Appendix A
Adjacent Channel Test Procedures and Recorded Data

Adjacent Channel Bench Tests

The marine VHF radios (both 25 and 12.5 kHz channelized units) were tested for susceptibility to adjacent channel interference by using either 25 or 12.5 kHz channelized marine radios as interfering transmitters. A diagram of the test set-up used to test the 25 kHz radios is shown below in Figure A-1. The frequencies selected for the desired signal channel and interferer radio for the tests are described in Appendix F.

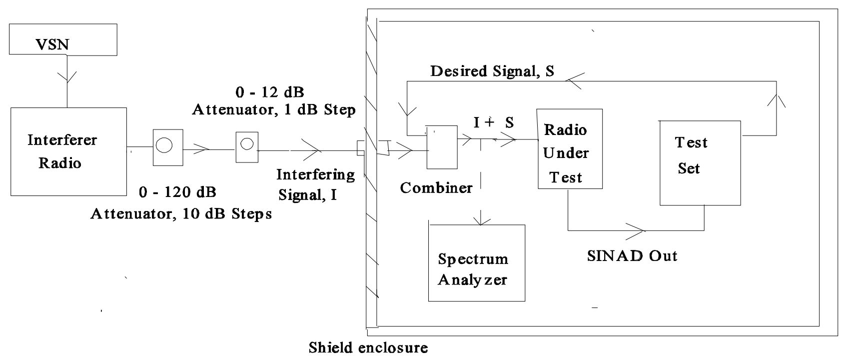

Figure A-1
25 kHz Receiver Bench Test Set-up

The following steps were taken to perform the tests on the 25 kHz radio receivers:

1. The receiver of the 25 kHz radio under test was tuned to the desired marine channel. The test set which was used as the 25 kHz desired signal transmitter was also tuned to that same channel and was modulated by an internal 1 kHz tone adjusted in amplitude for a 3 kHz signal deviation.

2. The power of the desired signal, S, from the RF output of the test set was adjusted and its value recorded in dBm when the SINAD of the radio receiver under test was 15 dB.

3. The interferer radio was set to the proper adjacent frequency. The frequencies used by the interferer radio and the desired signal radio for the testing are described in Appendix A.

4. The interferer radios were modulated by voice-shaped noise (VSN) played from a tape in a cassette player. The peak amplitude of the VSN signal from the cassette tape was matched as closely as possible

to the amplitude of a 1 kHz tone that would produce a 2.5 kHz signal deviation for a 25 kHz interferer radio. For the 12.5 kHz interferer, the peak amplitude of the VSN signal from the cassette tape was matched as closely as possible to the amplitude of a 1 kHz tone that would produce a 1.5 kHz signal deviation.

5. The RF output of the interferer radio, I, was fed through the step attenuators and then through the shielded enclosure. This signal was then combined with the desired signal, S, from the test set and connected to the RF input of the radio being tested.

6. The interferer radio was keyed so that it would transmit. The step attenuators were set to their maximum values and then adjusted till the interference power reduced the SINAD of the radio being tested from 15 to 12 dB.

7. The combiner at the RF input to the radio being tested was then connected to the spectrum analyzer and the RF power of the interfering signal, I, was measured in dBm. In some instances, the power of the interferer was below the noise floor of the spectrum analyzer. For those cases a 20 dB RF amplifier was connected to the output of the combiner before the measurement was made.

8. The interferer radio was tuned to the next adjacent frequency from the desired channel and the above steps were repeated till all adjacent frequencies were tested for that particular radio under test.

For testing 12.5 kHz radio receivers, the test set was used as the interferer radio and the 12.5 kHz radio located outside the shield room functioned as the desired signal radio. In this case, the desired signal radio was externally modulated by a 1 kHz tone for a 2.0 kHz signal deviation and its RF power adjusted by the step attenuators. The RF power of the test set acting as the 25 kHz interferer was adjusted from a front panel control and externally modulated by the VSN played from the cassette player. The peak amplitude of the VSN signal from the cassette tape was matched as closely as possible to the amplitude of a 1 kHz tone that would produce a 2.5 kHz signal deviation from the test set acting as the interferer radio. The test procedures were then repeated for the 12.5 kHz radio tests as in the 25 kHz radio tests, which was to reduce the SINAD of the 12.5 kHz radio receiver from 15 to 12 dB.

A diagram of this test set-up is shown below in Figure A-2. The frequencies used during these tests are described in section Appendix F.

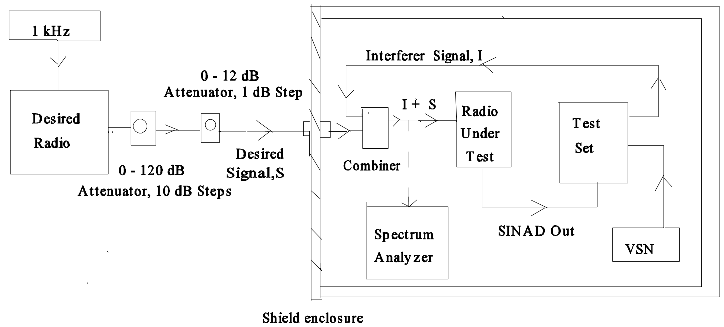

Figure A-2
12.5 kHz Receiver Test Set-up

Adjacent Signal Bench Test Results

The results of the adjacent interference susceptibility tests are contained in the following tables. Each table lists the desired signal power of each radio along with the power of the adjacent interferer needed to reduce the SINAD of the radio being tested from 15 to 12 dB (for each adjacent interference frequency).

Table A-1 contains the results of 25 kHz radio receivers versus a 25 kHz interferer on a simplex channel.

Table A-1
25 kHz receiver vs. 25 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)			
		-50 kHz	-25 kHz	25 kHz	50 kHz
Receiver A	-114	-48	-59	-58	-50
Receiver B	-119	-53	-63	-61	-51
Receiver E	-115	-48	-58	-59	-48
Receiver F	-116	-48	-58	-59	-48
Receiver G	-115	-55	-64	-62	-53
Receiver H	-115	-49	-61	-58	-47
Receiver I	-117	-51	-61	-60	-51
Receiver K	-118	-51	-60	-60	-51

Table A-2 contains the results of 25 kHz radio receivers versus a 12.5 kHz interferer on a simplex channel.

Table A-2
25 kHz receiver vs. 12.5 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)							
		-50.0 kHz	-37.5 kHz	-25.0 kHz	-12.5 kHz	12.5 kHz	25.0 kHz	37.5 kHz	50.0 kHz
Receiver A	-114	-46	-51	-55	-97	-99	-54	-54	-51
Receiver B	-119	-53	-55	-59	-99	-90	-59	-53	-52
Receiver E	-115	-48	-51	-56	-92	-95	-56	-52	-49
Receiver F	-116	-48	-50	-55	-95	-95	-55	-50	-48
Receiver G	-115	-55	-58	-63	-101	-99	-60	-59	-55
Receiver H	-115	-49	-55	-55	-103	-92	-54	-51	-49
Receiver I	-117	-50	-53	-57	-97	-101	-56	-52	-50
Receiver K	-118	-49	-52	-55	-105	-71	-54	-50	-48

Table A-3 contains the results of 25 kHz radio receivers versus a 25 kHz interferer on a duplex channel testing the mobile receiver.

Table A-3
25 kHz receiver vs. 25 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)			
		-50 kHz	-25 kHz	25 kHz	50 kHz
Receiver A	-114	-51	-60	-61	*
Receiver E	-115	-48	-58	-60	*

Table A-4 contains the results of 25 kHz radio receivers versus a 12.5 kHz interferer on a duplex channel testing the mobile receiver.

Table A-4
25 kHz receiver vs. 12.5 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)							
		-50.0 kHz	-37.5 kHz	-25.0 kHz	-12.5 kHz	12.5 kHz	25.0 kHz	37.5 kHz	50.0 kHz
Receiver A	-114	-46	-49	-54	-129	-113	-56	-53	*
Receiver E	-115	-42	-48	-52	-110	-115	-54	-50	*

Duplex communications requires that one radio be configured as a base unit and the other as a mobile. Most recreational boaters do not use base station radios in regular operations on duplex channels. For the most part base station marine radios on duplex channels in the United States are only used by those selling public correspondence services from coast stations to commercial shipping operators.

Table A-5 contains the results of a 25 kHz radio receiver versus a 25 kHz interferer on a duplex channel testing the base receiver.

Table A-5
25 kHz receiver vs. 25 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)			
		-50 kHz	-25 kHz	25 kHz	50 kHz
Receiver D	-119	-51	-59	-58	-51

Table A-6 contains the results of a 25 kHz radio receiver versus a 12.5 kHz interferer on a duplex channel testing the base receiver.

Table A-6
25 kHz receiver vs. 12.5 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)							
		-50.0 kHz	-37.5 kHz	-25.0 kHz	-12.5 kHz	12.5 kHz	25.0 kHz	37.5 kHz	50.0 kHz
Receiver D	-119	-56	-58	-61	-96	-88	-61	-56	-54

The 12.5 kHz channelized radios were tested for susceptibility to interference from a 25 kHz interferer. The results of adjacent signal interference tests for the 12.5 kHz mobile unit on a simplex channel versus a 25 kHz interferer are contained in Table A-7.

Table A-7
12.5 kHz Receiver vs. 25 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)			
		-37.5 kHz	-12.5 kHz	12.5 kHz	37.5 kHz
Receiver C	-117	-65	-86	-82	-64

The results of adjacent signal interference tests for the 12.5 kHz mobile unit on a duplex channel versus a 25 kHz interferer are contained in Table A-8.

Table A-8
12.5 kHz Receiver vs. 25 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)			
		-37.5 kHz	-12.5 kHz	12.5 kHz	37.5 kHz
Receiver C	-117	-78	-89	-82	-73

The results of adjacent signal interference tests for the 12.5 kHz base unit on a duplex channel versus a 25 kHz interferer are contained in Table A-9.

Table A-9
12.5 kHz Receiver vs. 25 kHz Transmitter

Radio under test	Desired Signal Power (dBm)	Power of Adjacent Interferer (dBm)			
		-37.5 kHz	-12.5 kHz	12.5 kHz	37.5 kHz
Receiver J	-114	-58	-67	-65	-60

Adjacent Channel Radiated Tests

The marine VHF radios (both 25 and 12.5 kHz channelized units) were tested for susceptibility to adjacent channel interference for the radiated tests by using either 25 or 12.5 kHz channelized marine radios as interfering transmitters. The frequencies of the channels used in these tests are shown in Table A-2 of Appendix A.

A diagram of the test set-up used to test the 25 kHz radios is shown below in Figure A-3.

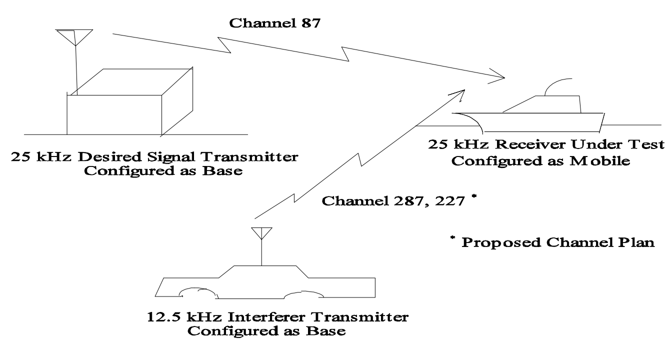

Figure A-3
25 kHz Receiver Radiated Test Set-up

The following steps were taken to perform the interference susceptibility tests on the 25 kHz radio receivers:

1. The receiver of the 25 kHz radio (configured as a mobile) being tested on board the boat was tuned to marine channel 87 and connected to a whip antenna. The 25 kHz desired signal transmitter (configured as a base) was also tuned to channel 87 and modulated by an 1 kHz tone adjusted in amplitude for a 3 kHz signal deviation. The RF output of the desired signal transmitter was connected to an antenna located on the roof of Ross Engineering.

2. The desired signal transmitter at the test facility was keyed. The boat moved out from the dock (located approximately 4.5 nautical miles from the test facility) into Clearwater Harbor and stopped when the SINAD of the radio being tested measured 15 dB with the communications test set. At that location, the level of the desired signal power was measured (at the receiver input) in dBm with the spectrum analyzer and its value recorded. The location of the boat was determined in latitude and longitude with a GPS receiver.

3. The 12.5 kHz interferer radio (configured as a base) was located in a car on the boat dock (approximately 2 miles from the boat) and was tuned to either adjacent interstitial channel 287 or 227. The carrier of these channels are +12.5 and -12.5 kHz from the carrier of channel 87. The RF output of the radio was connected to a 3 dB attenuator and then into adjustable RF step attenuators. The output of the adjustable attenuators was then connected to a whip antenna mounted on the roof of the car.

4. The interferer radio was modulated by voice-shaped noise (VSN) played from a tape in a cassette player. The peak amplitude of the VSN signal from the cassette tape was matched as closely as possible to the amplitude of a 1 kHz tone that would produce a 1.5 kHz signal deviation.

5. The interferer radio was keyed so that it would transmit on either adjacent interstitial channel. The RF power output of the interferer radio (located in the car) was adjusted with the step attenuators until the SINAD of the 25 kHz radio being tested (located in the boat) measured 12 dB with the test set. The location of the car was determined in latitude and longitude with a GPS receiver.

6. The cable to the RF input to the radio being tested on-board the boat was then connected to the spectrum analyzer, and the received RF power of the interferer radio was measured in dBm with the spectrum analyzer and its value recorded.

7. Steps one through six were repeated for each 25 kHz radio being tested.

A diagram of the test set-up used to test the 12.5 kHz radio's susceptibility to an adjacently tuned 25 kHz transmitter is shown below in Figure A-4.

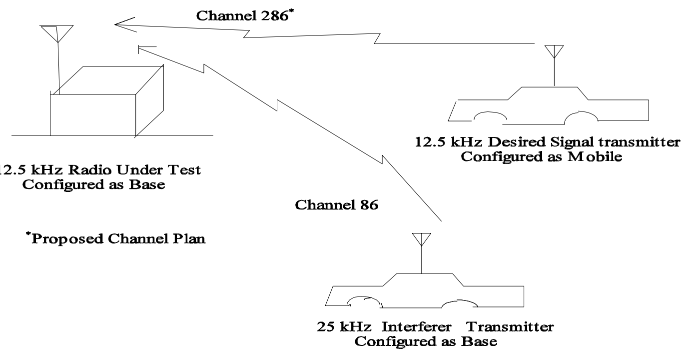

Figure A-4
12.5 kHz Receiver Radiated Test Set-up

The following steps were taken to perform the interference susceptibility tests on the 12.5 kHz radio receiver:

1. The receiver of the 12.5 kHz radio (configured as a base) being tested was located at a test facility in Tampa and was tuned to marine channel 286. The RF input to the radio was connected to adjustable RF attenuators and then to an antenna mounted on the roof the building. The 12.5 kHz desired signal transmitter (configured as a mobile) was also tuned to channel 286 and modulated by an 1 kHz tone adjusted in amplitude for a 2 kHz signal deviation. The RF output of the desired signal transmitter was connected to a whip antenna mounted on the roof of the car.

2. The desired signal transmitter in the car was keyed up and moved to a point approximately 1 mile north of test facility and stopped. The received desired signal power in the lab was adjusted with the attenuators until the test set measured a 15 dB SINAD for the 12.5 kHz radio being tested. The level of the desired signal power at the receiver input was then measured in dBm with the spectrum analyzer and its value recorded. The location of the car containing the desired signal transmitter was determined in latitude and longitude with a GPS receiver.

3. The 25 kHz interferer radio (configured as a mobile) was located in another car and was tuned to channel 86. The interferer radio was modulated by voice-shaped noise (VSN) played from a tape in a cassette player. The peak amplitude of the VSN signal from the cassette tape was matched as closely as possible to the amplitude of a 1 kHz tone that would produce a 2.5 kHz signal deviation.

4.The RF output of the 25 kHz interferer radio was connected to a 3 dB attenuator and then into adjustable RF attenuators. The output of the adjustable attenuators was then connected to a whip antenna mounted on the roof of the car.

5. The interferer radio was keyed so that it would transmit on channel 86. The car then moved south of the test facility and stopped when the SINAD of the 12.5 kHz radio being tested measured 12 dB with the communications test set. The location of the car containing the interferer transmitter was determined in latitude and longitude with a GPS receiver.

6. The received power of the 25 kHz interferer radio at the input to the 12.5 kHz radio (located at the test facility) was then measured in dBm with the spectrum analyzer and its value recorded.

7. As an additional test, the car containing the interferer radio moved closer to the test facility and stopped when the SINAD of the radio being measured in the lab was further reduced by 2-3 dB and the 1 kHz tone could no longer be heard.

8. The received power of the interferer radio at the input to the 12.5 kHz radio being tested was then measured in dBm with the spectrum analyzer and its value recorded. The GPS position of the car containing the interferer radio was also determined.

Adjacent Channel Radiated Test Data

The results of the adjacent signal interference susceptibility tests on the 25 kHz receivers are contained in the following paragraphs.

Column one in Table A-10 lists the radio receiver being tested. Column two lists the desired signal power required by each 25 kHz radio to produce a 15 dB SINAD as measured with the communications test set. Column three lists the received signal power of the adjacent narrowband transmitter at the receiver input which reduced SINAD of the 25 kHz radio receiver from 15 to 12 dB. The narrowband transmitter was operating on channel 227 which is -12.5 kHz off-tuned from the desired signal carrier of channel 87. Column four lists the received signal power of the narrowband transmitter at the receiver input which reduced the SINAD from 15 to 12 dB. In this case the interferer transmitter was operating on channel 287, which is 12.5 kHz off-tuned from channel 87.

Table A-10
25 kHz Receiver Radiated Test Data Vs 12.5 kHz Transmitter

25 kHz Radio	**Desired Signal Power,S (dBm)**	**Interferer power, I (dBm)**	
		-12.5 kHz off-tuned Channel 227	**12.5 kHz off-tuned Channel 287**
Receiver A	-107	-100	-109
Receiver B	-126	-116	-116
Receiver E	-108	-94	-112
Receiver F	-105	-95	-106
Receiver G	-111	-112	-123
Receiver H	-113	-114	-115
Receiver I	-124	-114	-120
Receiver K	-112	-107	-109

The signal-to-interference ratio (S/I) in dB for each radio was calculated by subtracting the interference power, I, from the desired signal power S. The results are shown below in Table A-11.

Table A-11
25 kHz Receiver S/I Values

25 kHz Radio	**Signal-to-Interference, S/I (dBm)**	
	-12.5 kHz off-tuned Channel 227	**12.5 kHz off-tuned Channel 287**
Receiver A	-7	2
Receiver B	-10	-10
Receiver E	-14	4
Receiver F	-10	1
Receiver G	1	12
Receiver H	1	2
Receiver I	-10	4
Receiver K	-5	-3

The location of the desired 25 kHz signal transmitter, the 12.5 kHz interferer transmitter, and the 25 kHz the radio for these tests are shown below in Table A-12.

Table A-12
25 kHz Receiver Test Locations

	Latitude	Longitude
Desired Transmitter	27E 53.147' N	82E 45.679' W
Interferer Transmitter	25E 55.066' N	82E 49.950' W
Radio under test	27E 56.597' N	82E 49.520' W

The results of the adjacent signal interference susceptibility tests on the 12.5 kHz receiver are contained in the following paragraphs.

The desired signal transmitter and the radio being tested were operating on duplex channel 286. The desired signal transmitter was configured as a mobile and the radio being tested was configured as a base. The 12.5 kHz receiver required a desired signal power, S, of -117 dBm from a 12.5 kHz transmitter to produce a 15 dB SINAD as measured with the communications test set without interference present in the link.

The 25 kHz interferer was operating on duplex channel 86 and configured as a mobile. It was 12.5 kHz off-tuned from the 12.5 kHz desired signal carrier. The SINAD of the radio being tested was reduced from 15 dB to 12 dB when the interferer power, I, at the input to the radio was -82 dBm. The resulting signal-to-interference ratio (S/I) is -35 dB. Due to frequency licensing restrictions the 12.5 kHz radio was not tested with a 25 kHz interferer off-tuned by -12.5 kHz.

The locations of the desired 12.5 kHz signal transmitter, the 25 kHz interferer transmitter, and the 12.5 kHz radio for these tests are shown below in Table A-13.

Table A-13
12.5 kHz Receiver Test Locations

	Latitude	Longitude
Desired Transmitter	27E 54.120' N	82E 45.720' W
Interferer Transmitter	27E 52.794' N	82E 45.701' W
Radio under test	27E 53.147' N	82E 45.679' W

In the second part of this test, the interferer moved closer to the radio under test and stopped when the 1 kHz desired signal tone was unintelligible. At this point, the power of the interferer at the input to the radio under test was measured to be -78 dBm. The location of the interferer was 27E 53.447' N latitude and 82E 45.731' W longitude.