Federal Telecommunications Recommendation 1047/3-1998

6 March 1998

HIGH FREQUENCY RADIO AUTOMATIC LINK ESTABLISHMENT ADDRESSING AND REGISTRATION

Federal Telecommunications Recommendations (FTRs) are issued by the Technology and Standards Division, National Communications System (NCS), after approval by the Federal Telecommunications Standards Committee and the Deputy Manager, NCS, pursuant to Executive Order 12472,[1] NCS Directive 4-1,[2] and Public Law 104-113.[3]

1. Name of Recommendation. High Frequency Radio Automatic Link Establishment Addressing and Registration.

2. Category. HF Radio Automatic Link Establishment, Telecommunications Standards.

3. Explanation. This Federal Telecommunications Recommendation (FTR) is one of a series of standards and recommendations pertaining to automatic high frequency (HF) radio equipment and operation. Federal Standard (FED-STD) 1045A, ATelecommunications: HF Radio Automatic Link Establishment,@ October 18, 1993, provides Federal departments and agencies with a comprehensive description of the performance and interoperability criteria for automatic link establishment (ALE) in high frequency (HF) radio. FED-STD-1045A provides the waveform, coding, and protocols to support ALE and is the foundation for the adaptive and automated radio features that are being defined in a family of Federal HF radio telecommunications standards and recommendations:

FED-STD 1046/1, AHF Radio Automatic Networking;@
FED-STD 1049/1, AHF Radio Automatic Operation in Stressed Environments: Linking Protection;@
FTR 1050, AHF Radio Baseline Parameters;@

[1]Executive Order 12472, AAssignment of National Security and Emergency Preparedness Telecommunications Functions,@ April 3, 1984.
[2]NCS Directive 4-1, AFederal Telecommunication Standards Program,@ February 21, 1991.
[3]Public Law 104-113, AThe National Technology Transfer and Advancement Act of 1995,@ February 27, 1996.

FED-STD 1052, AHF Radio Modems.@

This FTR establishes procedures for the assignment and registration of ALE addresses for use in network operations. This FTR also provides guidance for closed departmental network operations and directives for intra-department and shared network operations.

4. Approving Authority. Deputy Manager, National Communications System.

5. Maintenance Agency. Technology and Standards Division, National Communications System.

6. Related Documents.

a. FED-STD 1037C, ATelecommunications: Glossary of Telecommunications Terms.@

b. FED-STD 1045A, ATelecommunications: HF Radio Automatic Link Establishment.@

c. FED-STD 1046, ATelecommunications: HF Radio Automatic Networking, Section 1: Basic Networking - ALE Controller.@

d. MIL-STD-188-141, AInteroperability and Performance Standards for Medium and High Frequency Radio Equipment.@

At the time of publication of this FTR, the editions indicated above were valid. All publications are subject to revision, and parties to agreements based on this FTR are encouraged to investigate the possibility of applying the most recent editions of these publications. Copies of the specifications and related documents may be obtained from:

FED-STDs - General Services Administration
Federal Supply Service Specification Section
470 E. L'Enfant Plaza, S.W.
Suite 8100
Washington, DC 20407

MIL-STDs - Naval Publications and Forms Center
Attn: NPODS
5801 Tabor Avenue
Philadelphia, PA 19120-5099

7. Objective. The objective of this FTR is to improve HF radio interoperability for Federal departments and agencies by providing for the assignment and registration of ALE addresses for automatic network operations. This FTR establishes ALE address registration procedures that are considered necessary to ensure interoperability in network operations. This document was developed in accordance with the **A**Statement of Requirements (SOR) for the Development of a Family of Federal Standards for Automated High Frequency Radio@ to provide communications interoperability and to satisfy the requirements of Federal departments and agencies.

8. Applicability. This FTR is recommended for use by all departments and agencies of the Federal Government in the administration of HF ALE radio networks.

9. Specifications. High Frequency Radio Automatic Link Establishment Addressing and Registration.

9.1 General. This FTR establishes procedures for the assignment and registration of ALE addresses for use in network operations. This FTR also provides guidance for closed departmental network operations and directives for intra-department and shared network operations.

9.2 Definitions.

9.2.1 Terms. Definitions needed for the technical understanding of this FTR are found in FED-STD-1037C. For the purposes of this FTR, definitions are provided for the following terms, some of which have been repeated from FED-STD-1037C for the convenience of the reader.

9.2.1.1 ALE address code. A digital addressing structure based upon the standard 24-bit (3-bit preamble and three 7-bit characters) ALE word and the basic 38-ASCII subset characters. The address is composed of from one to five words (15 characters maximum).

9.2.1.2 Automatic link establishment (ALE). The capability of an HF radio station to make contact, or initiate a circuit, between itself and another specified radio station, without human intervention and usually under processor control. *Note:* ALE techniques include automatic signaling, selective calling, and automatic handshaking. Other automatic techniques that are related to ALE are channel scanning and selection, link quality analysis (LQA), polling, sounding, message store-and-forward, address protection, and anti-spoofing (FED-STD-1037C).

9.2.1.3 Automatic Sounding. The testing of selected channels or paths by providing a very brief beacon-like identifying broadcast that may be used by other stations to evaluate connectivity, propagation, and availability and to identify known working channels for possible later use for communications or calling. Automatic soundings are primarily intended to increase the efficiency of the ALE function, thereby increasing system throughput. Sounding information is used for identifying the specific channel to be used for a particular ALE connectivity attempt (FED-STD-1037C).

9.2.1.4 Link quality analysis (LQA). The overall process by which measurements of signal quality are made, assessed, and analyzed. In LQA, signal quality is determined by measuring, assessing, and analyzing link parameters, such as bit error ratio (BER), and the levels of the ratio of signal-plus-noise-plus-distortion to noise-plus-distortion (SINAD). Measurements are stored at--and exchanged between--stations, for use in making decisions about link establishment (FED-STD-1037C).

9.3 General Requirements.

9.3.1 Purpose. The purpose of this FTR is to provide for the orderly management of address codes used by HF radio networks employing ALE adaptive radio controllers. As Federal agencies acquire new ALE radio technology, the issue of address duplication becomes increasingly important. Because ALE calling commands are automated and little direct operator involvement is required, the potential for conflict among different agencies and networks is a legitimate concern. This document provides a standardized ALE address format that fosters agency interoperability within the Federal community and sets forth the process of centralized administration of addresses. Centralized registration of ALE addresses minimizes the possibility of address duplication in addition to providing for the required degree of traceability. The administrative process is designed to be flexible and responsive to the needs of the individual agencies and their components. This FTR was developed under the auspices of the Federal Telecommunications Standards Committee (FTSC), whose intent is to foster agency interoperability through the use of HF radio assets in support of national security and emergency preparedness (NS/EP) requirements.

9.3.2 Background. FED-STD-1045A, "Telecommunications: HF Radio Automatic Link Establishment,@ October 18, 1993, specifies an automatic link establishment protocol for use in HF radio systems which often must link over sky-wave channels. To

cope with the poor channel characteristics often encountered with such channels, the FTR specifies robust mechanisms at both the physical layer (modem) and the data link layer, in terms of the Open Systems Interconnection (OSI) reference model. The modem employs 8-ary frequency-shift keying (FSK) with 8 millisecond (ms) tones; thus 3-bit symbols are sent at a rate of 125 per second, giving a raw data rate of 375 bits per second. These radios automatically scan preselected frequencies (channels) to determine the communications suitability of each channel and store the information in a link quality analysis (LQA) table. With the push of a button, the ALE controller selects the best possible channel for existing conditions and automatically establishes a link with the distant station via a three-way handshake. ALE greatly enhances the speed and quality of HF communications, particularly with less experienced operators. This adaptive technology is revolutionizing the field of HF radio communications. HF radios with ALE controllers are no longer dependent on experienced operators to be able to quickly determine the optimal frequencies for specific links. FED-STD-1045A is applicable to all Federal departments and agencies designing and procuring medium frequency (MF) and high frequency radio systems employing ALE features. It is intended to assure interoperability among Federal MF and HF radio systems employing ALE in compliance with the provisions of Executive Order 12472 and National Security Decision Directive 97.

While FED-STD-1045A provides for technical interoperability, it does not provide for the procedural concerns that are also of importance in achieving interoperability. Many Federal agencies have purchased, or are in the process of purchasing, ALE equipment for use in their HF networks. As this equipment is installed and becomes operational, ALE address codes for each of the radios must be selected. Under FED-STD-1045A (and the nearly identical Military Standard 188-141A), each radio controller must be capable of storing, retrieving, and employing at least 20 different sets of information concerning self-addresses, and 100 different sets of information concerning the addresses of other stations and nets. The channels used by the radios are the frequencies assigned to the agency. Without the assignment and registration procedures detailed herein, more than one agency could be using the same ALE address with the potential of causing network complications and interoperability problems.

9.4 Detailed Requirements.

9.4.1 ALE address code structures.

9.4.1.1 General. As a function of the protocols established in FED-STD-1045A, ALE-equipped stations

have the capability and flexibility to automatically link or network with single or multiple stations. In order to ensure the required level of procedural interoperability within and among Federal agencies or users, a common address code structure, as specified in FED-STD-1045A, is required. See FED-STD-1045A, section 5.2. The ALE standard address code employs a digital addressing structure based upon the standard 24-bit ALE word which is composed of a 3-bit preamble and three 7-bit ASCII characters. The preamble words are THRU, TO, COMMAND, FROM, THIS IS, THIS WAS, DATA, REPEAT, with each word assigned three code bits. The three 7-bit ASCII characters are from the basic 38-ASCII subset (see FED-STD-1045A, section 5.2.5, and figure 6). The basic 38-ASCII subset contains numbers 0 through 9, upper case letters A through Z, and the "@" and "?" utility symbols. All ALE stations shall have the capacity to store and use at least 20 self-addresses of up to 15 characters each, in any combination of individual and net calls.

NOTE: Certain alphanumeric address combinations may be interpreted to have special meanings for emergency or specific functions and should be carefully controlled or restricted. See section 9.4.5.3.3 following.

9.4.2 Individual station. The fundamental address element in the ALE system is the single routing word, containing three characters, which forms the basic individual station address. This basic address word, used primarily for intranet and slotted operations, may be extended to multiple words and modified to provide increased address capacity and flexibility for internet and general use. An address which is assigned to a single station is an "individual" address. If it consists of one word (no longer than three characters), it is termed a "basic" address, and if it exceeds the one word, it is an "extended" address.

9.4.2.1 Basic address. The basic address word is composed of a routing preamble (TO, or possibly a REPEAT which follows a TO in the leading call time of a group call, or a THIS IS or THIS WAS) plus three address characters. The address characters shall be the alphanumeric members of the basic 38-ASCII subset. The use of the utility symbols "@" and "?" are described in section 9.4.4 below. The 3 characters in the basic individual address provide the minimum address word structure. One-word addresses should be used only for abbreviated address intranet and slotted response operations, and extended addresses should be used for intranet, internet, and general operations.

9.4.2.2 Extended addresses. Extended addresses

provide address fields which are longer than 1 word (3 characters), up to a maximum system limit of 5 words (15 characters). See table 1. This 15-character capacity enables Integrated Services Digital Network (ISDN) address capability. Specifically, the ALE extended address word structure shall be composed of an initial basic address word, using preambles such as TO or THIS IS, as previously described, plus additional words as necessary to contain the additional characters, in the preamble sequence DATA, REPEAT, DATA, REPEAT, for a maximum total of five ALE words.

Reminder: Each ALE word (24 bits) consists of a 3-bit preamble and three 7-bit ASCII characters.

9.4.3 Multiple stations. It is a critical requirement to simultaneously (or nearly simultaneously) address and interoperate with multiple stations in MF and HF networks. A prearranged collection of stations, with a commonly assigned additional address, is termed a "net," and the common address is a "net address." A nonprearranged collection of stations, without a commonly assigned additional address, is termed a "group." Note that the term "net" is also commonly used to identify any collection of stations which are, or were, interoperating, regardless of any prearrangement or the method of establishment. As used in this FTR, the terms "net" and "group" refer to the linking and networking methodology, not the subsequent traffic exchanges. Protocols for linking and networking with nets and groups are described in FED-STD-1045A, section 5.3.6.

9.4.3.1 Net. A net is a prearranged collection of stations which is generally organized and managed with significant prior knowledge of the member stations, including their quantities, identities, capabilities, requirements, and in most cases, their locations and connectivities. Maximum advantage should be taken of this knowledge to optimize the net timing, addressing, and interchanges. The purpose of a net call is to rapidly and efficiently establish contact with multiple prearranged (net) stations (simultaneously, if possible) by the use of a single net address, which is an additional address assigned to all net members in common. When a net address type function is required, a calling ALE station shall use an address structure identical to the individual station address, basic or extended as necessary (FED-STD-1045A, section 5.3.6.2).

TABLE 1. ALE address structures

Type	Number of words	Address characters	Types [and examples]
B	1	1	Stuff-2 [A@@]
	1	2	Stuff-1 [AL@]
	1	3	Basic [JOE]
E	2	4	Basic + Stuff-2 [RUB Y@@]
	2	5	Basic + Stuff-1 [JAM ES@]
	2	6	2 Basic [ITS 960]
	3	7	2 Basic + Stuff-2 [CHA RLI E@@]
	3	8	2 Basic + Stuff-1 [RED TRA IN@]
	3	9	3 Basic [FRA NCI SCO]
	4	10	3 Basic + Stuff-2 [BLA CKB ALL 2@@]
	4	11	3 Basic + Stuff-1 [MIS SIS SIP PI@]
	4	12	4 Basic [BLA CKL ION 718]
	5	13	4 Basic + Stuff-2 [FAS TCH ARG ER5 9@@]
	5	14	4 Basic + Stuff-1 [ACT IVE MOU NTA IN@]
	5 (limit)	15 (limit)	5 Basic [WAR FIG HTE RBR AVO]

9.4.3.2 Group. Unlike a net, a group is not prearranged and, in many cases, little or nothing is known about the stations except their individual addresses and scanned common frequencies. Despite this minimum of data, it is necessary to be able to create a new group where none existed, and it requires a standardized protocol which is compatible with virtually all automated stations. The purpose of a group call is to establish contact with multiple (group) stations (simultaneously if possible) rapidly and efficiently by the use of a compact combination of their own addresses. When a group address type function is required, a calling ALE station shall use a sequence of the actual individual station addresses of the called stations, in the manner directed by the specific standard protocol as described in FED-STD-1045A, section 5.3.6.3 and in FED-STD-1046/1.

9.4.4 Special modes "@" and "?" .

9.4.4.1 General. The special modes, which use the utility symbol "@" (1000000) and "?" (0111111), include the following:

Stuffing
Allcalls
Anycalls
Self-address
Null-address
Wildcards

9.4.4.2 Stuffing. The ALE basic address structure is based on single words, which, in themselves, provide multiples of three characters. The quantity of available addresses within the system, and the flexibility of assigning addresses, are significantly increased by the use of address character stuffing. This technique allows address lengths, which are not multiples of three, to be compatibly contained in the standard (multiple of three characters) address fields by "stuffing" the empty trailing positions with the utility symbol "@." See table 1, above. "Stuff-1" and "Stuff-2" words are only used in the last word of an address and therefore should appear only in the leading call (T_{lc}) of the calling cycle (T_{cc}).

NOTE: As an example of proper usage, a call to the address "MIAMI" would be structured "TO MIA" "DATA MI@."

9.4.4.3 Allcalls. An "allcall" is a general broadcast which does not request responses and does not designate any specific address. This essential function is required for emergencies ("HELP!"), sounding-type data exchanges, and propagation and connectivity tracking. The global allcall special address pattern is "TO @?@". See FED-STD-1045A, section 5.2.5.4.3 and table X.

9.4.4.4 Anycalls. An ALE station may call and receive responses from essentially unspecified stations and it thereby can identify new stations and connectivities. An "anycall" is a general broadcast which requests responses without designating any specific address(es). It is required for emergencies, reconstitution of network and systems, and creation of new networks. The global anycall special address pattern is "TO @@?" See FED-STD-1045A, section 5.2.5.4.4 and table X and also FED-STD-1046/1.

9.4.4.5 Wildcards. A wildcard is a special character that the caller uses to address multiple-station addresses with a single-call address. The wildcard character "?" is used as a substitute for any of the 36 characters (A to Z and 0 to 9) in the basic 38-ASCII subset. The total length of the calling (wildcard) address and the called addresses must be the same. See FED-STD-1046/1, section 5.2.5.4.5 and table II.

9.4.4.6 Self-address. For self-test, maintenance, and other purposes, stations shall be capable of using their own self-addresses in calls. Any ALE calling structures and protocols permissible within FED-STDs-1045A and -1046/1, and containing a specifically addressed calling cycle (such as "TO ABC," but not allcall or anycall), is acceptable.

9.4.4.7 Null address. For test, maintenance, buffer times, and other purposes, the station may use a null address which is not directed to, accepted by, or responded to by any station. The null address special address pattern is "TO @@@." Null addresses may be mixed with other addresses (group call), in which case they shall appear only in the leading call (T_{lc}), and not in the scanning call (T_{sc}). Nulls shall never be used in the conclusion (terminator) (THIS IS or THIS WAS).

9.4.5 Address assignment and registration.

9.4.5.1 General. Procedural interoperability among ALE radio users is affected by:

a. The manner in which individual address elements are assigned within the ALE address blocks.

b. The centralized registration and administration of address elements to enhance procedural interoperability.

9.4.5.2 Unique identifier address. To provide a means of agency differentiation, each Federal agency shall select and have recorded a unique identifier address (UIA). The UIA, composed of 3 alphabetical characters, will then be registered for each agency or component. No two organizations will have the same UIA. When possible, the UIA will be structured to reflect common abbreviations that identify a particular agency (e.g., FBI, DOE, DOJ, etc.). Ideally, all stations of that agency would have their UIA in one or more word positions of any of their individual addresses which could be used in internet or multiple agency operations. Where the identification of the parent agency must be protected (e.g., covert or clandestine operations), the agency may elect not to use a UIA. The actual position in which the UIA appears will be decided upon by the agency concerned. This permits use of the UIA in the first word position, serving as a net address, as well as use in the second word position, when it would function as an interagency identifier. However, it is strongly recommended that the station unique address word (3 characters) be placed in the first word position, regardless of the length of the address in question. The use of the UIA is also permitted, if desired, in any of the subsequent word positions (three through five). The actual use in any word position is left to the agency. The UIA is not required to be used in all addresses, but its use is recommended, where practical, as a means of agency identification. The use of UIAs enables each agency to recognize not only the single, three-character identifier for its own stations, but also those identifiers of other agencies, thus promoting interoperability. The UIA can serve as a net address (including slotted response operations) when used alone as a call.

9.4.5.2.1 First Word. The ALE address code structure covers all 5 words (15 characters) of the ALE address. These 15 characters are divided into 5 groups of 3-character ALE words. The basic unit of the address is the first group (first ALE word) of 3 alphanumeric characters. When used alone as an address, the first word is an efficient means of differentiating a small network of radios. For larger networks, additional words may be needed. The UIA alone as the first word may serve as a net address for multiple radios in a one-agency network. If an extended address (more than one ALE word) is

used, it is recommended that the station-unique address be used as the first word.

9.4.5.2.2 Second Word. The second word (if used) is also composed of 3 alphanumeric characters, and may also be the UIA. The combination of first word and second word may be used as a self-address or net address. Use of the UIA in the second word position is particularly appropriate for use in interagency networks to differentiate between the various agencies involved.

9.4.5.2.3 Third through Fifth Words. The last three words of an address, if used, may contain any alphanumeric characters of the 38-ASCII subset at the agency's discretion, excluding UIAs registered to any other agency or restricted alphanumeric combinations (see section 9.4.5.3.3 following). For ALE addresses, considerable flexibility is retained through the availability of multiple addresses in the first word blocks, the use of various two-word combinations (which greatly increases the number of available addresses), and discretionary use of the third, fourth, and fifth words.

9.4.5.3 Address Registration.

9.4.5.3.1 Procedures. Using the ALE address code structure, each agency should apply for registration of a "block" of 3-character alphanumeric addresses. The agency can request a specific number of non-sequential blocks, or request registration of a sequential series of addresses. Assignments will, where possible, satisfy the address configuration desired by each agency, and consist of any 3 alphabetic or alphanumeric characters (AAA-ZZZ, A00-Z99). The number of addresses registered to each agency will be based upon the size of the ALE network and number of radios involved, as determined on a case-by-case agency basis. Because each station can have as many as 20 self-addresses, registration of only the "permanent" addresses is required. However, registration grants exclusive use of that address. Permanent addresses are those assigned to a station, primarily in fixed networks, where there are no planned address changes. Stations, such as contingency or backup assets, without a network affiliation, may not need address registration if any foreseen deployment would be temporary (normally a month or less). Address registration for these "standby" units is recommended, however, to reserve those addresses for exclusive use.

9.4.5.3.2 Additional provisions. Each word registered should contain not less than 3 characters. The

use of a one- or two-character address in the first word position is reserved and shall not be used unless specifically authorized. The use of a one- or two-character address in the second word position is discouraged. Any agency may request the registration, for exclusive use, of any combination of 4 or more alphanumeric characters, using the characters from multiple word positions. Assignment will be made on a non-interfering basis.

Examples: COAST GUARD
ROME LAB
TREASURY

These registrations will be treated as groups of three character words, where COAST GUARD would involve the registration of C O A in the first word, S T G in the second, U A R in the third, and D @ @ as the fourth, the fifth word not being used. All registrations will be by agency request and on a non-interfering basis. Subsequent to the initial allocation of address blocks, additional addresses can be assigned based on valid requirements.

9.4.5.3.3 Restrictions. The following are restrictions to the assignment and registration of ALE address codes.

9.4.5.3.3.1 Certain alphanumeric combinations, commonly interpreted to have special meaning for emergency or other functions, will not be assigned. They may be used for their intended purposes by any agency at any time. Most of the emergency addresses may be programmed like an allcall (stop and listen but don't handshake). Among the special addresses are:

MAYDAY	MAINSAIL	EAM
SOS	SECURITY	ALL
PANPAN	SECURITE	ANY
HELP		NULL

9.4.5.3.3.2 Fully numeric addresses will not normally be registered. However, ISDN (15 digits) or telephone numbers (7 or 10 digits) may be used by any station as required by the agency concerned.

9.4.5.3.3.3 ALE address words beginning with A, K, N, or W, unless assigned as the agency's UIA, will not normally be registered. These are reserved for use by an agency for registration of its own officially assigned (NTIA or FCC) station call signs. These official call signs should be registered.

9.4.5.3.3.4 The following forms of addresses are special modes reserved for multi-station connectivity and testing purposes and will not be registered to individual agencies.

@?@ (global allcall)
@x@ (selective allcall)
@@? (global anycall)
@@x (selective anycall)
@xx (double selective anycall)
@@@ (null)
?@? (reserved)

NOTE: x represents any alphanumeric character from the ASCII-38 subset.

9.4.5.3.3.5 No address containing a wildcard (see section 9.4.4.5 above) will be registered.

9.5 Administration. Address registration is concerned primarily with the first two words of an address (3 to 6 alphanumeric characters). Registration of these address words establishes the exclusive use to include the unlimited use of address elements in the remaining word positions. Agencies with ALE-equipped radios, or those in the acquisition process, shall submit their preliminary addressing plan to the registration authority. The registration authority will search the data base for conflicts, attempt to resolve any conflicts, and register the newly approved addresses as well as registration of the UIA approved for the agency. The registration authority will maintain a master listing of all address codes registered to requesting agencies. The interim registration authority is:

National Communications System
SHARES Project Office, (N3)
701 South Court House Road
Arlington, VA 22204-2198

As an interim measure, SHARES Form 4 (attached) is to be used to request registration.

NOTE: This is an ALE address registration standard and is not a call-sign assignment document.

9.6 Operation in Networks. As an aid to the operation of both single-agency and interagency networks, the "Federal Automatic Link Establishment Network Operational Instruction" is

developed and published under the authority of the National Communications System (NCS). The Institute for Telecommunication Sciences (ITS) serves as the interim preparing agency. The Operational Instruction (OI) is the directive for interagency ALE network operations and instructions for single-agency ALE network operations. The OI provides information on non-closed interagency networks and the parameter settings and other requirements that must be met in order to operate in these networks. The purpose of the OI is to facilitate interoperability and functionality both in normal operations and in emergency and contingency operations. The OI will be updated as needed. The issuance identification consists of "OI" followed by the year, dash, and the issuance number for the year. The first issue for 1996 is "OI 1996-1."

10. Where to Obtain Copies. Additional copies of this FTR can be obtained from the National Communications System, Technology and Standards Division (N6), 701 South Court House Road, Arlington, VA 22204-2198. When requesting copies, refer to Federal Telecommunications Recommendation 1047/3-1998, High Frequency Radio Automatic Link Establishment Addressing and Registration.