- relay indicates to the continuity circuitry (see 8.) that a legitimate code word has been received on that particular line.

MANUAL

3.04 In FS18, receipt of the manual acknowledgment code word (via H, R, or S option) by the code receiver circuits associated with the two downstream lines associated with that downstream location, will provide a ground pulse on the MA lead from each receiver operating the AM and OK- relays. The operated AM relay (a) locks up to the AR relay normal, (b) disconnects the flashing battery from the ALERT ACK lamp, and (c) connects steady battery to that lamp. The operation of the OK- relay associated with each code receiver indicates to the continuity circuitry (see 8.) that a legitimate code word has been received.

4. ORIGINATING A TEST ALERT

GENERAL

4.01 The general comments as described for originating an alert, with regard to dual line facilities and provision for DX signaling, R or telegraph loop option, or carrier termination, S option, also apply to originating a test alert.

TO ALL LOCATIONS DOWNSTREAM

4.02 Operation of the TEST ALERT key, FS2, operates the TST relay via the Y, V, and 7 options. The TST relay operated (a) locks up to ground under control of the KT timer, FS38, option 13, (b) connects battery to the start lead of the KT timer, and (c) opens the operate path of the AL relay to avoid originating both an alert and test alert simultaneously.

4.03 Operation of the MASTER OPERATE key within 3 seconds will operate the MAS relay, FS4. The MAS relay operated will

(a) operate the AUM relay to open the start lead of the KT timer, (b) operate the KD relay, FS4, (c) lock up under control of the RR relay, and (d) connect ground to the winding of the RR relay, FS39, via the KD relay operated. The RR relay which is a slow-operate type will operate in approximately 50 msec. When the RR relay operates, the MAS relay will lock up via the RR and KD relays operated to ground on the T1 and T2 leads of the code sending circuit. The RR relay operated will lock up to the MAS relay. If the MAS relay key is not operated within 3 seconds of the time the TEST ALERT key has been operated, the KT timer will function and release the TST relay. This circuitry provides 2-key operation which guards against a false test alert being originated by accidental operation of the TEST ALERT key.

4.04 In FS17, a ground is connected to the TST lead of the Code Register Circuit (line 1) during the operate time of the RR relay via the MAS relay operated, the RR and RLS relays normal, the TST relay operated (contact 10), V and X options, and the LF1 relay normal. The ground pulse is also connected to the Code Register Circuit (line 2) via the TST lead. The Code Register Circuit and code sending circuit will cause the SE1 and SE2 relays to function and follow the PLC output pulses of the code sending circuits via the M4 lead and the LF1, LF2, and L2A relays normal. The Code Register Circuit and the sending circuit are arranged to send three PLC words automatically whenever a 50-msec ground is connected to the TST lead.

4.05 In FS20, the downstream line transmit circuit, pulsed operation of the SE1 (line 1) or SE2 (line 2) relay will, (a) with H option, operate and release the L1- and L2- relays of FS19 to open and close the telegraph line (b) with S option, alternately connect +80 volts and ground to the O lead of all 43A1 or equivalent telegraph terminals, and (c) with R option will operate and release the M- relays of FS19 to connect -48 volts and ground alternately to the M lead of the DX signaling equipment. A separate group of M- relays or the L1- relays will be provided for dual facilities line 1 and another group of M- relays or the L2- relays will be provided for dual facilities line 2. The functions of the COA, COB, CO-, and R relay contacts shown in FS20 are described in 4.06.

TO SELECTED LOCATIONS DOWNSTREAM

General

4.06 An arrangement is provided at NORAD and Regions whereby one or more downstream locations may be sent the test alert code words. In FS8, operation of one of the TEST ACK keys will operate its associated R- relay, the COA relay, and the TST relay. The COA relay operated, operates the COB and all CO- relays. In addition, in FS20, the COA, COB, and CO- relays open the interface connection between the L1- and L2- relays, H option, the SE1 and SE2 relays, S option, or the M- relays, R option, from the telegraph loop, telegraph terminals, or DX signaling circuits, respectively. The operation of the selected R- relay will reconnect the interface circuit to the lines associated with the downstream locations to be tested. Operation of additional TEST ACK keys will operate the selected R- relays and reconnect the interface leads as well. In this method of operation, the test alert words will be transmitted only to the location associated with the operated R- relays. Since the TST relay has already operated, operation of the MASTER OPERATE key, FS4, will cause the circuitry to function as described in 4.03. The R-, COA, COB, and CO- relays which lock up to the ground on the T1, T2 leads of the code sender circuit via the T1 diode will release when the three code words have been sent. The operate path of the TST relay is via the AL and AUM relays normal and the T2 diode of FS8.

5. RECEIVING A TEST ALERT

GENERAL

5.01 The same general comments as described for receiving an alert apply to receiving a test alert.

REGION AND SECTOR

A. Both Facilities Operative

5.02 In FS11, ground pulses equivalent to the PLC test alert word on the E lead, R option, or from the RS relay, 15 option, are connected to the M4 lead of the code receiver circuits via normal contacts of the CT1 and LT1 relays for line 1, and the CT2 and LT2 relays for line 2. If the ground pulses constitute a test alert word, the code receivers provide a ground pulse on the TST lead for approximately 200 msec, operating the TE1 or TE2 relay.

5.03 The TE1 relay (line 1) and the TE2 relay (line 2) will operate for a period of approximately 0.5 second, because they are of the slow-release type having a release time of approximately 300 msec. The TE1 and TE2 relays operated operate the OK1 and OK2 relays, respectively, to register a continuity pulse. In addition, in FS14, ground is connected to the winding of the TW and TZ relays via 5M of the TE1 and 5M of the TE2 relays in series, 14 option, a break contact of the TZ relay, and a continuity contact of the TW relay. The TW relay will operate and lock up to ground via the make of the continuity transfer and a break of the TT relay. The TZ relay is shunted down and will not operate at this time. When the ground is removed from the

output of the code receiver, FS11, the TE1 and TE2 relays will release and remove the shunt path from the winding of the TZ relay allowing it to operate. The TZ relay operated (a) transfers the input lead, connected to 5M of the TE2 relay, from the windings of the TW and TZ relays to the winding of the TCR relay via M10 of the TZ relay and break contacts of the TT and OLA relays, and (b) connects battery to the 12 lead of the TT timer to start that unit.

5.04 At this point in the sequence of operation, the test alert logic has registered the first test alert logic code word and has started the TT timer to provide a 5-second time gate, during which time the second code word must be received or the T relay of the TT timer will operate, operating the TT relay which will release the TW and TZ relays. The timer circuitry provides a guard against random false output occasioned by noise on the lines adding up and originating a false test alert. When the code receiver, FS11, has received the second test alert word, the TE1 and TE2 relays operate and release as described above. The ground pulse operates the TCR relay, via make contacts of the TE1, TE2, and TZ relays and break contacts of the TT and OLA relays. The TCR relay operates the T2C relay and provides ground to the Code Register Circuit to send the three alert codes downstream to alert those locations and upstream to provide automatic acknowledgment signals. The T2C relay operated (a) locks up to the TT relay normal, and (b) operates the RT relay via break contacts of the TST, ALL, and OLA relays to the RLS relay normal. The RT relay operated (a) connects ground to operate the bells of FS10, (b) operates the AUM relay of FS38 to disable the KT timer, (c) connects ground to the windings of the A and B relays, FS35, via the AB resistor to start the flashing circuit, and (d) disconnects back lighting battery and connects flashing battery, FS26, to the TEST ALERT lamps.

5.05 When the attendant at the operating console operates the TEST ALERT key in response to the audible and visual signals, the TST relay, FS2, operates and locks up to the RLS relay normal and the KT timer, 13 option, or ground, Y option. As mentioned above, the KT timer has been disabled to avoid releasing the TST relay in 3 seconds. This would normally happen unless the MASTER OPERATE key, FS4, is operated after the TST key is operated as for originating an alert as described in 4.03. In addition, the TST relay operated (a) releases the RT relay, FS14, to retire incoming alert signals, (b) connects steady signal-on battery to the TEST ALERT lamp, and (c) provides locking ground to the AUM relay.

B. One Facility Inoperative

5.06 If continuity on one of the upstream lines fails, the test alert logic circuit, FS14, will accept 2-out-of-3 test alert codes received by the receiver associated with the good line as a legitimate test alert. In FS11, assume that upstream line 1 has failed. The CT1 relay has operated as described in 8. When the code words are received by line 2, the TE2 relay operates and releases as described in 5.04. In FS14, the operation and release of the TE2 relay will cause the test alert logic circuitry to function as described in 5.01 through 5.05. The ground pulses are connected to the TW, TZ, and TCR relays with CT1 and TE2 relays operated.

SITE

5.07 Operation of the test alert receive circuitry at a Site installation is similar to that described in 5.01 through 5.05 except that only one line is terminated at these locations. Options 11 and Z are provided for the test alert switching logic. Of course, option H for telegraph loop, option R for DX signaling, or option S for carrier termination will be provided, depending on the type of line facility at each location.

5.08 In FS12, ground pulses are connected to the M4 lead of the code receiver circuit over the M4 lead via a break contact on the L1A relay, via H, R, or S option. When the code receiver recognizes the ground pulses as the first PLC alert word, a ground of approximately 200 msec is applied to the TST lead. The ground pulse will (a) operate and release the CMA relay via the TE1 diode and (b) operate the TW and TZ relays of FS14 via the TST lead. The CMA relay operated indicates to the continuity circuitry described in 8. that a legitimate code word has been received. Ground pulses from the code receiver indicating that the second and third code words have been received will operate the TCR, T2C, and RT relays as described in 5.04.

5.09 When the attendant at the operating console operates the TEST ALERT key, the TST relay operates to retire the incoming signals and also operates a relay in the Code Register Circuit. The Code Register Circuit and code sending circuit will transmit the manual acknowledgment word upstream to the Sector to inform that location that the Site has acknowledged the alert.

6. ACKNOWLEDGMENT OF TEST ALERT

6.01 The test acknowledgment circuitry of FS18 and test acknowledgment lamp control circuit of FS33 function in the same

manner as the alert acknowledgment circuits described in 3., except that the AT relay operates instead of the AA relay.

Caution: If at the time the test alert is released, the incoming test alert lamp and bell operate, but the acknowledgment lamps do not function, check to see if the T2C relay, FS14, is operated. If this condition exists, manually release the T2C relay and test the TT timer for proper operation.

7. RELEASE SIGNAL

GENERAL

7.01 Both the NORAD and Region locations have facilities to initiate a release signal. If BMEWS has originated an alert or NORAD has initiated an alert or test alert, only NORAD can initiate the release of the alert or test alert. Only one code word is transmitted for a release signal.

ORIGINATING A RELEASE SIGNAL

7.02 Operation of the ALERT RELEASE key, FS3, operates the RLS relay via V, X, and 7 options. The RLS relay operated (a) locks up to ground under control of the AUM relay normal and the KT timer, FS38, (b) connects battery to the start lead, terminal 12, of the KT timer, (c) operates the RA relay, and (d) opens the lockup paths of the AL and TST relays, allowing these relays to release. The RA relay operated connects battery to light the ALERT RELEASE lamp of FS27.

7.03 Operation of the MASTER OPERATE key within 3 seconds will operate the MAS relay, FS4. The MAS relay operated will (a) operate the AUM relay to open the start lead of the KT timer, (b) lock up to ground under control of the RR relay operated and the KD, EC1, and EC2 relays normal, and (c) connect ground to the winding of the SF relay, FS39, via the operated RLS relay and the S1 and S2 leads of the code sender. The SF relay will operate as soon as the code sending circuits have both returned to the idle, at rest, condition. A requirement of the circuit is that the RLS and MAS lamps remain lighted until the code word has been broadcast. By not operating the SF relay until the code senders have both come to rest, the lamps should remain lighted at least for the duration of a code word.

7.04 The SF relay operated connects ground to the winding of the RR relay. The RR relay is a slow-operate type and takes approximately 50 msec to operate. During this time, ground is connected to the Code Register Circuit, FS17, on the RLS lead via the SF relay operated, RR relay released, and the RLS relay operated. The release code word is transmitted downstream, and upstream if the signal is originated at Region.

7.05 The RR relay operated locks up to the MAS relay operated which in turn is locked up to the EC1 and EC2 relays in series. As soon as the code sender goes off-normal, the operate path for the SF relay is opened by a relay in the sender circuit and the SF relay will release. In FS21, the EC1 and EC2 relays will operate and release from a pulsed ground on the CF1 lead of the code sender. This is an end-of-code signal. The EC1 or EC2 relay operated will release the MAS relay, FS4. The MAS relay normal releases the RLS which releases the AUM relay. Release of these relays extinguishes the MASTER OPERATE and ALERT RELEASE lamps, and returns the circuit to an idle condition.

Caution: If at the time the alert or test alert is released the incoming alert or test alert lamp and bell operate, but the acknowledgment lamps do not function, check to see if the 2C relay, FS13, or T2C relay, FS14, is operated. If this condition exists, manually release the relay and test the AL or TT timer for proper operation.

RECEIVING A RELEASE SIGNAL

A. NORAD, Region, and Sector

Both Facilities Operative

7.06 In FS11, receipt of a release code via H, R, or S option by the code receiver circuits connected to the two upstream lines, will provide a ground pulse on the RLS lead operating the RR1 relay of line 1 and the RR2 relay of line 2. The RR1 and RR2 relays will remain operated for the duration of the ground on the RLS lead and the release time of the relays, for a total of approximately 0.5 second. During the operated time of the relays, the following functions are performed:

(a) The OK1 and OK2 relays will operate via ground on M7 of the RR1 and RR2 relays to indicate to the continuity circuitry, FS22, that a legitimate code word has been received.

(b) The AUM relay, FS38, via X option will operate.

(c) The RLS relay, FS3, will operate via ground from the RR1 and RR2 relays operated, X option, Y option, and the L1A and L2A relays normal. The RLS relay will not lock up because the AUM relay has operated as described in (b) above.

(d) The IM relay, FS13, X option, will release by opening the lockup path for that relay via 5M of the IM relay and 10B of the RR1 and RR2 relays in series with ground.

(e) In FS17, ground is connected to the RLS leads of the Code Register Circuit. The Code Register Circuit and the code sending circuit will cause the SE1 and SE2 relays to function and follow the PLC output pulses of the code sending circuits via the M4 lead and the LF1, LF2, L1A, and L2A relays normal. The code register and code sender are arranged to generate automatically the one release PLC word whenever a 50-msec ground pulse is connected to the RLS lead. Functions of the SE1 and SE2 relays are described in 1.03 and 1.04.

Operation of the RLS relay will perform the same functions as described in 7.02. In reference to (b) above, the AUM relay is operated to open the lockup path of the RLS relay and to open the start lead of the KT timer. In reference to (e) above, the code word is transmitted downstream to initiate the same release circuit operation as described above. The release code word is transmitted upstream where it is recognized by the code receivers of FS18 as a ground pulse on the RLS lead which operates the AR and OK- relays. The operated AR relay will open the lockup paths of the AM, AA, and AT relays. The AM relay, previously operated by the receipt of the manual acknowledgment code, will release extinguishing the acknowledgment lamps. Break contacts of the AR relay are provided in the lockup path of the AA and AT relays in order to provide a means of retiring these relays and their associated lamp signals.

7.07 Operation and release of the OK relay will indicate to the continuity circuitry, FS22, that a legitimate code word has been received.

One Facility Inoperative

7.08 Assume that line 1 of the dual facilities has failed. The continuity circuitry described in 8. will cause the CT1 relay to operate. Operation of the CT1 relay will operate the CTA relay, which is a slave of the CT1. In FS3, 13, and 17, the operated CT1 or CTA relay will bridge the RR1 relay contact and complete the circuit via the operated RR2 relay contact associated with the good line. If line 1 is good and line 2 has failed, the CT2 and CTB relays in series with the operated RR1 relay will complete the circuit.

B. Site

7.09 In FS12, receipt of a release code word by the code receiver circuit via H, R, or S option will result in a ground pulse on the RLS lead. The ground pulse will (a) operate and release the CMA relay to indicate to the continuity circuitry, FS22, that a legitimate code word has been received, (b) in FS17, Z option, cause the code register and code sender to transmit the code word upstream to the Sector to retire the acknowledgment lamps at that location, and (c) operate and release the RLS relay, FS3, via the R1 lead, Z option, the L1A relay normal, and 11 option. The RLS relay operated, will open the lockup paths of the AL and TST relays and return the circuit to an idle condition.

Caution: If at the time the alert or test alert is released the incoming alert or test alert lamp and bell operate, but the acknowledgment lamps do not function, check to see if the 2C relay, FS13, or T2C relay, FS14, is operated. If this condition exists, manually release the relay and test the AL or TT timer for proper operation.

8. CONTINUITY

8.01 A continuity check of each line is provided to (a) make sure continuity is maintained and (b) check that the properties of the noise on the facility are not such as to distort the PLC code. One of the code words is designated a continuity code and transmitted on all facilities every 6 seconds. If three successive continuity codes are not detected at the other end of the line, at NORAD and Region locations, and four successive codes at Sector and Site locations, an alarm is sounded and a continuity lamp indicates which line is in trouble.

8.02 A pulse generator at NORAD, FS22, triggers the code sender, causing it to outpulse the continuity code every 6 seconds. This code is transmitted to every Region. An output from the receiver associated with that line at the Region indicates that a continuity code has been received and triggers the local generator to transmit the same code upstream and downstream. It also holds off the continuity alarm associated with that line from NORAD. The continuity code upstream holds off the alarm at NORAD, indicating the integrity of the line both to and from the particular Region. The code broadcast from the Region is received at its Sectors and causes each Sector sender to generate a code both upstream to its Region and downstream to its Sites. The Sites receive continuity codes which cause their senders to outpulse continuity codes back to Sectors to hold off the continuity alarm there. If NORAD loses the downstream facility to a Region, alarms will sound at the Region and NORAD. In order to terminate this state, a continuity alarm at a Region indicating a break from NORAD will bring in the Region pulse generator and cause continuity codes to be initiated from the Region. When this occurs, the upstream facility to NORAD is isolated. This is necessary since the

receipt of continuity codes from a Region would again hold off the alarm at NORAD. If one continuity code is missed, the alarm is not sounded since there is a finite probability that it has been distorted beyond recognition. However, when three codes in succession have been missed, then an alarm will sound. Because the receivers cannot receive continuity codes when they are receiving other codes (ie, test, release, etc), all these are recognized as legitimate continuity codes.

8.03 When a line is in trouble, a buzzer sounds and a continuity lamp flashes. A nonlocking audible cutoff key is provided to silence the buzzer and, when this is done, the continuity lamp signal changes to steady. The lamp signal is extinguished when the facility is back in service. A continuity alarm closure is provided for telephone company alarms.

PULSE GENERATOR

8.04 In FS22, battery is connected to the start lead, terminal 12, of the PG timer through B10 of the PG relay and V option at NORAD, or the CTA or CTB relay, X and Y options, at Region and Sector. The PG timer, adjusted to function in 6 seconds will operate its T relay. The T relay operated will connect ground to the winding of the PG relay. The PG relay will operate and (a) lock up to the PG1 relay normal, (b) connect ground to the CON lead of the Code Register Circuit via the PG relay operated with V option, the GS relay, FS17, operated with X option, and the CT1 or CT2 timer operated with Y option, (c) open battery from the start lead of the PG timer, and (d) connect ground to the winding of the PG1 relay via the P thermistor. The PG1 relay will be slow in operating due to the heating time of the thermistor, which is approximately 300 to 600 msec. When the PG1 relay operates, the lockup path of the PG is opened and the PG relay releases, reclosing the battery to the PG timer start lead and releasing the PG1 relay. The circuitry will continue to recycle once every 6 seconds and the code sender will broadcast a continuity code during each cycle. When the PG1 relay operates, the P thermistor is shunted to bypass the relay operating current.

CONTINUITY RECEIVER CIRCUIT

8.05 In FS15, the CT1 timer is provided for upstream line 1 at Regions, Sectors, and Sites; CT2 is provided for upstream line 2 at Regions and Sectors; and the CT- timer is provided at NORAD, Regions, and Sectors for each downstream line. For example, at Region, CT1 and CT2 timers would be provided for the two upstream lines from NORAD, and two CT- timers would be provided for the two downstream lines from each Sector. The CT1, CT2, or CT- timer is adjusted to function in accordance with Circuit Note 104. Battery is connected to the timer via a normal contact of the OK1, OK2, OK-, or CMA relay. The OK- and CMA relays operate and release in response to the ground pulse from the associated code receiver on the CON lead, indicating that a legitimate code word has been received on that line. As long as at least one code word is received during any time-out period, the timer will not function. However, if a code word is not received, the timer will function and operate its T relay.

A. Lines From Upstream

Region and Sector

8.06 The operated T relay of the CT1 or CT2 timer will operate the CT1 or CT2 relay, respectively and the GS relay, FS17, with X option. If line 1 continuity has failed, the CT1 relay will operate and (a) operate the CTA slave relay, (b) in FS19, open the line transmit path of the upstream line, (c) in FS29, connect flashing battery to the line fail lamps for upstream line 1, (d) partially open the M4 input lead at the code receiver (see 11.11), (e) in FS10, connect ground to the BU and MBU buzzers to operate these audible signals, (f) in FS7, connect the key lead of the LINE FAIL - LOCAL TEST key to the LFW and LFZ relays, (g) provide lockup ground for the LFW and LFZ relays, and (h) in FS3, complete the path around the RR1 relay contact, which is probably not operated since the continuity on the line has failed. The CTA relay operated (a) in FS13, completes the path around the AL1 relay, (b) completes the path around the RR1 relay in FS13 and 17, (c) connects battery to the PG timer to start that unit functioning (see 8.04), and (d) in FS35, connects ground to the AB resistor to start the flashing circuit. The GS relay operated will open the CON leads from the code receivers of both lines and connect them to the PG relay contacts. This will guarantee synchronization of both senders to the local pulse generator so that the alert or test alert signals will be transmitted to the Sector locations on both lines at the same time (see 2.).

8.07 If the continuity of line 2 has failed, the CT2 timer and CT2 and CTB relays will operate. These relays provide similar functions for the line 2 circuitry.

Site

8.08 The operated T relay of the CT1 timer associated with the single line provided at the Site will (a) in FS35, connect ground to the AB resistor to start the flashing circuit, (b) in FS29, connect flashing battery to the line fail lamps, (c) in FS10 connect ground to the BU buzzer to sound the audible signal, and (d) connect the key lead from the LINE FAIL - LOCAL TEST key to the LFW and LFZ relay windings.

B. Lines From Downstream

8.09 These circuits are provided at NORAD, Region, and Sector. Operation of the T relay of the CT- timer will (a) in FS35, connect ground to the AB resistors to start the flashing circuit, (b) in FS29, connect flashing battery to the line fail lamps, (c) in FS10, connect ground to the BU and MBU buzzers to sound the audible signals, and (d) provide lockup ground for the TF or BF relay.

RETIRING CONTINUITY ALARM SIGNALS

A. Upstream Lines

8.10 In order to silence the buzzer and change the flashing continuity lamps to steady, the LINE FAIL - LOCAL TEST key of FS7 is operated. Functions of the circuitry for FS7 are described in 10.

B. Downstream Lines

8.11 The buzzer is operating and the lamp (LINE FAIL 1 or LINE FAIL 2) is flashing. In FS6, operation of a LINE FAIL 1 - LINE FAIL 2 key will connect ground to the winding of the TF and BF relays. Depending upon which line the continuity has failed on, the CT- timer associated with that line will have operated and provided lockup ground for the associated TF or BF relay. Release of the key will remove the operate battery from the relays and only that relay provided with lockup ground will remain operated. Assume that the line associated with the TF relay has failed and this relay is the one that has remained operated. The TF relay operated will (a) lock up to the CT- timer, (b) in FS29, disconnect the flashing battery and connect steady battery to the LINE FAIL 1 or LINE FAIL 2 lamp, (c) in FS10, disconnect the operate ground from the buzzers to retire the audible signals, and (d) disconnect the ground from the AB resistors to retire the flashing circuit. Functions of the BF relay are similar to the functions of the TF relay.

RELEASE OF CONTINUITY FAILURE CIRCUITRY

8.12 In FS11, 12, and 18, a legitimate code word recognized by the code receiver associated with the line experiencing continuity difficulties will operate the OK1, OK2, OK-, or CMA relay. Operation of these relays will open the start lead of the continuity timer of FS15. The T relay of the timer will release and all operated relays (described in 8.01 through 8.11) associated with this line will release and the continuity circuitry will return to normal.

9. CODE SENDER FAILURE ALARM

9.01 In FS21, a circuit is provided to check that each code sending circuit has completed transmitting a code word, and that it is not operating continuously due to a permanent false ground on the start leads of the associated code register circuit. If the code sender circuit does not complete sending the code word, the alarm circuit of FS21 will function, bring in a TELCO alarm, transfer the line from the sender experiencing trouble and connect the line in multiple with the code sender associated with the other line of the dual facility. If the code sender circuit is running continuously, the alarm circuit of FS21 will function and bring in the TELCO alarms, but the transfer circuit will not operate. This is done to avoid connecting the trouble condition to the other sender circuit. The circuit description is identical for both lines, so only the line 1 circuitry will be described.

9.02 In the code sender circuit, the SB relay is operated and the SA relay is released when the sender is not generating a code word. The SB relay is released and the SA relay is operated while a code word is being generated. With the SB relay released, battery is connected to the start lead (terminal 12) of the GA1 timer, FS21. If (a) the SB relay does not operate in 7 seconds due to the sender not completing a code word, (b) the sender is running continuously, or (c) the fuse associated with the sender operates, the GA1 timer will function and its relay T will operate. Operation of the T relay will (a) connect ground to light the GA- lamp and sound the GA- bell, which are locally mounted TELCO alarms used to indicate that the code sender has failed, and (b) operate the LF1 relay if the sender failure is not due to continuous operation from a permanent false ground on the AL, TST, RLS, MA or CON leads from FS21 to the code register circuit. The LF1 relay operated (a) in FS39, shorts the S1 and S2 leads of the code sender, (b) in FS17, opens the locking path of the RM (ALERT) relay of the Code Register Circuit, (c) in FS17, disconnects the SE1 relay from the M4 lead of the code sender for line 1 and connects it to the M4 relay of the code sender for line 2, (d) provides a break contact on the M4 lead of line 2 in order to isolate the code sender from the line if a local test on line 1 is made, (e) opens the AL lead to the code sender so that the RM (ALERT) relay of the code register cannot be operated, and (f) connects the LT1 lead of line 1 from FS39 to the code register for line 2. The circuit is now switched to that condition whereby the code register and sender circuits of line 1 are isolated from the transmit line, and the code register and sender circuits of line 2 are serving both line 1 and line 2.

9.03 When a legitimate code has been originated by the code sender or the trouble ground has been cleared, the SB relay of the code sender will operate and release the GA1 timer. The release of the timer will retire the T relay and the LF1 relay if previously operated. The release of the LF1 relay will reconnect the code register and sender circuit to line 1.

10. LOCAL TEST, LINE FAILURE, AND FILAMENT TEST KEY CIRCUIT

LOCAL TEST AND FILAMENT TEST

10.01 In FS7, operation of the nonlocking LINE FAIL 1 - LOCAL TEST key will (a) operate the KFT relay from key ground via either normal contacts of the LFZ, CT1, and the L2A relay at Region, Sectors, the LFZ and CT1 timer at Sites, or V option and the L2A relay at NORAD and (b) shunt down the LT2 relay by connecting ground to the LT2 resistor. The KFT relay operated, operates the LT1 relay via break contacts of the LT2 and OLT relays, if provided, and a break contact of the W1 relay. Although this ground is also applied simultaneously to the winding of the LT2 relay, via break contacts of the CT1, W1, and OLT relays, the LT2 relay will not operate because of the shunt-down circuit described above. As soon as the LT1 relay operates, the ground connection to the winding of the LT2 relay is opened. This will prevent the LT2 relay from operating during the release time of the KFT relay, which releases after the key has been released, removing the key ground shunt-down path. The KFT relay operated, will also operate the FT relays and these relays will disconnect back-lighting battery from the lamps (see 13.02 and 13.03), if provided, and connect steady battery to all lamps at both the operating and monitoring consoles. The attendants can now make a visual check of all lamps.

10.02 Release of the LINE FAIL 1 - LOCAL TEST key will release the KFT relay and the lamp circuits are returned to normal. The LT1 relay will remain operated and perform the functions described in 11.03.

10.03 Operation and release of the LINE FAIL 2 - LOCAL TEST relays will operate the KFT and LT2 relays. The KFT relay operated performs the same functions as above. The functions of the LT2 relay are described in 11.07.

LINE FAILURE

10.04 When the continuity circuit described in 8. operates, the lamps associated with this key will flash, the console buzzer will sound, and the CT1 relay will operate.

10.05 Operation of the LINE FAIL 1 - LOCAL TEST key will connect key ground to the windings of the LFW and LFZ relays via a normal contact on the LF1 relay and an operated contact of the CT1 relay, 14 option, or the CT1 timer, Z option. The LFW relay will operate and lock up to ground via the make contacts of the continuity transfer and the operated CT1 relay or CT1 timer. The LFZ relay is shunted down and will not operate at this time. When the ground is removed by releasing the key, the shunt path on the winding of the LFZ relay is removed and the relay will operate. The LFZ relay operated (a) transfers the key lead from the CT1 relay to the KFT relay winding so that subsequent operation of the key for filament or local tests will not affect the LFW and LFZ relays, (b) in FS10, opens the operate ground to silence the BU and MBU buzzers, (c) in FS35, opens the ground lead from the operated CT1 timer to the AB resistor to retire the flashing circuit, and (d) in FS29, J option, connects steady battery to the line failure lamps.

10.06 When continuity on the line is re-established, the CT1 relay releases as described in 8.12, the lockup path of the LFW and LFZ relays is opened, and the relays release, returning the circuits to normal.

10.07 If the continuity alarms for upstream line 2 are functioning, the operation of the LINE FAIL 2 - LOCAL TEST key will perform similar functions, except that the RFW and RFZ relays will operate.

11. LOCAL TEST

11.01 When a LINE FAIL - LOCAL TEST key is operated, the key lamp lights, all lines associated with the facility are disconnected from the alerting circuitry, and the code sender associated with the facility produces three alert codes. These code words are fed to all the receivers associated with that facility. The receiver on the upstream side at each location tests the alert logic circuit (ALC), FS11, and produces an alert. The receiver associated with each downstream location, tests the acknowledgment logic and causes the ALERT lamp to flash, thereby testing it too. After approximately 3 to 6 seconds, the local alert is automatically retired and the local test key lamp is extinguished. The other facility can now be tested. An electrical interlock prevents both facilities being tested at the same time.

11.02 Since the alert has been localized, no incoming signals are possible on a facility being tested. However, an alert or test received on the other facility will override a local test at Region and Sector installations.

REGION AND SECTOR

11.03 Operation of the LT1 relay as described in 10.01 will operate relay L1A. The L1A relay will operate the G1 and all G1- relays associated with the facility under test. The LT1, L1A, G1, and the G1- relays will perform the following functions. In FS7, the start lead of the LT timer is connected to battery via an operated contact of the RR relay. All relays associated with the local test will remain operated until the

LT timer functions. The operated LT1 relay will disconnect the line input to the upstream code receiver, FS11, and the operated G1 and G1- relays disconnect the line inputs from all downstream receivers. The LT1 relay operated also disconnects the output of the code sender from the SE1 relay, FS17, so that the alert code words used to test the facility locally are not broadcast on the lines. The operated G1 and G1- relays also apply ground to the winding of the ON1 relay of FS40. However, the ON1 relay will not operate until the upstream receiver and all downstream receivers have come to rest. As long as any receiver is functioning, a relay in that circuit will connect ground on the ON lead to the ON1 lead, shunting down the ON1 relay via a break contact on the RR relay and a make contact of the L1A relay. When all receivers are idle, the ON1 relay will operate.

11.04 Operation of the ON1 relay will connect ground to the winding of the RR relay, FS39, and via the LT1 lead of FS17 to ground the AL lead of each the Code Register Circuit. The RR relay is a slow-operate type and will take approximately 50 msec to operate. Operation of the RR relay will terminate the ground on the AL lead to the code sender. The Code Register Circuit and the sender circuit will generate three alert code words on the M4 lead of the sender circuit. The code word pulses operate and release the PL1 relay. Contacts of the PL1 relay, in turn, transmit ground pulses to the upstream receiver via the GGL lead to FS11 and the M4 lead to the receiver. Downstream receiver input connections are via the DRL lead to FS18. When the downstream receivers recognize one of the alert words, a ground pulse is applied to the AL lead, operating the AA and OK- relay of each line. The functioning of the AA relay, described in 3.03, will result in flashing all ALERT ACK lamps. The flashing lamps indicate to the attendant that the downstream and acknowledgment circuitry is operating in a satisfactory manner. The operation of the OK- relays is described in 8.05. Receipt of the three alert code words by the upstream receiver will result in three ground pulses being applied to the AL lead, FS13. These pulses will cause the AL1 relay to operate and release three times. The first operation of the AL1 relay will connect ground to the winding of the W1 and Z1 relays via 7M of the AL1 and 11M of the L1A relays in series (X, Y option), a break contact of the Z1 relay, and a continuity contact of the W1 relay. The W1 relay will operate and lock up to ground via the make of the continuity transfer and a break of the ALT relay. The Z1 relay is shunted down and will not operate at this time. When the ground is removed from the output of the code receiver, FS11, the AL1 relay will release and remove the shunt path from the winding of the Z1 relay allowing it to operate. The Z1 relay operated (a) transfers the input lead connected to 11M of the L1A relay from the windings of the W1 and Z1 relays to the windings of the W2 and WZ relays via the operated LT1 relay, and (b) connects battery to the 12 lead of the AL timer to start that unit.

11.05 At this point in the sequence of operation, the alert logic has registered the first alert logic code word and has started the AL timer to provide a 5-second time gate, during which the second and third code words must be received or the T relay of the AL timer will operate, operating the ALT relay which will release the W1 and Z1 relays. When the code receiver, FS11, has received the second alert word, the AL1 relay operates and releases to operate the W2 and Z2 relays in the same manner as described above for the W1 and Z1 relays. The Z2 relay operated disconnects the input lead connected to 11M of the L1A relay from the windings of the W2 and Z2 relays and connects it to the winding of the CR relay via M10 of the Z1 relay, M10 of the Z2 relay, 11M of the LT1 relay, and break contacts of the 2C, OLT, and ALT relays. The circuit has now received and stored the first and second alert code words. The third operation and release of the AL1 relay, in response to the equivalent of the third code word, operates the CR relay. The CR relay connects ground to operate the 2C relay. The 2C relay operated (a) opens the operate path of the CR relay, (b) locks up to the ALT relay normal, and (c) operates the ALL relay via break contacts of the AL and OLT relays and locks up to the LT timer normal. The ALL relay operated (a) connects ground to operate the bells of FS10, (b) operates the AUM relay of FS38 to disable the KT timer, (c) connects ground to the windings of the A and B relays, FS35, via the AB resistor to start the flashing circuit, and (d) disconnects back-lighting battery and connects flashing battery, FS25, to the ALERT lamps.

11.06 In FS7, the LT timer will operate after approximately 12 seconds from the time the LOCAL TEST key was operated. The LT timer operated will release the LT1 relay and operate all AR relays of FS18. The LT1 relay releases and all other relays associated with local test for line 1 release. The operated relays of the alert logic, FS13, release when the AL timer operates. The release of the AR relays, FS18, retires the acknowledgment lamps and the incoming alert signals are retired when the AL relay releases via a break contact of the LT timer.

11.07 The description of circuit operations for the local testing of line 2 circuitry is the same as described above except that the LT2, L2A, ON2, G2, G2-, PL2, and AL2 relays function to provide similar switching sequences for line 2.

Caution: If at the time the local test is released, the incoming alert lamp and bell operate, but the acknowledgment lamps do not function, check to see if the 2C relay, FS13, is operated. If this condition exists, manually release the 2C relay and test the AL timer for proper operation.

A. Override of Local Test

11.08 When one line is being tested locally and an alert or test alert code word is received on the other upstream line, the override circuitry of FS11 and 13 will function to terminate the local test and register the first alert code word in the logic of FS13. Receipt of the second code word will activate the incoming alert audible and visual signals.

11.09 Assume the local test 1 is in progress and an alert or test alert code word is received by the code receiver associated with upstream line 2. In FS11, the receipt of an alert code will operate the AL2 relay and a test code will operate the TE2 relay. In FS13, operation of either relay in series with the operated LT1 relay will connect ground to the winding of the OLB relay, causing that relay to operate and release under control of the AL2 or TE2 relay. The OLB relay will operate the OLT and OLA relays. The OLT relay will operate the RLS relay, FS3. The four relays will operate for approximately 0.5 second. At the installation being overridden, the operated OLT, OLB, OLA, and RLS relays will release all other operated relays of this circuit with the exception of the continuity circuitry described in 8., the W1 relay of FS13, and the TW relay of FS14, as described below. When the AL2 or TE2 relays release, the circuit is in an idle condition, except that the W1 or TW relay is operated. Also in FS13, operation of the OLT relay will open the lockup path of the W1 and Z1 relays, if those relays are operated. The lockup path is via ground, B11 contact of the ALT relay, M4 of the W1 relay, and B1 contact of the OLT relay. The Z1 relay will release, but the W1 relay will either operate or remain operated due to the ground from M1 of the OLT relay. When the OLT relay releases at the end of the ground pulse, the Z1 relay will operate to ground via M4 of the W1 relay. The logic circuitry has now registered and stored the first alert code word. Further operations of the alert logic circuitry, FS13, are the same as described in 2.05 and 2.06.

11.10 In FS11, the receipt of a test alert code will operate the TE1 and TE2 relays. In FS14, these relays operated will in turn operate the TW relay via M12 of the OLT relay. The TW relay operates and locks up to the TT relay normal. Further operation of the test logic, FS14, is described in 5.04.

B. Local Test With One Code Register and Sender Circuit Inoperative

11.11 Operation of the sender failure alarm circuitry of FS21 will operate the LF1 relay if line 1 equipment has failed or the LF2 relay if line 2 equipment has failed. Assume that the line 1 sender circuit has failed and the LF1 relay has operated. In FS17, the operated LF1 relay (a) opens the NS lead of the code register from the TR lead of the code sender to disable those units, and (b) opens the M4 lead from the sender of line 1 from the winding of the SE1 relay and connects that relay to the M4 lead of the sender of line 2. The SE1 relay is now connected in multiple with the SE2 relay and both lines will broadcast all outputs from the sender for line 2.

11.12 If a local test is made on line 1 facilities when the sender for line 1 is disabled, both the SE1 and SE2 relays are disconnected from the lines to avoid broadcasting the local test alert codes on the line facilities. During the approximately 12-second period required to make the test, the continuity codes will not be broadcast on line 2. This will not bring in continuity alarms at the associated upstream and downstream locations since the continuity alarm receiver circuits (see 8.01) are adjusted for a 20- to 30-second operate interval.

11.13 In FS17, when the LINE FAIL 1 - LOCAL TEST key, FS7 (see 10.02), is operated, a ground pulse is connected to the code register for line 2 via M1 of the operated LF1 relay and the LF1 lead to the A1 lead of the line 2 code register. This will cause the line 2 code sender to generate three alert codes. The M4 lead of the line 2 code sender is connected to the line 1 receivers via M4 of the LF1 and M10 of the L1A relays. The local test circuitry will now function in the same manner as described above.

11.14 All of the features described above are provided on the line 2 facilities and function in a similar manner.

SITE

11.15 The Site installations are arranged for single facilities and do not have downstream lines. The local test circuitry described in 11.11 through 11.13 is very similar to that provided at the Sites. Options 11 and Z are employed, and the line 1 code register and sender are used. Since only a single upstream line facility is provided, the override and sender failure features described above are not provided.

"NORAD"

11.16 NORAD installations are not arranged for upstream lines, but the override feature as described in 11.08 and 11.09

applies to the BMEWS computer circuitry described in 1.06 through 1.08. The OLB relay, FS13, is operated via option 8, the BM and BMZ relays operated, and the BP relay normal. The functions of the OLB and its associated slave relays are described in 11.08 and 11.09. If a local test is in progress, it will be overridden and the equivalent of the first alert code word will be registered by operating the W1 and Z1 relays. Further alert logic circuit operations are the same as described in 1.06 and 1.08. The code sender line failure feature described in 9.01 and 9.02 is also provided at NORAD.

12. FILAMENT TEST

12.01 An arrangement is provided to check the continuity of all lamp filaments at the consoles. Operation of the LINE FAIL 1 - LOCAL TEST or LINE FAIL 2 - LOCAL TEST keys, FS7, will operate the KFT relay as described in 10.01. The KFT relay operated, will operate the FT or FTS relay and all FT- relays, if provided. Operation of the relays will connect signal-on battery to all lamps at both the control and monitor consoles.

13. LAMP POWER SUPPLY

"NORAD", REGION, AND SECTOR

13.01 The A transformer, FS36, provides the ±28 volt lamp supply. Optional voltage taps on the secondary side of the transformer provide for variations of the nominal 115 volts connected to the primary side of the transformer. The C lead should be connected to house ground in order to provide a return path for the -24 volt backup lamp supply described below.

13.02 The NVA relay and associated full wave rectifier bridge (diodes N1, N2, N3, and N4) provide a monitor circuit on the output of the transformer. The relay is normally operated from the ±ac voltage. If the ac supply fails, the NVA relay releases. The NVA relay released (a) operates the NVB relay, if provided, or (b) provides a closure on the AT, AR leads to operate locally provided telephone company alarms, M option. If the NVB relay is provided, the operation of the relay will (a) provide the closure to the telephone company alarms and (b) disconnect the ±28 volt lamp supply from all lamp circuits and connect 24-volt dc battery. The 24-volt dc supply will be locally provided at those installations where the dc backup feature is provided.

13.03 The BL transformer, FS37, provides the ±10 volt lamp supply used at dark environment locations. Depending upon the ambient lighting, optional transformer connections providing a nominal 6, 8, 10, 12, or 14 volts ac may be used to provide sufficient lamp intensity to read the key designations. The C lead of the secondary winding is connected to house ground.

SITE

13.04 Lamp battery at these locations is provided by -48 volts dc. Because of possible long cable runs between the relay rack equipment and the lamps in the consoles, zener diode circuitry, shown in FS25, 26, 29, and 30, is provided, and the diodes reduce the voltage at the lamps to approximately 26 volts dc.

13.05 In FS25, the AL diode, 5 option, collocated with the ALERT lamps will shunt all voltage higher than a nominal 26 volts to ground via the AL resistor. The function of the TE, LF, and LT diodes is similar to that described above for the AL diode.

14. FLASHING CIRCUIT

14.01 The flashing circuit shown in FS35 will provide flashing lamp signals. The duty cycle will be on for approximately 0.5 of each second.

14.02 The operation of the RT, ALL, etc, relays will operate the B relay via the AB resistor and a break contact of the A relay. The B relay operated will connect battery to the winding of the A relay. The A relay will operate and open the battery connection to the winding of the B relay. After a period of time (approximately 0.5 second), determined by the release characteristics of the relay, the B relay releases. The B relay released will open the battery connection to the winding of the A relay and that relay will start to release. The A relay, also of the slow-release type, will take approximately 0.5 second to release. The A relay released will connect battery to the winding of the B relay. The A and B relays will continue to operate and release at a 1-cps rate as long as the ground is connected to the AB resistor. Each time the B relay operates, ground is connected to the FLA and FL- relays and these relays will follow the operation of the B relay. Lamp circuits connected through contacts of these relays will flash at the rate of 0.5 second on, 0.5 second off.

14.03 The AB resistor is provided to reduce the current in the winding of the A and B relays in order to hold the wattage dissipation and timing requirement to specified values.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

None.

2. FUNCTIONAL DESIGNATIONS

None.

3. FUNCTIONS

3.01 Transmit and receive pulse length code (PLC) words.

3.02 Recognize 2-out-of-3 alert PLC words as an alert signal.

3.03 Recognize 2-out-of-3 test alert PLC words as a test alert signal.

3.04 Recognize one alert PLC word as an alert acknowledgment signal.

3.05 Recognize one test alert PLC word as a test alert acknowledgment signal.

3.06 Transmit a continuity PLC word once every 6 seconds.

3.07 Transmit a manual acknowledgment PLC word.

3.08 Recognize a manual acknowledgment PLC word as a manual acknowledgment signal.

3.09 Locally test all alert sending and receiving circuitry.

3.10 Control audible and visual signals upon receipt of PLC words.

3.11 Control audible and visual signals when the code words have not been received for a period of 20 seconds.

3.12 Control audible and visual signals when the code sender has not completed sending a code word during any 7-second period or operates continuously.

3.13 At installations equipped with dual line facilities:

(a) Receive and recognize PLC word signals when one facility is disabled.

(b) Transmit on both facilities when one sender is disabled.

(c) Locally test either facility when one sender is disabled.

3.14 Provide a flashing circuit to flash the console lamps at a rate of 0.5 second on and 0.5 second off.

3.15 Provide a 28-volt ac lamp supply; provide a 10-volt ac lamp supply.

3.16 Provide a backup lamp switching circuit to connect the lamps to 24 volts dc automatically in the event that the 28-volt ac supply is disabled.

3.17 Provide connection to telephone company alarm circuits to indicate failure of the 28-volt ac lamp supply.

3.18 Disable AL key during local test mode.

3.19 Disable LOC TST keys during alert or test alert mode.

3.20 Disable TST ACK key during alert or test alert mode after MA OPR key has been operated.

3.21 Disable MA OPR until the AL, TST AL, or RLS key is operated.

3.22 Light all console lamps and sound buzzer when LOC TST- LP FIL key is operated.

4. CONNECTING CIRCUITS

4.01 The following are typical connecting circuits. When this circuit is listed on a keysheet, the connecting information thereon is to be followed:

(a) Code Sender and Code Receiver Circuit - SD-1G214-01.

(b) Standard DX Signaling Circuits.

(c) Code Register Circuit - SD-1G148-01.

(d) Standard Audible and Visual Alarm Circuits.

(e) Common Systems - Testing and Maintenance - 60-cycle Supply Alarm Circuit - SD-95005-01.