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[redacted]

[redacted]

4 September 1959

SUBJECT: CCS Evaluation Proposal

Enclosure: Technical Proposal, same subj, Serial AA590632 dtd 9/3/59

Dear Andy:

In accordance with your request we are pleased to submit this proposal whose technical details are contained in the enclosure.

The program for the testing and evaluation of the CCS System will generally consist of three parts:

(Phase I) 1. Evaluation of the Crystal Switch System.
(Phase II) 2. Evaluation of the Communication System consisting of [redacted] units. 25X1
(Phase III) 3. Evaluation of the entire system as it is intended to be used in the field; life-testing will be run concurrently with this evaluation.

We propose to issue a final report composed of three sections in the order listed below.

1. At the completion of Phase I - approximately 12 months after date of contract acceptance and receipt of material.

2. At the completion of Phase II - approximately 6 months from completion of Phase I.

3. At the completion of Phase III - approximately 6 months from completion of Phase II.

The total time required to complete this proposed program is twenty-four months from date of contract acceptance.

This program will be conducted in [redacted] 25X1
25X1

Our estimated cost breakdown for conducting this evaluation program is as follows on page 2.

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COST BREAKDOWN

Engineering, DL		25X1
ILE at [ ]		25X1
Material & Other Chgs		
Sub-Total		
G&A at [ ]		25X1
Total Cost		
Fixed Fee at [ ]		25X1
Total Cost Plus Fee	$ 49,844	

There has been a long-term activity conducted here in the Laboratory, under the technical cognizance of [ ] and known as Task Order No. 3 under the basic contract. A very large portion of this activity has resulted in the recording of test data which bears directly on your current problem. It is suggested that you make arrangements so that the people who did this previous work and their experimental evidence may be brought in contact with the group working for you. Two benefits will result from this: first, some of the ground which has been plowed need not be plowed again; second, the experience may be passed on so as to ease the work on your job. 25X1

Very truly yours,

[ ] 25X1

Prepared by: [ ] 25X1

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DOC. IDEN. NO. AM590632

Carrier Current System Evaluation

I. PURPOSE

The primary objective of the program as proposed herein is to obtain, through test and observation, sufficient data to allow evaluation of the performance, suitability, and reliability of the Carrier Current Surveillance System, to include both the communication portion and the latching relay portion. A secondary objective is the generation of conclusions and recommendations as to engineering modifications and operating techniques which may improve the usefulness of the equipment. The equipment to be evaluated will include the [redacted] Carrier Current Receiver and Transmitter as well as the [redacted] Carrier Current Crystal Switching System. 25X1 25X1

II. DISCUSSION OF THE PROBLEM

To be of maximum use, equipment of the nature to be evaluated herein must fulfill a number of important technical and operational requirements. The characteristics of the equipment relating to these requirements must be measured or otherwise appraised for any evaluation to be of maximum usefulness to the customer. The general requirements which must be present and which are to be evaluated are as follows.

Reliability of the equipment is of great importance. Since the [redacted] Switch Receiver and the [redacted] Transmitter will normally not be available for servicing after installation long life under operational conditions is vital. 25X1

Of equal importance is basic technical performance of the equipment alone. Installation will, in nearly all cases reduce the performance characteristics obtained in the laboratory. These

characteristics include system range when operating on various power line configurations, audio range in terms of sensitivity, intelligibility, and linearity, and reliability of the switching system under various operational conditions. The effects upon these factors of such external influences as orientation of parts, power source variations, and deterioration with time should be measured as far as possible.

A third criterion concerning the usefulness of this equipment is the factor of security. Since location of the equipment would prove moderately simple if its existence is known, system operation must be such as to minimize external indications of its presence. Development of excessive heat, emission of spurious radiation, audible hum or clicks, and the insertion of noticeable disturbances on the power line can be considered serious limitations.

A final criterion is that of equipment utility. This includes such items as ease of installation, operation, and maintenance as well as the influence of various installation conditions upon system performance.

Measurement or observation of these factors should provide the necessary information upon which a sound evaluation can be based. This information will also provide the basis for recommendations for improvement of the devices and of instructions for any desirable special installation or operating techniques. Since in this problem it is not possible to test a statistically adequate sampling of equipments, test results cannot necessarily be considered

conclusive. Because direct comparison with other units often can not be made, conclusions drawn must stand alone. However, general difficulties will usually be detected, and using personnel will have some better idea of the desirable installation requirements and operating capabilities and limitations of the equipment.

III. PROPOSED PROGRAM

The program for the testing and evaluation of the Carrier Current Surveillance System will generally consist of three parts.

The first will be the evaluation of the Crystal Switch System. Next an evaluation of the Communication System consisting of the [redacted] units will be made. Finally an evaluation of the entire system as it is intended to be used in the field will be accomplished. Initial testing will be in the laboratory, but operational testing will be done in the field. A life testing program will be initiated and will run concurrently with the other evaluation. 25X1

The final report will be issued in three sections: one at the completion of each of the three phases of the work. This follows directly from the grouping of the tests as proposed herein. The first section of the report will deal with the testing of the Crystal Switching System. The second section will cover the communications portion of the system, and the final section will cover tests on the system as a whole as well as miscellaneous observations made throughout the program. The results of the life testing program will also be summarized in this final section of the report.

IV. TESTS TO BE PERFORMED

While it is beyond the scope of this proposal to describe in detail the tests required, the following listing is indicative of the types of tests to be performed. Included are those measurements specifically called for by the customer, plus others which are deemed advisable. In addition, as the tests proceed, if observations indicate the need for measurements not specifically outlined herein, they will be included.

Standard test conditions applicable to this equipment will be established as soon as possible after receipt of the units.

A. Crystal Switch System Tests

1. Receiver measurements: Measurements will be made on receivers in the condition received. One receiver will be aligned and partially rechecked. Should a substantial difference be noted, all receivers will be re-aligned and rechecked. Wherever possible measurements on the [redacted] alone will be made using a CW signal from a precision signal generator suitably coupled to the power line at the point where the [redacted] is itself connected to the source of power. 25X1 25X1

a. Frequency and Bandwidth of Input and Amplifier Circuit.

1. Measure output of Input and Amplifier Circuit. as a function of input frequency.

2. Determine center or peak frequency.

3. Determine halfpower (3 db) points.

b. Sensitivity of Input and Amplifier Circuit. Measure output of Input and Amplifier Circuit at the center frequeney as a function of input signal amplitude.

c. Frequency and Bandwidth of "Off" Channel Circuit.

1. Measure output across "Off" relay coil as a function of input frequency.

2. Determine the center or peak frequency.

3. Determine frequency at which relay fails to energize to the "Off" condition consistantly.

d. Frequency and Bandwidth of "On" Channel Circuit.

1. Measure output across "On" relay coil as a function of frequency of input signal.

2. Determine the center or peak frequency.

3. Determine frequency at which relay fails to energize to the "On" condition consistently.

4. Determine time required for triggering to occur.

e. Power source variations: For a $\pm$ 30% change in voltage input to the unit, measure the following:

1. Current drawn by the unit.

2. Power consumption.

3. Measure frequency and bandwidth of both the "On" and "Off" channels as described in sub paragraphs c and d above.

f. Temperature and Humidity: Temperature and humidity will be varied between 0° C at 0-5% relative humidity and 60° C at 95-100% relative humidity and the frequency and bandwidth of both the "On" and the "Off" channels will be measured as described in sub paragraphs c and d above.

g. Contact resistance: Relay contact resistance will be measured for several values of current within the range specified by the manufacturer. No life testing of the relay itself will be accomplished, since this work has been done as part of a previous task. Results of this relay testing will be included for reference in the final report, however.

h. Field tests: The following tests will be conducted in the field:

1. Random triggering. A random selection of voice, musical, and CW signals will be fed to the input of the receiver and note will be made of any triggering which may occur. Observations will be made throughout the testing to note whether any particular type of transient or other signal will cause regular triggering of the receiver to either the "On" or the "Off" position.

2. Altitude. One unit will be subjected to a pressure of 2.5 psi, corresponding to an altitude of 40,000 feet for a period of one hour. Operation will be checked after return to ambient conditions.

3. Temperature: One unit will be subjected to a temperature of -65° F for a two hour period. Operation will be checked after return to ambient conditions.

4. Vibration: One unit will be vibrated for a half hour

period along each of three mutually perpendicular axes at rates cycling from 10 to 60 cps once each minute. Double amplitude will be 1/32 inch. Equipment will be observed for any resonances and will be vibrated at the reasonant frequency if one is found. Equipment will be tested for normal operation both during and after the tests.

5. Drop: One unit will be dropped in the manner which has been specified by the customer. Upon completion of the drop, the unit will be tested for proper operation.

2. Transmitter measurements: Measurements will be made on one transmitter tuned in accordance with the instruction manual.

a. Frequency: Frequency will be measured for both the "off" and "On" positions of the Crystal Selector Switch, with the equipment tuned as per the instruction manual.

b. Power Output: Power output will be measured for various settings of the Output Impedance switch. Measurements will be made for both the "Off" and "On" Channels. A check of the adequacy of the output meter for determining optimum loading will be made.

c. Power Line Variations: For a $\pm$ 30% change in input voltage to the unit the following items will be measured:

1. Current drawn by the unit.

2. Power consumption.

3. Power output for both the "Off" and "On" channels as described in b above.

4. Frequency for both the "Off" and "On" channels as described in a above.

d. Temperature and humidity: Temperature and humidity will be varied between 0° C at 0-5% relative humidity and 60°C at

95-100% relative humidity and the following items will be measured:

1. Frequency for both the "Off" and "On" channels as described in a above.

2. Power output for both the "Off" and "On" channels as described in b above.

e. Field tests: The following tests will be conducted in the field:

1. Spurious outputs: Transmitter output will be checked for harmonic content and for parasitic oscillations.

2. Altitude: One unit will be subjected to a pressure of 2.5 psi for a period of one hour. Operation will be checked after return to ambient conditions.

3. Temperature: One unit will be subjected to a temperature of -65°F for a period of two hours. Operation will be checked after return to ambient conditions.

4. Vibration: One unit will be subjected to the vibration described in sub paragraph h (4) above. Operation will be checked both during and after the vibration period.

3. Crystal Switch System tests: Operation of the XCS-2 system will be checked with transmitter and receiver located in two rooms on the same floor of an office building and between two rooms five floors apart. Operation will also be checked in a typical home between circuits on the same side of a split phase system and between circuits on opposite phases of the system. Operation will also be attempted between houses which are on the same power linea and which do not have transformers between house and line. An attempt to obtain some sort of range figures for such operation

will be made. Experiments will be made with both single and three phase systems to attempt to determine the sypes of systems over which reliable operation can be expected. No attempt will be made to bridge any transformers with capacitors or other devices, since it is expected that normal operation of the equipment would preclude such activity. A qualitative conclusion will be reached concerning the effects of various types of transformers in the transmission path.

B. Communications System Tests

1. Transmitter measurements: Except where they are test variables, the following parameters will be standardized throughout the test program:

Warm up time	1 hour
Line voltage	115 volts 60 cps
Audio signal frequency	1 KC
Deviation control	Factory setting
Frequency control	Factory setting

a. Repeated tests: Before and after any specific tests, the following checks will be made and recorded to obtain long term drift or drift caused by any specific testing.

1. RF Power output: Measured across a standard resistor after suitable filtering. This measurement will be necessarily a function of the filter used and will only serve to measure variations from time to time or equipment. Absolute values will not be determined using this setup.

2. Noise level.

3. Deviation control range.

4. Audio Frequency response.

5. Cumulative Operating Time.

6. Input Power requirements.

b. Audio measurements:

1. Transmitter audio frequency response for various settings of the deviation control.

2. Deviation sensitivity and linearity from noise level to overload.

3. Microphone frequency response for [redacted] 25X1 microphones. These responses have previously been completed and will not be repeated in these tests. The data previously obtained will be included in the final report, however.

4. Frequency response of microphone-transmitter combination.

5. Harmonic distortion.

6. Intermodulation distortion.

7. Articulation tests made in anechoic room with master tape. Runs will be made with [redacted] 25X1 microphones. Runs will be recorded on tape.

c. Temperature and Humidity effects: Temperature and humidity will be varied between 0° C at 0-5% relative humidity and 60°C at 95-100% relative humidity and the following measurements will be made:

1. Frequency shift.

2. Deviation sensitivity .

3. Audio frequency response.

4. Power output (measured as described in sub paragraph a (1) above and subject to the same limitations)

5. Noise level

6. Case surface temperature.

7. Temperature will be increased to failure of one unit only.

d. Power source effects: For a ± 30% change in line voltage about 115 volts and about 230 volts, the following measurements will be made:

1. Power input.

2. RF power output (measured as described in sub paragraph a (1) above and subject to the same limitations).

3. Deviation sensitivity.

4. Audio frequency response.

5. Frequency shift.

6. Noise level.

e. Field Tests:

1. Altitude: One unit will be subjected to a pressure of 2.5 psi for a period of one hour. Operation will be checked upon return to ambient conditions.

2. Temperature: One unit will be subjected to a temperature of -65°F for a period of two hours. Operation will be checked after return to ambient conditions.

3. Vibration: One unit will be vibrated for three half-hour periods along three mutually perpendicular axes as described above in sub paragraph A 1 h (4). Operation will be checked both during and after the vibration period.

4. Drop: One unit will be dropped in a manner which has been specified by the customer. Operation will be checked after the drop.

f. Miscellaneous Observations:

1. Ease of handling and adjustment during tests.

2. Structural weaknesses or under-rated components.

3. Visible and operational effects of shock and vibration, resulting from handling during commercial transportation.

4. Audible hum or other noticeable noise.

5. Sensible heat transmitted through various wall structures.

2. Receiver measurements: Except where they are variables, the following parameters will be standardized throughout the program:

Warm up time	1 hour
Line voltage	115 volts
Radio Frequency	80 or 110 KC
Audio Frequency	1 KC
Voltage Adjust Switch	Adjust for meter reading of 50
Phone Gain Control	Maximum

a. RF Section Tests.

1. Bandwidth

2. Gain as a function of frequency over the tuning range.

3. Oscillator frequency stability - conversion linearity.

4. Noise figure as a function of frequency.

5. Input and output impedances.

b. IF Section Tests.

1. Bandwidth.

2. Gain at the IF frequency.

3. Limiter action for various input levels.

4. Discriminator linearity and width.

5. Noise figure.

6. Input and output impedances.

c. Audio Section Tests:

1. Bandwidth.

2. Gain.

3. Linearity.

4. Noise figure.

5. Input and output impedances.

d. System Tests: Certain tests by their very nature must incorporate all of the various components of the system before they can be made. Tests of this type to be made on the CCR-2 are:

1. Overall bandwidth for a constant input audio signal.

2. Overall gain - sensitivity.

3. Overall noise figure.

4. Tests to determine quieting action as a function of the magnitude of the audio portion of the input signals.

5. Intermodulation distortion.

6. Harmonic distortion.

7. Noise introduced by various lengths of wire attached to the Headphone and Recorder outputs.

8. Information concerning the performance of the AGC circuit with respect to input signal amplitude.

e. Power source tests: The following tests will be performed at intervals over the voltage range of ± 30% about the 115 v standard. No compensation will be attempted with the use of the Voltage Adjust Switch. This will allow the performance of the system over extremely wide voltage changes to be determined.

1. Overall bandwidth.

2. Sensitivity.

3. Noise figure.

4. Harmonic distortion.

5. In addition to the above tests, the line voltage will be dropped until the oscillator ceases to function. The voltage at which this phenomenon occurs will be noted.

f. Environmental Tests.

1. Temperature and Humidity Tests: Temperature and humidity will be varied between 0°C at 0-5% relative humidity and 60° C at 95-100% relative humidity, and the tests listed above under Power Source Tests will be made at various points in the cycle.

2. Low temperature tests: The unit will be subjected for a period of two hours to a temperature of -65°F. Operation will be checked upon a return to ambient conditions.

3. Altitude Tests: The unit will be subjected to a pressure of 2.5 for a period of one hour. Operation will be checked upon the return to ambient conditions.

3. Combined tests employing both receiver and transmitter:

Operation of the system will be checked with the transmitter and receiver located in two rooms on the same floor of an office building, and between two rooms five floors apart. Operation will also be checked in a typical home between circuits on the same side of a split phase system and between circuits on opposite phases of the system. Operation will also be attempted between houses which are on the same power line, but which do not have transformers between the house and the line. An attempt to obtain some sort of range figures for such operation will be made. Experiments will be made with both single and three phase systems in an attempt to

determine the types of systems over which reliable communication can be expected. No attempt will be made to bridge the transformers with capacitors or other devices, since it is expected that normal operation of this equipment would preclude such activity. A qualitative conclusion will be reached concerning the effects of various types of transformers in the transmission path.

C. Carrier Current System Tests

A final series of rests will be made, employing the entire carrier current system operating together. No definite statement of the tests to be made can be made at this time but rather a program will evolve from the experience gained in testing the individual pieces of equipment involved in the system. In general, however, tests will be made using the various types of lines described in the two sections on system testing the switching and communications portions of the system respectively. These tests will be oriented towards determining which of the two sub systems is the limiting factor in successful operation of the entire system. Idiosyncracies exhibited by any of the equipment when operated in close proximity to the other pieces will be noted during this phase of the testing. This includes "loading" or other attenuation effects.

The system portion of the testing will be oriented, as far as possible, towards using the equipment under simulated field conditions. In this manner, information concerning the utility of the equipment may be gained.

D. Life Testing

Initial Checks will be made on all equipment, and a representative system will be chosen for life test. One Crystal switch system will be operated continuously. The [redacted] units will be controlled by the Crystal Switch receiver. Both an 80 KC and a 110 KC [redacted] will be used. The Crystal switch transmitter will be triggered such that the controlled units will have two eight hour "On" periods daily. Operation of the entire system will be checked daily. Operation will continue until the failure of any unit. When a unit fails, it will be replaced by a spare unit, and operation will continue. Tests will continue for one year. Every 200 hours of operation, certain routine checks will be made on the equipment as follows:

25X1

25X1

1. [redacted] 25X1

   a. Frequency of both "On" and "Off" channels.

   b. Current drawn by the unit.

   c. Power consumption.

   d. Power output for both the "On" and "Off" channels.

2. [redacted] 25X1

   a. Current drawn by the unit.

   b. Power consumption.

   c. Frequency and bandwidth of both the "On" and "Off" channels.

3. [redacted] 25X1

   a. Power input.

   b. RF power output.

   c. Deviation sensitivity.

   d. Audio frequency response.

e. Frequency shift.

4. [redacted] 25X1

a. Bandwidth.

b. Sensitivity.

c. Noise figure.

d. Harmonic distortion.

e. Minimum input voltage for operation of oscillator.

V. EQUIPMENT TO BE FURNISHED BY THE CUSTOMER

The following equipment is considered reasonable for the performance of the tests.

A. Four (4) [redacted] receivers with spare tube complement. 25X1

B. Four (4) [redacted] transmitters (80 KC) with microphones.

C. Four (4) [redacted] transmitters (110 KC) with microphones.

D. Four (4) [redacted] receivers.

E. Four (4) [redacted] transmitters.

VI. OBSERVATIONS

Throughout the test program, the equipment will be observed for the following general information:

A. Reliability in use and general structural reggedness.

B. Vulnerability to damage due to mishandling or wrong connections.

C. Detectability as caused by audible noise, clicks, or hum.

D. Irregular operation of relays in the switching system which might cause the equipment to trigger at an undesired time.

E. Apparent adequacy of the instruction manuals.

F. Installation notes which may make for improved field installation and operation.

9/3/59

CCR-2 RECEIVER WIRING ERROR

Two of the [redacted] receivers were not found to be operating properly when they were received at [redacted] The area of malfunction was in the quieting obtained for specific input signals. The two receivers, Serial Numbers 106 and 110 respectively, required approximately 100 times the input signal level as the remaining receivers in order to obtain equivalent quieting. This effect occurred both at the 20 db and 40 db quieting levels. 25X1 25X1

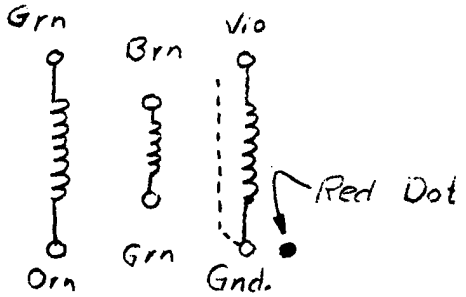
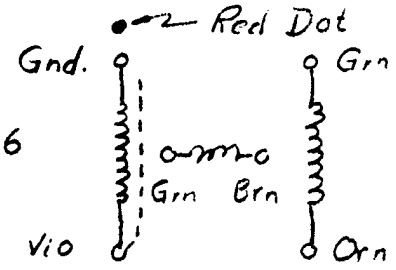
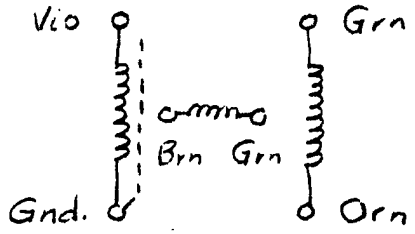
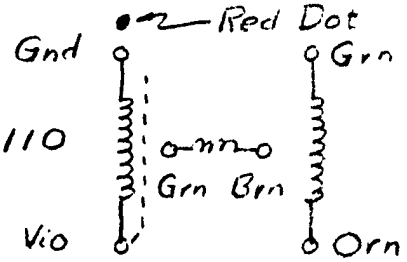
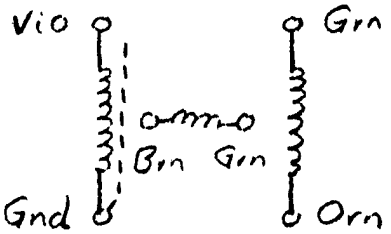
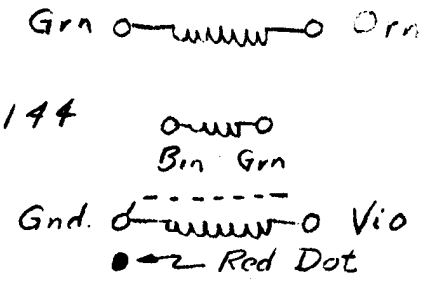
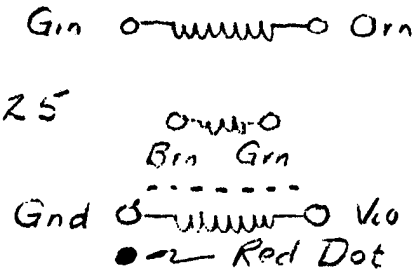
Upon investigation, the trouble was found to be in the area of the RF input transformer, T1. Connections to this transformer were not properly made in each of the two faulty units. The electrical result was that an internal electrostatic shield within the transformer (which is not shown on the equipment schematic) was not connected to chassis ground. This chassis ground is also not shown on the equipment schematic.

There are two possible reasons for the erroneous connections which should be mentioned in order to facilitate the elimination of this error from future equipments. First, the transformers, while they were apparently electrically identical, were physically different. This difference was in the internal connections between the transformer elements and the external solder lugs. In addition, the red marking dot, which was apparently supposed to locate the pin connected to the electrostatic shield, was not properly placed on all the transformers. Secondly, the orientation of the transformers in the receivers was not the same for all units. These two facts can be clearly seen on the accompanying sketch. It is quite likely, in the light of these facts, that considerable confusion could have arisen when the equipment was wired with the resultant error. The soldered joints on this transformer gave evidence of having been tampered with in the faulty equipments. This is further evidence that some effort might have been made to correct the trouble.

By reference to the first column of the attached sketch, it can be seen that due to the differences in orientation of the red dot with respect to the pins on the various transformers, it was impossible to make the proper corrections on the miswired units without disassembling the transformers and visually locating the internal connections. This was done, but no attempt was made to make all the units physically identical. For purposes of test, electrical identity is sufficient. After the changes were made, the two faulty units functioned well within the manufacturer's tolerances with respect to quieting.

25X1

Lead connections to RF transformer T-1, Receiver. Shown as received and as corrected. Shown looking at bottom of receiver with front to left.

	As Received	As Corrected
# 138		No change
# 106		
# 110		
# 144		No Change
# 125		No Change

Carrier Current System

Pete called on JUNE 7, 1960 and said that of the carrier current stuff, there was no CST – CSR arrangement that was freq compatible. He felt that changing the crystals might remedy this. I told him to do this. He wanted to start CSS life test.

As of this date, 6-7-60 he had not yet done anything with the audio system.