CHAPTER 2 - LORAN-C TRANSMISSIONS

A. Transmitted Pulse

All specifications listed herein are defined in terms of the current waveform at the base of the transmitting antenna.

1. Pulse Leading Edge

Each station transmits signals which have standard pulse leading-edge characteristics. Each pulse consists of a 100 kHz carrier that rapidly increases in amplitude in a prescribed manner and then decays at a rate which depends upon the particular transmitter and antenna characteristics. The leading edge of the standard Loran-C pulse waveform, against which the actual antenna current waveform is compared, is defined as i(t), where

$$i(t) = 0 \; ; \text{ for } t < \tau \qquad (2.1)$$

$$i(t) = A(t-\tau)^2 \exp\left[\frac{-2(t-\tau)}{65}\right] \text{SIN}\,(0.2\pi t + PC) \; ; \text{ for } \tau \leq t \leq 65 + \tau \qquad (2.2)$$

where:
A is a normalization constant related to the magnitude of the peak antenna current in amperes.
t is time measured in microseconds.
tau is the envelope-to-cycle difference (ECD) in microseconds. The range is -5 ≤ tau ≤ +5 usec.
PC is the phase-code parameter (in radians) which is 0 for positive phase code and pi for negative phase code.

Note in equations 2.1 and 2.2 that the first half-cycle of antenna current is 5 microseconds or shorter. When the ECD is positive, the first half-cycle commences at time tau and ends at time t = 5 microseconds, for a length of 5-tau microseconds. When the ECD is negative, the pulse theoretically begins before time (t) = 0, at time (t) = tau. The energy in this interval, however, is usually too small to be measured and does not constitute a half-cycle. Therefore, the first half-cycle begins at time t = 0 and ends at time t = 5 when the ECD is negative. Because of the difficulties of measuring and shaping the beginning of the antenna current pulse, these specifications allow a greater tolerance over the first few half-cycles.

Note that the principal transformation which occurs between the antenna current and far E-field is a 90° carrier phase shift and a resultant change in the ECD (tau) by approximately 2.5 microseconds. See Chapter 4 for a mathematical description of this transformation.

a. <u>Envelope-to-Cycle Difference (ECD)</u>

The ECD of an actual Loran-C pulse is determined in the following manner:

(1) The deviation between the actual waveform, sampled at the first eight half-cycle peaks, and the standard leading edge (equation 2.2) is computed.

(2) This deviation is minimized in a root-sum-square sense over ECD and the first 40 microseconds.

(3) The ECD of the pulse is that value which minimizes this deviation.

(4) The following empirical relationship for an all-seawater path is used to determine the best Nominal ECD for a transmitting station:

$$\mathbf{ECD = 2.5 + NECD - 0.0025d}$$

where:

NECD = nominal ECD of transmitting station (as defined in Chapter 4)

d = distance in nautical miles from the transmitting station

(5) Figure 1 shows the first six half-cycles of loran pulses with ECDs of -3, 0 and +3 microseconds. The theoretical envelope of each pulse is superimposed. These envelopes are exactly 3 microseconds apart along the horizontal scale.

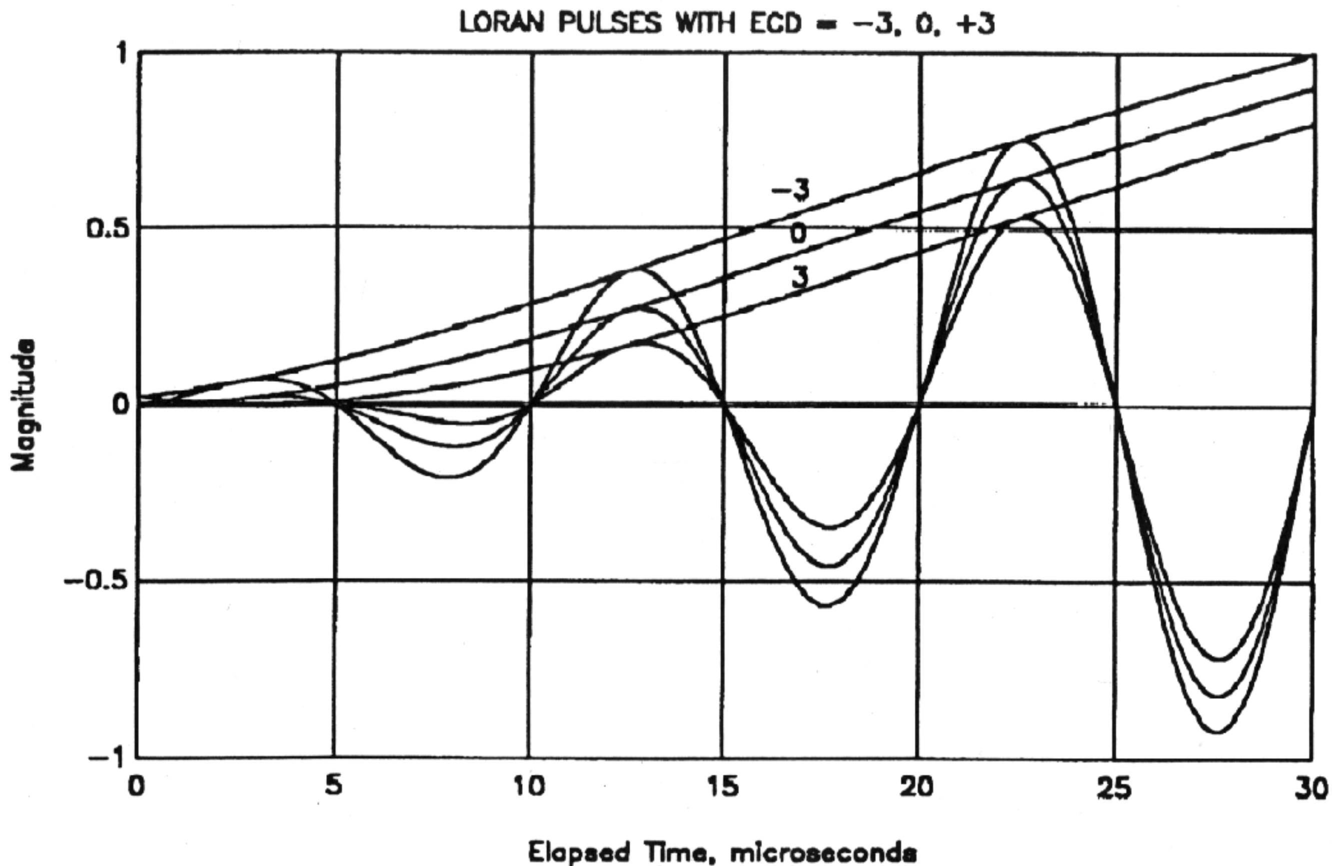

Figure 1

b. Half-Cycle-Peak Amplitudes (Ensemble Tolerance)

For any ECD in the range -2.5 to +2.5 microseconds, the ensemble of the peak amplitudes of the first eight half-cycles of the first pulse of each group meets the following criterion:

$$\left[\frac{\sum_{N=1}^{N=8} (I_N - S_N)^2}{8} \right]^{1/2} \leqslant .01 \qquad (2.3)$$

where:

I_N and S_N are normalized samples of the Nth half-cycle peaks of the standard and actual, respectively, antenna current waveforms.