

# **An Investigation of Federal Standard 1045 High-Frequency ALE Radio Performance in the Southern Trans-Auroral Zone**

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## **PREFACE**

The Naval Undersea Warfare Center (NUWC) Military Interdepartmental Purchase Request (MIPR) N6660492MP25003 dated 8 November 1991, tasked the Institute for Telecommunication Sciences (ITS) to conduct an assessment of the National Science Foundation Office of Polar Programs' (NSF/OPP) primary high-frequency (HF) radio link between Christchurch, New Zealand, and McMurdo Station, Antarctica, and to provide specific recommendations to improve the voice and data transmission quality, as well as increase the circuit time availability. These recommendations include equipment configuration and specification.

This NTIA Report presents the professional opinions and recommendations of the ITS authors. However, the report does not reflect NTIA, NUWC, or any other Federal agency position, policy, or decision unless otherwise designated by other official documentation, and it does not constitute product endorsement by any agency of the U.S. Department of Commerce nor the sponsor of this project.

The technical and administrative monitoring of this project was performed by Mr. Joseph Katan of the Naval Undersea Warfare Center. Technical leadership and administrative supervision of the project at ITS were provided by Mr. David F. Peach, P.E.



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## ACRONYMS AND ABBREVIATIONS

AEA	Advanced Electronic Applications, Inc. A manufacturer of HF data modems designed primarily for the amateur radio market.
ALE	Automatic link establishment. The capability of an HF radio station to make contact, or initiate a circuit, between itself and another specified radio station, without operator assistance 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.
AMAF	A manufacturer of the Lincompex™ voice companders. The corporate name of this company changed to Link-Plus in 1992.
AMTOR	Amateur teleprinting over radio. An error-free radio-teletype system developed by amateur radio experimenters from a maritime mobile service protocol (CCIR Recs. 476, 625).
ASA	Antarctic Support Associates. A contractor supporting the NSF and the U.S. Antarctic Program.
ASAPS	Advanced stand alone prediction system. A computer HF radio propagation system developed by the Australian IPS Radio and Space Services, Department of Administrative Services (1992).
BER	Bit error ratio. The number of erroneous bits divided by the total number of bits transmitted, received, or processed over some stipulated period of time.
Bit	Binary digit. A signal having two states, represented by a “1” or “0”.
BW	Bandwidth. The difference between the limiting frequencies within which performance of a device, in respect to some characteristic, falls within specified limits.
CCIR	The International Radio Consultative Committee. An international standards making body that develops radio standards.
COMSTA	A U.S. Navy communications station.
cw	Continuous wave. Used for manual Morse code telegraphy.

## ACRONYMS AND ABBREVIATIONS (cont.)

dBi	Decibels referenced to an isotropic antenna.
dBW	Decibels referenced to one watt.
EIRP	Equivalent isotropic radiated power. The rf power radiated from an antenna, in a specified direction, referenced to that of an isotropic antenna.
FEC	Forward error correction. A coding technique that detects and automatically corrects some or all of the errors in a data transmission.
FOT	Optimum traffic frequency. A frequency below the maximum frequency that will propagate, and that is relatively immune to minor changes in the ionosphere.
FSK	Frequency shift keying. A form of frequency modulation in which the modulating signal shifts the output frequency between predetermined values.
HF	High frequency. A band of radio frequencies from 3-30 MHz, that is used for world-wide communications.
HLPA	Horizontal log periodic antenna.
IONCAP	Ionospheric communications analysis and prediction. An HF radio propagation program developed by ITS and widely used throughout the Federal Government.
ISB	Independent-sideband. A method of transmission in which the information carried by each sideband is different.
ITS	The Institute for Telecommunication Sciences, an engineering element of NTIA.
LEO	Low earth orbit, as applied to satellites in circular, near-earth orbits (700-900 km height above mean sea level).
LQA	Link quality analysis. A composite score, defined by FED-STD-1045, representing the received SINAD and pseudo-bit error ratio (PBER) of an ALE signal.
LUF	Lowest usable frequency. For sky-wave signals in the MF/HF spectrum, the lowest frequency effective under specified conditions for ionospheric propagation of radio waves between two specified points on a planetary surface.

## ACRONYMS AND ABBREVIATIONS (cont.)

MUF	Maximum usable frequency. The highest frequency of radio waves that can be used between two points under specified conditions for reliable transmission by reflection from the regular layers of the ionosphere.
NASU	Naval Antarctic Support Unit, Christchurch, NZ.
NIST	The National Institute of Standards and Technology (formerly the National Bureau of Standards).
NSF	The National Science Foundation.
NTIA	The National Telecommunications and Information Administration. An agency of the U.S. Department of Commerce, responsible for setting telecommunications policy for the U.S. Government.
NUWC	Naval Undersea Warfare Center.
PBER	Pseudo-bit error ratio (see BER). A measure of the BER produced by the Harris RF-7210 ALE modem.
PCA	Polar cap absorption. The result of infrequent but major disturbances of the ionosphere, caused by high-energy solar protons. Guided by the earth's magnetic field, these protons increase the ionization level of the D region causing total absorption of radio signals from HF into the VHF spectrum. PCAs may last for several days.
PM	Preventive maintenance. Tests, measurement, replacements, adjustments, repairs and similar activities, carried out with the intention of preventing faults or malfunctions from occurring during subsequent operation. Preventive maintenance is designed to keep equipment and programs in proper operating condition and is performed on a scheduled basis.
PSK	Phase-shift keying. A method of modulation used for digital transmission wherein the phase of the carrier is discretely varied in relation to a reference phase, or the phase of the previous signal element, in accordance with the data to be transmitted.
RATT	See RTTY.
RF	Radio frequency. Those frequencies of the electromagnetic spectrum normally associated with radio wave propagation.

## ACRONYMS AND ABBREVIATIONS (cont.)

RLPA	Rotatable Log Periodic Antenna.
RTTY	Radio teletypewriter. A teletypewriter employed in a communication system using radio circuits. Note: Such systems are spoken of as RATT systems.
SATCOM	Satellite communications.
SID	Sudden ionospheric disturbance. Abnormally high ionization densities in the D region caused by an occasional sudden outburst of ultraviolet light on the Sun (solar flare). This results in a sudden increase in radio-wave absorption, which is most severe in the upper MF and lower HF frequencies.
SINAD	An acronym for “signal plus noise plus distortion to noise plus distortion ratio” expressed in decibels (dB), where the “signal plus noise plus distortion” is the audio power recovered from a modulated radio frequency carrier, and the “noise plus distortion” is the residual audio power present after the audio signal is removed. This ratio is a measure of audio output signal quality for a given receiver audio power output level.
SITOR	Simplex telex over radio. A form of radio teletype protocol used in the Maritime Mobile Service, that incorporates error detection and automatic repeat request in a selective calling mode or forward error correction in a broadcast mode.
SNR	Signal-to-noise ratio. The ratio of the amplitude of the desired signal to the amplitude of noise signals at a given point in time. Usually expressed in decibels, and in terms of peak values for impulse noise and root-mean-square values for random noise. Both the signal and noise should be defined to avoid ambiguity; e.g., peak-signal to peak-noise ratio.
SOP	Standing (or Standard) operating procedures.
SSN	Sunspot number. A physical count of the number of sunspots on the solar disk. This number has been shown to be correlated with ionospheric behavior. A daily or monthly average count may be obtained from the Space Environment Service Center (SESC), Boulder, CO, or from other sources around the world.
VHF	Very high frequency. Frequencies from 30 to 300 MHz.
Z	Zulu Time. Synonym for Coordinated Universal Time (UTC, Z Time). Formerly a synonym for Greenwich Mean Time