Test Plan for SSR Antenna Rotation Rate Stabilization

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Transportation Systems Center
Cambridge MA 02142

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The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.
A comprehensive test plan is presented to evaluate the impact of wind and ice loading on the rotation rate stability of a Secondary Surveillance Radar (SSR) antenna used for air traffic control surveillance. Antenna rotation rate variations may introduce errors in the estimate of a position of an intruding aircraft in a passive collision avoidance system used in conjunction with the SSR antenna. The test plan provides a method for determining the statistics of the antenna rotation rate variations. Analytical methods are then presented to assess the affects on CAS performance. The measurement system design, mathematical model development of the antenna system, test data reduction, and analysis programs are presented in detail. Sample calculations of preliminary field data are given and compared with the results obtained from computer simulations. The computer simulations are also intended to predict antenna rotation rate variations at the upper limit of the FAA specified range, which were not generally encountered during normal operations.
Airborne collision avoidance systems can be characterized as being active or passive depending upon how the protected aircraft obtains surveillance information. The active CAS utilizes an onboard interrogator capable of independent surveillance of surrounding traffic. The passive CAS obtains similar surveillance information primarily by listening-in to the ground interrogations and surrounding aircraft replies. One of the design options of a passive CAS is to use the Secondary Surveillance Radar (SSR) antenna rotation position as azimuth reference. Such information is obtained by decoding the regularly broadcasted Discrete Address Beacon System (DABS) (Mode S) squitter messages from the ground-based Radar Beacon Transmitter (RBS) located at the same SSR site. The antenna rotation rate constancy between the uplink squitter messages becomes a critical parameter in deriving the position of an intruder. This test plan is intended to determine, by measurements and analysis, the impact of such antenna rotation rate variations.

A high precision measurement system was developed to evaluate the SSR antennas rotation rate stability under environmental conditions encountered at a test site. For the extreme environmental conditions, a mathematical model was also developed to extrapolate its performance. Measurement system design, software, a mathematical model, and data analysis programs were developed at TSC, by the staff of the Telecommunication Branch (DTS-531). Support was provided for test system software design, by Martindale Associates, Inc., Reading, MA, especially by Maurice C. Devine.

Preparation of the test plan required efforts of many individuals and organizations. Particular recognition goes to John L. Brennan, ARD-243 for coordination of tasks and specifying requirements and George Mahnken, ATC-154 for arranging the test site, installation of test equipment, and conducting the tests. The contribution of following TSC personnel are hereby gratefully acknowledged: Dr. Kanti Prasad for mathematical model development and the initial design of the test equipment; and William Wade and Robert Jones for design, development and checking-out of the system; Juris Raudseps for specifying output data formats; and Marsha D. O'Connell for developing mathematical algorithms for the data analysis programs.
## Metric Conversion Factors

### Approximate Conversions to Metric Measures

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1. INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The FAA, under the Air Traffic Control Radar Beacon System (ATCPBS) improvement program, has requested the TSC (1) to present a plan to investigate the impact of wind loading on the rotational stability of the Secondary Surveillance Radar (SSR) antenna mounted on the ASR-7 or 8 pedestal, and (2) to assess the impact on the passive BCAS operation. This plan gives the sequence of tests to be performed at the test sites, the analysis and computer simulation to be carried out using field data and mathematical models, and to make appropriate conclusions.

This test plan specifies the measurements to be performed and the analysis to be conducted in order to determine the variations that may occur in the Secondary Surveillance Radar (SSR) antenna rotation rate under different environmental conditions and to evaluate the effect of those variations on Full Beacon Collision Avoidance System (BCAS) operation. Alternatives will be proposed if the current design is found to be inadequate. The FAA specifications for the antenna rotation rate of the Airport Surveillance Radar (ASR) (to which the SSR antenna is rigidly attached) is 12.5 rpm ±10 percent over the range of service conditions, which include wind velocities up to 85 knots and a 1/2 inch radial icing conditions. Analyses conducted by the Institute for Defense Analyses (IDA)\(^1\) have indicated that such variations may lead to unacceptably large errors in calculated relative target position for the Full BCAS.

The passive and semiactive modes of Full BCAS calculations of position for ground radar sites and aircraft requires a knowledge of aircraft azimuth relative to the SSR sites. The determination of azimuth is based on measurements of time of receipt

of the ground squitter messages and of the time when the rotating interrogation beam passes the aircraft.

Approximately once per second the Radar Based Transponder (RBX) at an SSR site emits a squitter message giving the current direction of the SSR antenna main beam. The BCAS determines the time of passage of the SSR main beam past the own aircraft by estimating the centroid of the sequence of approximately 16 ATCRBS interrogation pulse pairs which it receives while in the beam.

The bearing of the BCAS from the SSR (own azimuth) can be calculated by adding the antenna angle (at the time of the squitter message) to the change in antenna angle between the time of the squitter and the time the main beam passes the BCAS. If the antenna is assumed to rotate at a constant rate, the change in antenna angle is assumed to rotate at a constant rate, the change in antenna angle is the observed time interval multiplied by the rotation rate.

Similar calculations can be performed to determine the bearing of a target from the SSR (target azimuth) and the differential azimuth. The time of passage of the antenna main beam past the target is estimated from the centroid of the sequence of elicited target transponder replies. The angle calculations again depend upon an assumption of a constant rotation rate.

Even when the period of a complete antenna revolution remains constant, wind loads on the antenna may cause significant accelerations and decelerations within each revolution giving instantaneous rotation rates substantially different from the average rate. Figure 1 illustrates the error that may result in the computed position of a target relative to BCAS if the rotation rate deviates 10 percent from its average value while the antenna rotates through a differential azimuth angle of approximately 40°. The maximum possible separation in angle between BCAS and a target is < 90° for a 1-second squitter rate and at a 15-rpm antenna rotation rate.
The tests and analyses specified herein will determine what deviations of antenna rotation rate from the nominal will occur under different environmental conditions, and will calculate the extent to which these deviations will degrade BCAS target tracking accuracy.

1.2 BACKGROUND

During ATCRBS improvement studies in 1973, two analyses were performed to predict antenna performance for dynamic operation and for antenna survival.

Some analytical data are available which may be applicable to this current problem. Illustrative samples of these data are given in Figures 2 and 3. A sample plot of antenna speed vs. wind angle-of-incidence for an 85-knot wind and icing conditions is shown in Figure 2, and yawing moment as a function of wind angle-of-incidence alone is shown in Figure 3.

From the analysis, it is concluded that the dynamic yaw moment can change the antenna rotation speed, and since the antenna drive motor is vital in maintaining a constant antenna rotation rate, the motor should be studied. Induction motors are used. From the manufacturer's test data of the torque-speed characteristics, it is possible to predict acceptable performance limits and to specify modifications for improvements, provided that the other system and environmental factors are also known. Typical torque-speed plots for the 5-hp motor presently used for ATCRBS antenna drives are shown in Figure 4 and for comparison a curve for a 30-hp motor is shown in Figure 5.

Under a Texas instruments in-house effort, a one fourth scale SSR antenna model was constructed and tested in a wind

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\(^2^\)Preliminary Draft of Report 10991, Phase I, ATCRBS Antenna Modification Kit, Section IV, Hazeltine Company.


\(^4^\)Armand J. Mailet, AF230, Private Communications.

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Figure 2. Reflector Speed vs Wind Angle of Incidence
Figure 3. Calculated Dynamic Yaw Moment vs Wind Angle of Incidence
FIGURE 4. 5-HP MOTOR TORQUE CHARACTERISTICS
FIGURE 5. 50 HP MOTOR TORQUE CHARACTERISTICS
tunnel. Two field tests were also conducted. The results of a field test conducted by the FAA Technical Center\(^5\) over a limited range of environmental conditions, are shown in Figure 6. The results of the second, a large military antenna, do indicate the effects of wind and have some bearing on the current problem. See Figure 7. Nevertheless, there are no known data from dynamic field tests which would be useful for (Full BCAS program) answering the SSR rotation constancy question satisfactorily.

\(^5\)George J. Hartranft, ANA-120, Memo-Wind Speed Affects on ACP Count at NAFEC ASR-7 Site, January 14, 15, 16, 1976.
2. TEST OBJECTIVES

2.1 DETERMINE CAPABILITY OF SSR ANTENNA ROTATION RATE STABILITY WITH THE FULL BCAS DESIGN REQUIREMENT.

1. To perform SSR antenna rotation rate measurements in the field for a wide range of environmental conditions in order to determine the range of conditions over which rotational stability under the Full BCAS concept is acceptable.

2. To assess performance degradation of Full BCAS outside this range of conditions.

2.2 IDENTIFY ANTENNA ROTATION STABILIZATION ALTERNATIVES, IF REQUIRED

Conduct data reduction and analysis of the field data and compare these data with analytical data and with parametric simulation results. Assess whether or not current performance is adequate for Full BCAS utilization. If not, then evaluate improvements by analysis and simulation using various alternative approaches and identify more promising ones for field evaluation.
3. SCOPE

3.1 SCOPE OF THE TASKS

The thrust of this effort lies in obtaining useful field measurements of antenna rotation speed, supplemented by analyses and simulation, for the range of environmental conditions specified by the FAA. The final recommendations will be based on these results. With the foregoing in mind, the program will consist of the following elements, which are of equal importance.

1. Field measurements at operational sites,
2. Analysis,
3. Simulation,
4. Evaluation of alternatives by analysis and simulation and identification of alternatives for field evaluation.

3.1.1 Requirements for Field Measurements

3.1.1.1 Types of SSR and ASR Antennas - The present antenna for ATCRBS sites is the ATCRBS five-foot open array antenna, Type FA-9764, colocated with the ASR or ARSR antenna. "Colocated" means that the beacon antenna is mounted on the same pedestal as the primary antenna. This setup, although very convenient for ATCRBS antenna installation, is of some concern in the implementation of the Full BCAS concept because of the much larger projected area of the antenna which is exposed to the wind loads and icing conditions. The Open Array antenna has replaced the Hog Trough antennas which was specified by FAA for the Terminal and En Route sites. Under the ATCRBS improvement program, the DABS systems is being developed. It is currently proposed that DABS sites will have two types of antenna installations, either the Open Array, FAA-E-2660, or the Back-to-Back, FAA-ER-240-35a, antenna. The Open Array Antenna mounted on top of an ASR-7 antenna is shown in Figure 8.
Figure 8. Installation of ATCRBS Antenna on ASR-7 Structure
With the Open Array antenna installation, the antenna rotation speed may be affected even more by wind than before, because the projected area for the Open Array is 5 ft x 28 ft, and the antenna has to maintain the same rotational speed of up to 15 rpm.

Only the SSR Open Array antenna will be tested beginning with the Open Array, FAA-E-2660, installed at the FAA Technical Center Terminal Radar Beacon Test Facility (TRBTF) site, Atlantic City, N.J.

3.2 DATA COLLECTION

3.2.1 Selection of Test Sites

To obtain as many field measurements as possible during extreme environmental changes, a variety of climates at the selected sites is required. Test areas other than Federal Aviation Administration Technical Center, Atlantic City, NJ are being considered, including remote sites, such as, sites in Alaska or Greenland or windy, desert areas in California. The Full BCAS concept is based on the reception of both ATCRBS and DABS signals. Although ATCRBS and DABS sites have some distinct differences, test results are to be compatible.

It is worthwhile to notice that all en route ARSR antennas are protected by radomes, and it is assumed for our purposes that the drag torque, inertia-induced torque, and the off-center torque will have a minimal effect on the dynamic yaw moment and therefore will not require any testing.

3.2.2 Test Planning

Major items facing the planning of the study of the SSR antenna rotation rate constancy are the progress of the Full BCAS design definition and the engineering model development tasks. Timely inputs at various phases during these developments are anticipated at the early stages in the program. More comprehensive results are expected by May 1, 1982 when the First
Phase Report is to be released which will summarize the test results, the impact assessments on Full BCAS performance, and identify the problem areas. A detailed schedule of the tests to be performed and test options are given in Section 8.0 of this test plan.

3.3 ANALYSIS

Analyses will include the derivation of results from the field measurements, analysis of mathematical models, design of algorithms, and computer simulation.

3.3.1 Mathematical Analysis

Total dynamic yaw moment may produce non-uniform SSR rotation of the antenna when it is subjected to environmental changes. All components of the total yaw moment under dynamic conditions contribute in varying degrees. A colocated ASR-8 antenna and SSR antenna simulation model is shown in Figure 9. It consists of three major subassemblies:

Induction Motor,

Gear Train, and

ASR-8/SSR Antennas.

![Figure 9. ASR-8/SSR Antenna System Simulation Model](image)
The 5-hp induction motor rotates the ASR-8 and SSR antennas at 15 rpm under all weather conditions. A typical ASR-8 site installation will have two induction motors, however the test site selected at TRBTF site has only one 5-hp induction motor and, therefore this site represents a typical ASR-7 site.

3.3.1.1 Induction Motor Equivalent Circuit

As equivalent circuit of the induction motor is shown in Figure 10.

![Equivalence Circuit Diagram](image)

**FIGURE 10. EQUIVALENT CIRCUIT OF THE INDUCTION MOTOR**

Using mathematical expressions and substituting the given motor parameters, the following equation of motion can be derived for the electromagnetic torque to be generated for the system.

\[ T_{EMM} = J_M \frac{d^2 \theta_M}{dt^2} + B_M \frac{d\theta_M}{dt} + T_{SA} \]

- \( T_{EMM} \) = Electromagnetic motor torque
- \( J_M \) = Viscous damping
- \( T_{SA} \) = shaft torque applied to antenna = \( J_\theta \ddot{\theta} + T_{WD} \)
- \( J_\theta \) = Antenna Torque
- \( T_{WD} \) = Yaw torque due to wind variation
3.3.1.2 Gear Train

The gear train reduces the speed of the drive shaft of the antenna by an 1800:15 ratio, where

\[ \theta = \theta_M/n \]
\[ \dot{\theta} = \dot{\theta}_M/n \]
\[ \ddot{\theta} = \ddot{\theta}_M/n \]
\[ T_{SA} = n/T_{SM} \]

and \( \theta \), \( \dot{\theta} \), and \( \ddot{\theta} \) represent the displacement angle, angular velocity, and angular acceleration for the antenna and \( \theta_M \), \( \dot{\theta}_M \), and \( \ddot{\theta}_M \) represent same parameters for the motor, \( T_{SA} \) and \( T_{SM} \) are the torque for antenna and the motor respectively, and \( n \) is the gear ratio.

The other components of the yaw torque are,

1. Wind velocity induced torque,
   \[ M_\omega = F_D \frac{\omega W}{V} - \frac{W}{6} |\cos \beta| \]
   \( F_D \) is the dynamic drag force, \( F_D = 1/2 \rho v^2 C_D HW \)
   \( \rho \) is the density of air
   \( v \) is stream velocity
   \( C_D \) is the drag coefficient, which varies with icing conditions
   \( H \) and \( W \) are height and width of the antenna
   \( \omega \) is the reflector rotation rate

2. Offset induced torque, \( M_o = F_D b \sin(\cos \beta) \)
   \( b = 1.5 \) feet

3. Inertia induced torque, \( M_I = I_M (\Delta \omega) \), (ft-lbs).
   \( I_M \) is the mass moment of inertia

3-6
SSR ANTENNA
SYSTEM SIMULATION MODEL
(FAA TECH CENTER ASR-8 MODEL)

WIND TORQUE

\[ T_{\text{wind}} = k_1 v^2 \cos(\omega-t) \sin(\theta-t) + k_2 v \sin(\omega-t) \frac{\partial \theta}{\partial t} + k_3 \left( \frac{\partial \theta}{\partial t} \right)^2 - k_4 \cos(\omega-t) v^2 - k_5 \cos(\omega-t) \frac{\partial \theta}{\partial t} + k_7 \]

INDUCTION MOTOR TORQUE

\[ T_{\text{EMM}} = \frac{90 \frac{R}{\pi} \sin \theta}{5 \pi \eta} \]

SYSTEM SIMULATION EQUATION

\[ \frac{d^2 \theta}{dt^2} + k_8 \frac{\partial \theta}{\partial t} - k_9 \left( a - b \frac{\partial \theta}{\partial t} + c \frac{\partial \theta}{\partial t} + e \left( \frac{\partial \theta}{\partial t} \right)^2 \right) + k_{10} \left( k_1 v^2 \cos(\omega-t) \sin(\theta-t) + k_2 v \sin(\omega-t) \frac{\partial \theta}{\partial t} + k_3 \left( \frac{\partial \theta}{\partial t} \right)^2 - k_4 \cos(\omega-t) v^2 - k_5 \cos(\omega-t) \frac{\partial \theta}{\partial t} + k_7 \right) = 0 \]

FIGURE 11. SSR ANTENNA SYSTEM SIMULATION MODEL (FAA TECH CENTER ASR-8 MODEL)
4. Friction torque, $T_f = 100 \text{ ft-lbs}$ for ASR

5. "Fanning" torque, $M_F = 2 \rho C_D \omega^2 \frac{W^4}{64} H$

6. Feedhorn induced torque, $M_H = \sum q (A \times d) \sin(\text{ft-lbs})$

   \[ q = \frac{1}{2} \rho \frac{v^2}{C_D} \]

   $v_s$ net wind velocity on the effective area of the feedhorn

   $d$ is distance to feedhorn

   $A$ is effective area at distance $d$

Then the total dynamic yaw is:

\[
M_{\text{YAW}} = M_W + M_o + M_I + M_f + M_F + M_H = T_{\text{EMM}}
\]

Figure 11 is a mathematical model developed for the ASR-8/SSR antenna system to be used in analysis. All parameters for this study are the actual values at the test site. The wind-induced torque with ice or heavy rain conditions is the most significant one for this study. A typical graph showing the relative contribution of each torque is given in Figure 12. It is desirable to test antenna rotation speed at 15 rpm and at wind speeds of 85 knots. Estimates predict that the peak torque in winds of 30 knots is about 50 percent of the peak wind torque in winds of 85 knots. Parametric studies may be performed for estimating drag coefficients to match field test results.

Performance obtained from the field operational measurements will not be adequate to define the cause of the problem for two reasons: (1) probably not all limiting environmental cases can be obtained from a few selected sites, and (2) speed variation is due to the composite effect of numerous factors which may not be identifiable from the data collected in the field. To overcome this limitation, mathematical analysis and simulation will be used to enhance field measurements.
3.3.2 Simulation

Parametric evaluation and trade-off studies will be made using computer simulations to synthesize the total dynamic yaw moment and its effects on the antenna rotation rate. To achieve this, the equation of motion must be developed so as to include dynamics of the drive motor, gear train, and antenna, which are subject to the wind and other torque effects. From the parametric study, the significance of the wind component, backlash, and inertia will be determined. Proposed design modifications will be introduced and simulate operation of the modified system.

A typical simulation result is shown in Figure 13A. It may be compared with the actual data measured in the field, Figure 13B. Nonlinearities were omitted in this simulation, which shows poor agreement with the measurements except for the amplitudes of the yaw moment, which agree satisfactorily.

3.3.3 Preliminary Data Analysis

A rate of change of SSR antenna rotation as computed from the mathematical model is shown in Figure 14, 15, 16, and 17. Preliminary analysis is used to compare derived data with measured data at a wind velocity of 15 mph.

The results are as follows.

Wind velocity 15 mph -- 15 rpm is reduced by 2.9%, computed for 70° change in antenna pointing direction.
15 rpm is reduced by 0.7%, measured for 45° change in antenna pointing direction.

SSR antenna rotation rate changes predicted at higher wind velocities using the same mathematical model are as follows,

- 30 mph - will produce 3.3% reduction in rotation rate
- 97.8 mph (85 knots) - will produce 22.2% reduction in rotation rate.

There are no data to verify these predictions.
FIGURE 13A CALCULATED YAW MOMENT VS WIND ANGLE

FIGURE 13B. MEASURED YAW MOMENT VS WIND ANGLE
INITIAL CONDITION TETA=0  DTETA/DT=0 FOR T=0

V (M/HOUR) = 0.0  PSI (DEG) = 0.0

FIGURE 14. COMPUTED SSR ANTENNA ROTATION RATE
INITIAL CONDITION TETA=0 DTETA/DT=0

V(M/HOUR)= 15.0 PSI(DEG)= 0.0

FIGURE 15. COMPUTED SSR ANTENNA ROTATION RATE
INITIAL CONDITION \( \Theta = 0 \) \( \frac{d\Theta}{dt} = 0 \) FOR \( t = 0 \)

\[ V \text{ (m/hour)} = 30.0 \]
\[ \text{PSI (deg)} = 0.0 \]

FIGURE 16. COMPUTED SSR ANTENNA ROTATION RATE
INITIAL CONDITION $\theta = 0$, $\theta_{\Delta t} = 0$ FOR $t = 0$

$V(M/HOUR) = 97.8$ PSI(EG) = 0.0

**Figure 17.** Computed SSR Antenna Rotation Rate
A corresponding variation also occurs in the Yaw Moment and is shown in Figures 18 and 19.

3.4 IDENTIFICATION OF ALTERNATIVE DESIGNS

From the analysis, collected field data, and simulation results, the most promising alternative designs will be evaluated by parametric studies and identified for additional evaluation in the field.
INITIAL CONDITION \( \theta = 0 \) \( \dot{\theta} = 0 \) FOR \( T = 0 \)

\( V(\text{M/HOUR}) = 15.0 \) \( \text{PSI(\text{DEG})} = 0.0 \)

FIGURE 18. COMPUTED SSR ANTENNA YAW MOMENT
INITIAL CONDITION \( \theta = 0 \) \( \dot{\theta} = 0 \) FOR \( t = 0 \)

\( \dot{v} \) (M/HOUR) = 97.8 PSI (DEG) = 0.0

FIGURE 19. COMPUTED SSR ANTENNA YAW MOMENT
4. TECHNICAL APPROACH

4.1 DEFINITION OF TASKS

The basic approach used to determine if the SSR antenna rotation rate is stable enough to support FULL BCAS operation, will be the analysis of the measurements collected in the field and of the mathematical model of the antenna system. If it is not stable enough then approaches for improving the rotation rate stability will be identified. The total effort will consist of two parts.

1. Perform field measurements at selected sites by collecting SSR antenna rotation measurements under different service conditions.

2. Analyze the collected data, identify service conditions for which Full BCAS performance would be acceptable, and predict performance degradation outside those limits. Perform analysis and simulation studies for the whole range of service conditions as specified by FAA. Then on the basis of these analyses, the measured data, and the simulation, identify alternatives which will meet requirements over the full range of operational conditions. Using mathematical models and computer simulation, perform parametric studies of the alternative designs.

Under the proposed measurement method, antenna rotation rate variations will be measured between the two pulses of each Azimuth Change Pulse (ACP) pair (4096ACP pulses per revolution) and will be compared with wind characteristics measured at the same time and sampled at 54 ACP pulse intervals.

All analysis is being performed at TSC, using a DEC-10 computer. Data reduction software and mathematical models and algorithms to conduct simulation analysis are also being developed at TSC. (For R&D computer programs see Appendix B.)
4.2 MEASUREMENT TECHNIQUE (Figure 20)

The azimuth change pulses (ACP's) and azimuth reference pulses (ARP's) are received from the SSR's antenna system [Antenna-Azimuth-Range-Timing Unit (AARTU)] as shown in the Test System Block Diagram, Figure 21. Intervals between successive ACP's will be measured by counting clock pulses from the 1 MHz system clock. These counts, together with antenna position data, will be recorded on magnetic tape. Concurrently, wind speed and direction will be measured. The data will be written on magnetic tape in logical records of 64 bytes each; 32 logical records of 2048 bytes written by the Kennedy recorder on 9-track standard magnetic tape at a density of 1600 bpi.

4.3 INPUT SIGNALS

Azimuth Change Pulses (ACP's) originating in the Antenna-Range-Timing-Unit (AARTU) (Figure 21) already processed by the Azimuth Pulse Generator (APG) Shaper Assembly (Figure 22) and accessed through a BNC connector at the antenna sight are fed into the SSR Antenna Computer Assembly at a rate of 4096 ACP pulses per revolution. A counter counts the number of clock pulses from an internal 1 MHz clock between successive ACP's and the total count, modulo 256, is entered into the computer on an interrupt basis as an 8-bit number (see Figure 23).

Azimuth Reference Pulses (ARP's) are generated like the ACP's, except at a much lower rate - one pulse for every 4096 ACP counts. The ARP pulses are made to coincide with one of the ACP pulses and provide information on antenna zero crossings thus indicating the completion of a full revolution.

Weather Data Wind speed and direction data are received serially on two independent channels and are entered into the computer under interrupt control.
FIGURE 20. MEASUREMENT TECHNIQUE
FIGURE 22. AZIMUTH PULSE GENERATOR (APG) BLOCK DIAGRAM
FIGURE 23. SIMPLIFIED BLOCK DIAGRAM
4.4 OUTPUT DATA

The output will consist of clock pulse counts (approximately 1000, given modulo 256) between each pulse of an ACP pair and of formatted wind data written on a magnetic tape. The magnetic tape recorder will be able to collect 7 hours of test data on a 10.5 inch (2400 feet) reel of tape in standard 9-channel format at 1600 bpi.

4.5 RECORDED DATA FORMATS

The logical record (see Figure 24) will contain, in order:
- The record sequence number (binary, 2 bytes).
- Wind direction in degrees from magnetic north, given as three decimal digits, expressed in binary, one per byte.
- Wind speed in statute miles per hour given as three decimal digits expressed in binary, one per byte.
- Antenna direction, given as a count of ACP pulses since the last ARP pulse (binary number in two bytes).
- Fifty-four (54) consecutive bytes, each giving the clock count between a pair of successive ACP pulses. The clock count is given modulo 256 as an 8-bit binary number. If \( n \) is the count of ACP pulses since the last ARP pulse, then the first clock count will be the interval between the \( n \)-th and \( n+1 \)-st ACP pulse, the next for the interval between \( n+1 \)-st and \( n+2 \)-nd, etc. The ACP pulse coincidence with the ARP pulse is considered to be numbered zero.
<table>
<thead>
<tr>
<th>Byte #</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>consecutive logical record #, byte 2</td>
</tr>
<tr>
<td>3</td>
<td>wind direction, 100's of degrees</td>
</tr>
<tr>
<td>4</td>
<td>wind direction, 10's of degrees</td>
</tr>
<tr>
<td>5</td>
<td>wind direction, degrees</td>
</tr>
<tr>
<td>6</td>
<td>wind speed, 100's of mph</td>
</tr>
<tr>
<td>7</td>
<td>wind speed, 10's of mph</td>
</tr>
<tr>
<td>8</td>
<td>wind speed, mph</td>
</tr>
<tr>
<td>9</td>
<td>ACP count since last ARP, byte 1</td>
</tr>
<tr>
<td>10</td>
<td>ACP count since last ARP, byte 2</td>
</tr>
<tr>
<td>11</td>
<td>clock period count</td>
</tr>
<tr>
<td>12</td>
<td>clock period count</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>clock period count</td>
</tr>
</tbody>
</table>

**FIGURE 24. LOGICAL RECORD STRUCTURE ON DATA TAPE**
5. DESCRIPTION OF THE TEST

5.1 UNIT UNDER TEST

Figure 25 shows the SSR site under test with an Open Array collocated with the primary radar (ASR-8) antennas. The test site selected is the FAA Technical Center's Terminal Radar Beacon Test Facility (TRBTF) site. Of the two 5-hp induction motors used in the system, (a typical ASR-8 site installation), only one motor is being used at the TRBTF site for driving the antennas. Therefore, this site represents a typical ASR-7 site installation, which is of primary interest for this study.

5.2 TEST EQUIPMENT

The SSR antenna rotation rate measurement test equipment assembly is shown in Figure 26. The assembly consists of the following units:

1. Anemometer, VA-320 with digitized output and 140-foot RF cable; mounted on the pole close to the Open Array under test.

2. Kennedy digital tape recorder, Model 9100-3, with accessories - rack mounted

3. SSR Antenna Test Computer Assembly - rack mounted
   - INTEL SBC-905 Board - rack mounted
   - INTEL SBC-80/20 Board - rack mounted
   - INTEL SBC-116 Board - rack mounted

A simplified block diagram of the test set-up was shown in Figure 23 which also shows the hardware and software interfaces and data extraction.

5.3 SSR TEST COMPUTER ASSEMBLY

The Computer Assembly for the SSR test consists of three INTEL Single Board Computer Assemblies modified to process input signals.
(OPEN ARRAY AT UPPER RIGHT)

FIGURE 25. FAA TECHNICAL CENTER TERMINAL RADAR BEACON TEST FACILITY (TRBTF)
Figure 26. SSR Antenna Rotation Rate Test Equipment Assembly
and the sampled output data. An Input Data Counter Schematic in Figure 27 shows interconnections of INTIEL SBC-905 and INTIEL SBC-80/20, as well as all input and output signals of ACP, ARP and wind velocity and wind direction signals.

5.3.1 INTEL SBC-905, Input Data Counter

The SBC-905 consists of two major circuits, the Azimuth Change Pulse (ACP) logic and the Azimuth Reference Pulse (ARP) logic.

**ACP Logic.** The ACP pulse (BNC on Front Panel) is connected to a 74C14 (U1) on pin #1. The 74C14 (U-1) is a high-impedance, input-inverting amplifier used to isolate the input from the radar system during power shut-down. Since the 74C14 is an inverting amplifier its output pin, #2, is connected to a 74LS04 (U2A) inverting amplifier on pin #1 which makes the ACP pulse positive logic and TTL compatible. The output is pin #2 which is connected to a 74S74 (U3A) pin #3, which is an Edge-Triggered Flip-Flop. This Flip-Flop is so configured that the Preset and Clear are tied through 10k-ohm resistors to the 5-volt power. The $Q$ output is tied to the $D$ input so as to have complementary $Q$ and $\bar{Q}$ outputs.

The $Q$ output, pin #5, is connected to pin #1 of a 7408A, which is a 2-input positive AND gate. The other input to this AND gate, pin #2, is connected to a 1 MHz signal source.

**1 MHz Signal Source.** The 1 MHz signal is derived from a 4 MHz crystal oscillator. The 4 MHz crystal oscillator is a standard configuration for an oscillator using a 7404 (U9). The output pin #6 is connected to pin #1 of a 7493 (U10), which is a 4-bit binary counter, configured to be a "divide-by-4" counter. The output pin #8 is connected to pins #2 and 5 of U4.

The output pin #3 of the U4A is the ACP pulse with the 1 MHz signal superimposed on the peak. This signal is connected to pin #14 of "Counter A," consisting of two-74793's (4-bit binary counters) so configured as to create an 8-bit counter, U5 and U6. This is done by connecting pin #11 of U5 to pin #14 of U6.
Pin #12, the output, is connected to pin #1 to create a 4-bit ripple-through counter. The same configuration applies to U6, which completes the 8-bit counter.

The resetting of Counter A is done by connecting, F-1, pin #22 (bit #1, Port C, 8255 #1) of the SBC-80/20 CP4 board to 1-D(74C14) pin #9. Its output pin, #8, is connected to U2-D (74LS04) pin #9 and its output pin, #8, is connected to pins #2 and 3 of U5 and pins #2 and 3 of U6.

The use of U1-D, U2-D, which are inverting amplifiers, are for buffering the 8255 #1 (C-MOS) to the U-5, U-6 (TTL) counters.

The output pin, #6, of U-3 is connected to pin #4 of U-4, which is a 2-input positive AND gate, the other input to this AND gate, pin #5, is connected to a 1 MHz signal source at pin #2.

The output pin, #6, is connected to pin #14, of U-7, Counter B. Counter B is configured the same as Counter A. The reset for Counter B is derived from the SBC-80/20, J1 pin #24, (Part C, Bit-# of the 8255 #1). This in turn is connected to U-1E; pin #11, (C74C14). Its output pin, #10, is connected to U-2E pin #11, (C74LS04) and its output pin, #10, is connected to pins #2 and 3 of U-7 and pins #2 and 3 of U-8.

The use of U-1E, U-2E, which are inverting amplifiers, are for buffering the 8255 #1 (C-MOS) to the U-7, U-8 (TTL Counters).

ARP Logic. The ARP pulse (BNC connector on Front Panel) is connected to U-1B, pin #3 (74C14) which is a high impedance, input inverting amplifier used to isolate the input from the radar systems during power shut-down.

The output, pin #4, of U-1B is connected to U-2B, pin #3, (74LS04) an inverting amplifier which makes the ARP pulse positive logic and TTL compatible. The output, pin, #4, is connected to U-11D, pin #9, an inverting amplifier, to create a negative logic pulse output.

U-11D, output pin #8, is connected to U-3B, pin #10. U-3B is a D-type, Edge-Triggered Flip-Flop, and its pins #11 (C input) and #12 (D input) are tied Low (Ground). Pin #10 is the preset input
and pin #13 is connected through a 10k-ohm resistor to High (+5V) Pin #13 is also connected to the output, pin #6, of U-2C which is a reset pulse from the SBC-80/20 board, C8255 #1, Part C, J-1 pin #20. It is then connected to U-1C a 74CL14 pin #5. The output of U-1C, pin #6 is connected to U-2C pin #5, 74LS04. U-1C and U-2C, are used as buffers for the SBC-80/20, 8255 #1 (C-MOS).

The output of U-3B, pin #9, is connected to the SBC-80/20 board, J-1, pin #34, which is in the Port A, (bit 7) of the 8255 #2, (Test pin #11).

The output of U-3A, pin #5 is connected to the SBC-80/20 board, J-1 pin #2, which is the Port B (bit 7) at the 8255 #2, (Test point #13).

U-11, a 74LS04, is used as an inverting amplifier-buffer for the digital output of the anemometer wind speed which is C-MOS. The significant digit of wind speed (C0) is connected to U-11A at pin #1. The output of U-11A is pin #2 which is connected to a U-12, 432 (2-input positive-OR gate) at pin #1 (1A). The next significant digit, C1, is connected to a U-11B at pin #3. The output of U-11B, pin #4, is connected to pin #2 of the U-12 (1B) which creates an output at pin #3 (1Y). (Positive Logic: Y = A + B). Pin #3 of U-12(1Y) is connected to pin #4 (2A) of U-12. The least significant digit, C2, is connected to U-11C at pin #5. The output of U-11C, pin #6, is connected to #9 of the U-12(3A). Pin #10(3B) is connected to ground, this creates an output at U-12(3Y) pin #8. Pin #8 of U-12(3Y) is connected to U-12 (2B) pin #5 to create an output at U-12(2Y) pin #6. Pin #6 is connected to connector, P-1, pin #42 (interrupt Routine #1), which is connected to, P-1, pin #42, of the SBC-80/20 board.

The most significant digit of wind direction (C0) is connected to U-13 (2-input positive-OR gate) at pin #1, digit of wind direction (C1) is connected to U-13 #2(1B) which creates an output at pin #3(1Y). Pin #3 of U-13 is connected to pin #4(2A) of U-13. The least significant digit of wind direction is (C2) connected to U-13 pin #9(3A). Pin #10 of U-13 is connected to ground. This creates an output at U-13 pin #8(3Y). Pin #8 is connected to U-13 pin #5(2B), this creates an output at U-13 pin #6(2Y).
U-13 pin #6 (interrupt Routine #2) is connected to J-1 at pin #39. J-1 pin #39 is connected to J-1 pin #39 of SBC-80/20 board.

Power Supply

The power supply and the wiring diagram are shown in Figure 28.
Test Points

The following test points are located at socket U-14, at pin #:

TP1 + TP16 = +5.0 V, (Vcc)
TP8 + TP9 = Ground
TP2 = Reset Counter B (U7, U8) see waveform #
TP3 = Reset Counter A (U5, U6) see waveform #
TP4 = Reset ARP (U3B) see waveform #
TP5 = Output of Counter A (USB) see waveform #
TP6 = Output of Counter B (U7B) see waveform #
TP7 =
TP10 = 1 MHz Clock (U2F) see waveform #
TP11 = SARP see waveform #
TP12 = BACP see waveform #
TP13 = Gate see waveform #
TP-14 = ARP see waveform #
TP-15 = ACP see waveform #
SBC 80/20 board: I/O Assignments  See Figures 29 to 34

8255 #1 (port adr OE4H) PORT A:
INPUTS
DO-D7 is counter A DO-D7

(port adr OE5H) PORT B: (INPUTS)
DO-D7 is counter B DO-D7

(port adr OE6H) Port C:
b0=Counter A reset pulse; l = reset
b1=Counter B reset pulse, l = reset
b2=x-loop-
b3=x
b4= main loop test flag
b5= ACPINT test flag
b6= SPINT test flag
b7= DRINT test flag

8255 #2 (port adr OE8H) Port A: (Wind speed inputs)
b0-b3 is 4 bit BCD, b0=LSB
b4= C0 pulse, speed, l=TRUE
b5= C1 pulse, speed, l=True
b6= C2 pulse, speed, l=true
b7= ARP input, l=ARP

(Port OE9H) Port B: (Wind direction, inputs)
b0-b3 is 4 bit BCD, b0=LSB
b4= C0 pulse, direction, l=True
b5= C1 pulse, direction, l=True
b6= C2 pulse, direction, l=True
b7= Counter B RSAD=1

(Port OE9H) Port C: (Status inputs)

8259 INPUTS:
IRO-Positive-going ACP pulse, not divided
IR1-Speed C0,C1,C2, OR'ed, positive pulse
IR2-Direction C0,C1,C2 OR'ed, positive pulse
IR#-IR7 should be disabled (grounded)
**Jumper Wire List for SBC-80/20 Board**

<table>
<thead>
<tr>
<th>Location</th>
<th>Pin #</th>
<th>to</th>
<th>Pin #</th>
</tr>
</thead>
<tbody>
<tr>
<td>A20</td>
<td>51</td>
<td></td>
<td>52</td>
</tr>
<tr>
<td>A21</td>
<td>70</td>
<td></td>
<td>71</td>
</tr>
<tr>
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<td></td>
<td>3</td>
</tr>
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<td></td>
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<td>A19</td>
<td>27,28,29,30</td>
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<td>31 (GND.)</td>
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<td>A19</td>
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# Interconnection Wiring
## SBC-905 to SBC-80/20

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<th>Pin #</th>
<th>SBC-80/20 Connector</th>
<th>Pin #</th>
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<tr>
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<td>2</td>
<td>J-1</td>
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<td>J-1</td>
<td>42</td>
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<td>J-1</td>
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<td>PCC-1</td>
<td>46</td>
<td>J-1</td>
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<td>PCC-1</td>
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## Interconnection Wiring

Anemometer to SBC-905 and SBC-80/20

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<th>Rear Panel</th>
<th>Anemometer DB-25 Pin</th>
<th>SBC-905 UX-1 Pin</th>
<th>SBC-80/20 J-2 Pin</th>
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<td>P1</td>
<td>1</td>
<td>UX-1 1</td>
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</tr>
<tr>
<td>P1</td>
<td>2</td>
<td>UX-1 2</td>
<td></td>
</tr>
<tr>
<td>P1</td>
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<td></td>
</tr>
<tr>
<td>P1</td>
<td>4</td>
<td>UX-1 4</td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>5</td>
<td>UX-1 5</td>
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</tr>
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<td>P1</td>
<td>6</td>
<td>UX-1 6</td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>7</td>
<td>UX-1 7</td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>8</td>
<td>UX-1 8</td>
<td>SBC-80/20 J-2 48</td>
</tr>
<tr>
<td>P1</td>
<td>9</td>
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<td>J-2 48</td>
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<td>J-2 44</td>
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<td>J-2 16</td>
</tr>
<tr>
<td>P1</td>
<td>14</td>
<td>UX-1 14</td>
<td>J-2 14</td>
</tr>
<tr>
<td>P1</td>
<td>15 (GND)</td>
<td>UX-1 15</td>
<td>J-2 12</td>
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<td>SBC-905</td>
<td>UX-1 Pin</td>
<td>UX-1 GND</td>
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</tr>
<tr>
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<td>16</td>
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<td></td>
</tr>
<tr>
<td>UX-1</td>
<td>15</td>
<td>SBC-80/20 J-2 40</td>
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</tr>
<tr>
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<td>14</td>
<td>J-2 40</td>
<td></td>
</tr>
<tr>
<td>UX-1</td>
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<td></td>
</tr>
<tr>
<td>UX-1</td>
<td>12</td>
<td>J-2 36</td>
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</tr>
<tr>
<td>UX-1</td>
<td>11</td>
<td>J-2 8</td>
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S-19
<table>
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<tr>
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<th>SBC-80/20</th>
<th>Pin #</th>
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<tr>
<td>P-2</td>
<td>1 10</td>
<td>J-2</td>
<td>34</td>
</tr>
<tr>
<td>P-2</td>
<td>2 9</td>
<td>J-2</td>
<td>2</td>
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<td>Pin #</td>
<td>SBC-80/20</td>
<td>Pin #</td>
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</tr>
<tr>
<td>P-1</td>
<td>42</td>
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<tr>
<td>P-1</td>
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<td>P-1</td>
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# Interconnection Wiring

<table>
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<th>Connector Type</th>
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<td>Front Panel</td>
<td>SBC-90S</td>
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<tr>
<td>ACP - J-1 (Center Pin)</td>
<td>UX-1</td>
<td>9</td>
</tr>
<tr>
<td>ARP - J-1 (Center Pin)</td>
<td>UX-1</td>
<td>10</td>
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<tr>
<td>ACP + ARP - J-1's (shell, GND.)</td>
<td>UX-1</td>
<td>7, 8  (GND.)</td>
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</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>SBC-80/20</th>
<th>Pin #</th>
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</thead>
<tbody>
<tr>
<td>DB-25</td>
<td>J3</td>
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</tbody>
</table>
Interconnection Wiring

Anemometer Terminal Board to DB-25 Pin #

- Speed C0 (MSD) to DB-25 1
- Speed C1 (NSD) to DB-25 2
- Speed C2 (LSD) to DB-25 3
- Direction C0 (MSD) to DB-25 4
- Direction C1 (NSD) to DB-25 5
- Direction C2 (LSD) to DB-25 6
- Speed 8 to DB-25 7
- Speed 4 to DB-25 8
- Speed 2 to DB-25 9
- Speed 1 to DB-25 10
- Direction 8 to DB-25 11
- Direction 4 to DB-25 12
- Direction 2 to DB-25 13
- Direction 1 to DB-25 14
- Ground to DB-25 15
## Interface Wiring SBC-116 to Kennedy, Model 9217B Buffer Formatter

**SBC-116** (See Figures 35 to 40)

<table>
<thead>
<tr>
<th>From Connector #, Pin #</th>
<th>To DB-25F</th>
<th>To DB-25M</th>
<th>Kennedy, Connector &amp; Pin #</th>
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<tbody>
<tr>
<td>J1-16 Bit 0 (Form ENA)</td>
<td>1</td>
<td>1</td>
<td>P1-18</td>
</tr>
<tr>
<td>J1-14 Bit 1 (Write SEL)</td>
<td>2</td>
<td>2</td>
<td>P1-5</td>
</tr>
<tr>
<td>J1-24 Bit 0 (Write Data Strobe)</td>
<td>3</td>
<td>3</td>
<td>P1-6</td>
</tr>
<tr>
<td>J1-22 Bit 1 (Off Line)</td>
<td>4</td>
<td>4</td>
<td>P3-8</td>
</tr>
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<td>J1-20 Bit 2 (Init)</td>
<td>5</td>
<td>5</td>
<td>P2-4</td>
</tr>
<tr>
<td>J1-18 Bit 3 (Rew)</td>
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<td>6</td>
<td>P1-9</td>
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<td>J1-26 Bit 4 (EOF)</td>
<td>7</td>
<td>7</td>
<td>P1-8</td>
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<td>J1-28 Bit 5 (EOR)</td>
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<td>P1-7</td>
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<td>J2-34 Bit 7 (On Line)</td>
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<td>P3-4</td>
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<td>J2-36 Bit 6 (EOT)</td>
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<td>P1-3</td>
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<td>J2-42 Bit 3 (WR RDY)</td>
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<td>P1-11</td>
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<tr>
<td>J2-44 Bit 2 (Load Pt.)</td>
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<td>J2-46 Bit 1 (MEM Busy)</td>
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<td>P1-4</td>
</tr>
<tr>
<td>J2-48 Bit 0 (FMTR Busy)</td>
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<td>14</td>
<td>P3-18</td>
</tr>
<tr>
<td>J2-16 Bit 0 (Data Bit 0)</td>
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<td>15</td>
<td>P1-10</td>
</tr>
<tr>
<td>J2-14 Bit 1 (Data Bit 1)</td>
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<td>16</td>
<td>P1-11</td>
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<td>J2-10 Bit 3 (Data Bit 3)</td>
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<td>P1-13</td>
</tr>
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</tr>
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<td>J2-4 Bit 6 (Data Bit 6)</td>
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</tr>
<tr>
<td>J2-2 Bit 7 (Data Bit 7)</td>
<td>22</td>
<td>22</td>
<td>P1-17</td>
</tr>
</tbody>
</table>

Pin # 23, 24, 25 are ground connections

A jumper wire is connected from Pin #53 to Pin #54
5.4 COMPUTER FLOW CHARTS

FIGURE 41. INITIALIZATION ROUTINE
FIGURE 42. ACP COUNT AND ROUTING INTERRUPT ROUTINE
FIGURE 43. ACP COUNT LOADING AND RECORD COUNT ROUTINE
FIGURE 44. WIND SPEED AND WIND DIRECTION ROUTINES
FIGURE 45. DATA RECORD INTERRUPT ROUTINE
FIGURE 41. INITIALIZATION ROUTINE
FIGURE 42. ACP COUNT AND ROUTING INTERRUPT ROUTINE

5-32
FIGURE 43. ACP COUNT LOADING AND RECORD COUNT Routines
FIGURE 44. WIND SPEED AND WIND DIRECTION ROUTINES

S-34
WTA

OVERLAYS GO HERE
TO LINK TESTING ROUTINES

JMP
WTAP

FIGURE 45. DATA RECORD INTERRUPT ROUTINE

WTAP

DATA + TAPDAT

DATA TO RECORDER

WDS + TAPCTL

SET WRITE STROBE

0 + TAPCTL

CLEAR WRITE STROBE

RET

5-35/36
6. DATA COLLECTION PLAN

6.1 APPROACH

The data collection flow diagram is shown in Figure 46. The data format consists of 64 byte logical record containing the clock counts for each two-pulse spacing of 54 ACP pulses (given modulo 256) and 3-digit direct recording of wind velocity and direction samples stored in two, 1028-bit buffers each and recorded on a 10.5 inch (2400 feet) reel of magnetic tape in standard 9-channel format at 1600 bpi with a capability of collecting 7 hours of test data.

Mathematical methods have been developed to derive statistics from the collected data at the sites and then applied to make inferences about these sites.

Collection of data is intended at different sites and over a wide range of environmental conditions as found at the sites enumerated earlier. The details of data collection plan presented in Section 8 of this test plan.
FIGURE 46. MEASUREMENT DATA COLLECTION ROUTINE
7. DATA ANALYSIS PLAN

7.1 PRECISION OF RECORDED DATA

Antenna Azimuth Angle. By using a 0.99985 MHz counter, precision in measuring the time between the two pulses of an ACP pair may be assured as follows:

\[
\Delta \theta \text{precision} = \frac{360^\circ}{4096(ACP)^3 \times 890(\text{CP})} \approx 9.87 \times 10^{-5} \text{ degrees}
\]

Wind Velocity. Speed constant for the VA-320 Anemometer is:

Speed Constant = 6 mm.

Using sampling rate of 52 milliseconds it is possible to sense wind changes of

\[
v = \frac{D}{t} = \frac{0.6}{2.54 \times 12 \times 0.052} \approx 4 \text{ ft/sec. or } 2.3 \text{ mi/hr.}
\]

Accuracy of wind speed measurement is ± 2% full scale.

Accuracy of wind direction measurement ± 4° at 4.5 mph

± 2° above 9 mph

7.2 SAMPLED DATA STATISTICS: MEAN, VARIANCE, AND STANDARD DEVIATION

7.2.1 Mean, Variance, and Standard Deviation

A direct measurement of the clock counts (n) is recorded in each pulse-pair interval and a variation in the \( n_i \) among consecutive ACP's is interpreted as variation in the antenna rotation speed within the revolution. It is assumed that there are no angular variations between the ACP pulse intervals. A single complete revolution is indicated by an ARP pulse always following 4096 equally positioned ACP pulses. Wind loading affects the actual time to reach next ACP pulse position but not the angular increment (0.088°) which is fixed within 360° of azimuth.
For the sample calculations of the sample mean and variance used in the data analysis shown in Figure 47 and 48. It is the data sampled in one logical record consisting of 54 consecutive ACP's and in addition wind velocity and direction information. The sample mean is defined as

\[ m_s = \frac{1}{54} \sum_{i=1}^{54} n_i \]

where

\[ n_i = \text{the remainder in the counter after } 3 \times 256 \text{ overflow (modulo 256)}. \]

A mean of one revolution is computed by averaging the sample means of 75 logical records.

\[ m_r = \frac{1}{75} \sum_{i=1}^{75} m_{s_i} \]

Variations of the samples are derived by squaring the difference between two means, i.e., a mean of a single logical record minus the mean for that revolution as computed from the sample taken from the same revolution.

\[ s^2 = \frac{1}{75} \sum_{i=1}^{75} \left( m_{s_i}^2 \right) - m_r^2 \]

Standard deviation as defined here is,

\[ s_{SD} = \sqrt{s^2} \]

7.2.2 **Sliding Window Sum Total Variations (Histogram)**

A plot of additive sums (a sliding window) sliding forward to complete one revolution is shown in Figure 49, where 75 logical records approximate one full antenna revolution. From these data a possible error in azimuth estimate based on an earlier squitter reading may be derived. The error estimate is
TAPE ID: FT-1

REVOLUTION NUMBER: 2

APRIL 13, 81 LOW OVERCAST GUST TO 40

FIGURE 47. MEASURED DATA STATISTICS- MEAN
TAPE ID: FT-1
REVOLUTION NUMBER: 2
APRIL 13, 81 LOW OVERCAST GUST TO 40

FIGURE 48. MEASURED DATA STATISTICS - STANDARD DEVIATION

NUMBER OF LOGICAL RECORDS

STANDARD DEVIATION
based on the difference between the two clock count sums converted into degrees, thus representing a difference in azimuth between two readings

\[ \Delta \theta_{AZ} = \frac{0.088^\circ \times \Delta N}{890} \]

where,

\[ \Delta N = \text{difference between two sums in comparison.} \]

7.3 A CUMULATIVE SUM COMPARISON WITH THE NOMINAL

A computer plot of a cumulative sum for one completed revolution is plotted in Figure 50. Adding of these pulses begins with an ARP pulse time. A straight line, constant slope projection is used for comparing actual measured data with ideal conditions.

For deriving the total sum, the clock counts between each of 4096 ACP pulses are added increasingly as follows,

\[ N_K = \sum_{i=1}^{K} n_i \]

where,

\[ n_i = \text{clock count between two adjacent ACPs in a partially filled register based on modulo 3.} \]

7.4 SAMPLE STATISTICS: INFERENCES

Field test data will be analyzed to make inferences about the SSR antenna rotation rate stability. Significance levels will be determined between various test sites based on wind and icing characteristics over the seasons.

7.5 CORRELATION OF DATA DERIVED FROM A MATHEMATICAL MODEL WITH DATA MEASURED IN THE FIELD

Analytical data will be compared with the data collected at the radar site, and extrapolated for the service ranges where such data may not be obtainable in the field. Critical parameters
TAPE ID: FT-1

REVOLUTION NUMBER: 2

APRIL 13, 81 LOW OVERCAST GUST TO 40

FIGURE 50. CUMULATIVE MEASURED VS NOMINAL CLOCK PULSE SUMMATION
of the system will be set and used in the parametric studies to arrive at satisfactory fixes for the service ranges outside of which the Full BCAS performance is not acceptable.
8. SCHEDULES

A detailed test schedule is presented in Figure 51. Two major factors will determine the route to be taken as testing progresses. These factors are the preliminary analysis of the data collected at the FAA Technical Center and the TSC in-house computer simulation results. A decision will be made to either continue with the testing at the Technical Center or to move the equipment to one or more other sites.

The principal activities are as follows:

1. Test Plan
   Draft - November 1980
   Final - September 1981

2. Equipment: Hardware and Software Development and Debugging
   March 1981

3. Equipment Installed, Debugged and Operating at the FAA Technical Center
   April 1981

4. Tests Continue at FAA Technical Center
   December 1981
   Optional February 1983

5. Decision on Testing at Multiple Sites
   November 1981

6. Defining the Problem
   January 1982

7. Reports
   Interim: February 1982
   First June 1982
   Final April 1983

The major purpose in going to alternative sites is to be able to collect wind data for the whole operational range specified by the FAA. By extending tests at a single site, possibly for each season, significant variations in the environmental conditions may be encountered. This would allow reliable
FIGURE 51. SSR ANTENNA ROTATION RATE STUDY SCHEDULE
conclusions as to the acceptable operational range for that site. Also, environmental characteristics for individual sites may have some unique differences.
<table>
<thead>
<tr>
<th>Week</th>
<th>Hours</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
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</tr>
<tr>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

**TOTAL: 24 hours**
APPENDIX A
ORGANIZATIONAL RESPONSIBILITIES

Organizational responsibilities for the SSR Antenna Rotation Stability Studies program are divided among ARD-240, TSC, and the FAA Technical Center, as shown in the following chart.

ARD-240
John Brennan

TSC
DTS-531
Janis Vilcans

FAA Technical Center
ATC-154
George Mahnken

ARD-240, as the sponsoring organization, has overall management responsibility and direct responsibility for the following specific details:

1. Obtaining access to the district sites
2. Selecting and approving the test sites

TSC, DTS-531, has primary responsibility for the technical success of the programs with the following specific details:

1. Designing, building, and debugging one set of test hardware and software.
2. Designing algorithms and software for data reduction and analyses.
3. Designing mathematical models and performing parameter trade-offs using analysis and computer simulation.
4. Selecting alternatives for improvement.

5. Preparing draft interim data report and final report.

FAA Technical Center, has coordination responsibility with District sites, ARD, and TSC. Detailed tasks are:

1. Supporting installation at the TRBTF site and running the tests.

2. Coordination and scheduling of tests at other sites, if required.

3. Responsibility for supplying test equipment to the sites and interfacing with the site operational technical personnel.

4. Collecting and delivering field data to TSC for analysis.
APPENDIX B

SIMULATION SOFTWARE FOR SOLVING SSR ANTENNA SYSTEM MODEL
TYPE DIFRUN.FOR

PBZ - IS THE WIND DIRECTION IN RADIANS
U - IS THE WIND SPEED IN MILES PER HOUR

EPE, ETA - ARE SMALL NUMBERS
N - CURRENT STEP

Y(1) = U*ETA
Y(2) = B*ETA/B

LET CB = COS(EPE*PBZ)
SN = SIN(EPE*PBZ)

P = 0
TETA/B = T

S = 0E199E0B5B08BHE2624P4BHE838P844E8484E8484P3E87

THEN OUR EQUATION

Y2 TETA/B Y3 = -(A13+E26(C13C38)/(B13B26P13884P13A386)

COMMON /API/0,PBZ

COMMON /DAT/ A1,A2,A3,E1,B1,B2,B3,E2,E3,E4,E5,E6,E7

DIMENSION Y(2),Y2(27),Y3(27),Y(24)(2401),TETA(400),/TETA(400)

1 DATA (A1,A2,A3,C0.01377,0.078125,0.000451

DATA C12/155.377,206.727,

DATA B1,B2,B3/10.27,-21.76,6.7


1 243.74,-0.17035,1.778,-4.644,225

DATA T/0.10/

DATA EPS, ETA, EP/0.0001,0.0001,0.000001/
VALUES OF VP, INE TO BE ASSIGNED ON TERMINAL.

WRITE (5,91)

91 FORMAT ('GIVE VP, VALUES')
READ (5) INE, PSI

11 FORMAT (2D)
8 = 100. / 3.1415927

16
C
9 = 0.
T = (1) ;
C(TA(I)) = Y(I) ;
BETA(I) = Y (2) ;
CS = COB(Y(I)) ;
SN = SIGM(B(INY(I)) - PSI))

P = Y (2) ;

GMM: $\text{GMM}(\text{EIV}, \text{EHE}, \text{E2EP}) + \text{E3EP} + \text{E4V}, \text{E5EP} + \text{E6V}, \text{E7EP}$

BMM: $\text{BMM}(\text{C1C3EP}), \text{B1B2EP}, \text{B3EP}$

DZET = - $\text{ATP} + \text{2oH}, \text{H2} + \text{ATZET}$

XFIN = 9.2
HMIN = 0.001
HMIN = 10
PSI = PSI / 8

C

BEG I OF R I NGE-KU I TA

CALL RKINT(X(1), Y(2), NM, XI, YI)

13 CALL RKINT(X, Y1*, X2; Y2)

20 CALL RKINT(X2; Y2*, X3; Y3)

25 DO 30 K = 1, 2

30 G = ABS(Y1(K))

IF (G(I) < 0.02) GO TO 17

G = 2

17 IF (G(I) < 0.02) GO TO 18

G = 61

27 S = ABS(Y1(K) - Y2(K))

30 CONTINUE

IF (I > NAME) GO TO 49

46
49 X = X3

51 NM = NM1

52 DO 47 K = 1, 2

47 Y(K) = Y(K)

51 NM = NM - K

TET(A(NM)) = Y(1) - 28

CS = COB(Y(1) - PS1)

SN = SIGM(B(INY(1) - PSI))

P = Y (2) ;

GMM: $\text{GMM}(\text{E1IV}, \text{E4C6EP}), \text{E3EP} + \text{E4V}, \text{E5EP} + \text{E6V}, \text{E7EP}$

BMM: $\text{BMM}(\text{C1C3EP}), \text{B1B2EP}, \text{B3EP}$

DZET = - $\text{ATP} + \text{2oH}, \text{H2} + \text{ATZET}$

IF (XFIN) 13, 100, 100

39 IF (I < HMIN) 44, 44 + 55

55 XMIN = 0.5

57 X = X2

60 Y(K) = Y(K)
PRINT RESULTS ON DATA FILE='KANT.DAT'

100         WRITE(N,155) NUM
155         FORMAT(1X,8X,NUM OF POINT FOR PLOT IN 'F')
            OPEN UNIT=2,FILE='KANT.DAT'
            PBI=PB1
105         FORMAT(10X,3')
            WRITE(2,106) NUM, NUM
106         FORMAT(2X,4I4)
107         FORMAT(2X,2F)
            WRITE(2,108) (I(1), TETA(I)+I(1)+1.57)/100
108         FORMAT(10X,9')
            WRITE(2,109) NUM, NUM
109         FORMAT(2X,2F)
            WRITE(2,110) (I(1), TETA(I)+I(1)+1.57)/100
110         FORMAT(10X,9')
            WRITE(2,111) NUM, NUM
111         FORMAT(2X,2F)
            WRITE(2,112) (I(1), TETA(I)+I(1)+1.57)/100
112         STOP
END

THIS SUBROUTINE COMPUTES
TH(1) = VALUE OF FUNCTION
TH(2) = VALUE OF DERIVATIVE
"AT POINT X=TH(1)" IF WE KNOW
Y(1) = VALUE OF FUNCTION
Y(2) = VALUE OF DERIVATIVE
"AT POINT X." SUBROUTINE AXIST(K,Y,KH,YH)
COMMON 'APS' / V,PBI
COMMON '/DAT/ A1#/A2# A3# C1# C2# B1# B2# B3# E1# E2# E3# E4# E5# E6# E7
DIMENSION Y(2),YH(2)
TH(1)=TH(2)=Y(1)=Y(2)=A(1)=0.548
A(2)=0.548
A(3)=0.548
A(4)=0.548
K=K+1
DO 5 K=1,2
TH(1)=Y(1)
Y(1)=Y(1)
DO 500 K=1,2
TH(1)=TH(1)+Y(1)
DO 500 K=1,2
COMMON (E1#(1)=PBI)
SN=ABS(E1#(1)-PBI)
100 FORMAT(1X,"BENOMINATOR=",FP)
101 FORMAT(1X,"DIVIDEND=",FP)
102 FORMAT(1X,"FDIVIDER=",FP)
103 FORMAT(1X,"FRESULT=",FP)
104 FORMAT(1X,"NUMBER=",I4)
105 FORMAT(1X,"RESULT=",F7.4)

C TYPE PIFNAME:FOR
C PSI - IS THE WIND DIRECTION IN RADIANS
C V - IS THE WIND SPEED IN MILES PER HOUR
C EPS,ETA - ARE SMALL NUMBERS
C K - CURRENT STEP
C
C ALGORITHM
C
C LET CS=COS(TETA-PSI)
C LET SN=SIN(TETA-PSI)
C
C THEN OUR EQUATION I
C
C
C COMMON /API /V,PSI
C COMMON /W/AT=1,AS=1,ACT=A3,C1=C2/PSI,ET1,E2,E3,E4,E5,E6,E7
C DIMENSION Y1(12),Y2(12),Y3(12),Y(400),PSI(400)
C
C ALL COEFFICIENTS AND PARAMETERS ARE INPUTTED IN NEXT DATA STATEMENTS

C DATA AS1,A2,A3,ET1,ET2,ET3,ET4,ET5,ET6,ET7
C DATA C1,C2/C45,47,-204.76/
C DATA B1,B2,B3/B18.223,-21.777,
C DATA C1,C2/1.170903,1.778,-1.644,223.
C
C VALUE OF PSI ARE TO BE ASIGNED ON TERMINAL.
C
C 81 FORMAT ("GIVE PSI VALUE")
C 82 FORMAT (2F9.3)
C 83 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 84 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 85 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 86 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 87 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 88 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 89 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 90 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 91 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 92 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 93 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 94 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 95 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 96 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 97 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 98 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 99 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 100 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 101 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 102 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 103 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 104 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 105 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 106 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 107 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 108 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 109 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 110 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
C 111 FORMAT (1X,1H10,2X,1H10,1X,1H10,1X,1H10,1X,1H10,1X,1H10,1X)
100 WRITE(3,155) NUM
105 FORMAT(1X,'NUM OF POINT FOR PLOT IS':I1)
   PSI=PS1
101 FORMAT(2X,'INITIAL CONDITION TETA=0 DTETA/DT=0 FOR T=0')
117 /2X,'U1=NUM':F(5,1),2X,'PSI1=PS1':F(5,1)
110 WRITE(21,102)U1,NUM,PSI1
102 FORMAT(1X,'T':F(5,1),'TETA':F(5,1),'X':F(5,1))
119 WRITE(21,107)U1,TETA(T),X(T)
111 WRITE(21,108)
103 FORMAT(2X,0')
112 WRITE(21,109)NUM,NUM
104 FORMAT('/2X,'TETA'/2X,'Y=MOMENT'/2X,'T':F(5,1),F(5,1),F(5,1))
114 WRITE(21,107)TETA(T),Y10M(T),T(T)
116 WRITE(21,108)
C
100 CONTINUE
C
STOP
END

C--------------------
C THIS SUBROUTINE COMPUTES
C YH(1) - VALUE OF FUNCTION
C YH(2) - VALUE OF DERIVATIVE
C AT POINT X=XY
C
C IF K=0
C Y(1) - VALUE OF FUNCTION
C Y(2) - VALUE OF DERIVATIVE
C AT POINT x.
C
SUBROUTINE RK1ST(X,Y,B+XY+YH)
COMMON/HPS/ V,PSI
COMMON /DAT/ A1-A2,A3,C1,C2,B1,B2,B3,E1,E2,E3,E4,E5,E6,E7
DIMENSION Y(2),TH(2),Z(2),Z(2),S(2)
A(1)=0.588
A(2)=0.588
A(3)=0.588
A(4)=0.588
B=0
K=0
DO 1 X=1,3
1 YH(K)=Y(K)
S
K=K+1
Z(K)=W(K)
B=0.1
DO 2 K=1,2
2 C=EXP(W(I))
R1=ABS(W(K))
Z(K)=W(K)+R1
IF (ABS(W(K))>EP) GO TO 99
R2=A2*EXP(C2*P)/R1*Ai0
99 RETURN
END
APPENDIX C

SOURCE LISTINGS FOR BCAS DATA REDUCTION AND ANALYSIS

C-1 OPERATIONAL PROCEDURES

C-1.1 Procedure to Reduce Data Tapes

C-1.2 Procedure to Transfer Data Files from Prime to Scratch Tape (PDATA)

C-1.3 Procedure to Input Plot Data onto KL-10.

C-1.4 Procedure to Run Plot Program on KL-10

C-2 BCAS Program Source Listings

C-3 Program BCASPL

C-3.1 Initialization

C-3.2 Subroutine One

C-3.3 Subroutine Two

C-3.4 Subroutine Three

C-3.5 Subroutine Four

C-1
C-1.1 Procedure to Reduce BCAS Data Tapes and Generate Plot Files on Prime 55U

1. Mount Magnetic Tapes on Tape Unit 0

2. At User Terminal Type Underlined Sections:

3. Login Yutkins
   Name: Yutkins. Password: BCAS Account #: A1700B
   (Messages......)

4. OK, Assign MTO
   Device MTO Assigned

5. OK, SEG # BCAS
   BCAS Program
   (Source Program Listing, C-2.)

   Tape on unit (0/1)? 0
   Enter Tape Label - FT-4
   Do you Wish a Dump of the Tape? Yes
   Do you Want Data for Plots? Yes
   Enter Max. Number of Revolutions to Be Examined. 2
   Enter Any Comments (A40). Test Run

   100 Logical Records
   4 Physical Records
   Spool FT-4 - FTN: For Tape Dump Listing
   File DP-FT-4: Contains Means Plot Data
   File SS-FT-4: Contains Sliding Sum

6. OK, Spool FT-4 - FTN
   [Spool Rev 18.1]
   PRT01 Spooled, Records: 19, Name FT-4

7. Rewind and Remove Data Tape.

C-2
C-1.2 Procedure to Transfer Data Files From Prime to Scratch Tape (PDATA)

1 Mount Scratch Tape
   (System Utility Program)

2 OK, Magnet
   [Magnet Rev. 18,1]
   Option: Write
   MTU # = 0
   MT File # = 1
   Logical Record Size = 80
   Blocking Factor = 1
   ASCII, BCD, Binary, or EBCDIC? ASCII
   Input File: PD-FT-4
   Done... 102 Physical Records Output to Tape

3 OK, Magnet
   [Magnet Rev. 18,1]
   Option: Write
   MTU # = 0
   Mt. File # = 2
   Logical Record Size = 256
   Blocking Factor = 1
   ASCII, BCD, Binary, or EBCDIC? ASCII
   Input File: SS-FT-4
   Done... 1434 Physical Records Output to Tape

4 OK, Unassign MT0
   Device Released.
   OK,

5 Rewind and Remove Scratch Tape
6 OK, Logout

Yutkins Logged out at 15:27 082081

Time Used 0:11 0:34 0:10

OK,
C-1.3 Procedure to Input Plot Data Onto KL-10

1 Login


Request Queued
Waiting... Two C's to Exit
PDATA Mounted. MTA012 Used
(Load Means and Variances Data File to Disk)

3 R TAPIN (System Utility Program)

Input Device: PDATA
Code: ASCII
CRLF in Input? No
[Block Length 80 Bytes]
Logical Record Length: 80
Delete Sequence Numbers? No
Suppress Trailing Spaces? Yes

Output Device: DSK
Output Filename.Ext: FT4.DMN

[Copying.]
[End of File]
[Odd Parity is Set.]
[Block Number 103]

[102 Logical Records, 102 Blocks Read.]
[0 Soft Read Errors]
[0 Hard Read Errors]

More? N
Exit
(Loads Sliding Sum Data File to Disk).

4 R TAPIN

Input Device: PDATA
[Input Mag Tape Density: 800, Reel ID: PDATA]
Code: ASCII
CRLF in Input? No
[Block Length 256 Bytes]

Logical Record Length: 256
Delete Sequence Numbers: No
Suppress Trailing Spaces? Yes

Output Device: DSK
Output Filename.Ext: FT1.SUM

[Copying...]
[End of File]
[Odd Parity is Set]
[Block Number 1436]

[1434 Logical Records 1435 Block Read.]
[0 Soft Read Errors.]
[0 Hard Read Errors.]

More? No
Exit

Dismount PDATA: /R

PDATA Dismounted.
C-1.4 Procedure to Run Plot Program on KL-10

(At User Terminal Type in Underlined Sections.)

1 Log 3072, S41
   Name: YUTKINS  Password: BCAS

2 Mount MTA: 16 /Reelid: 2267/Vid: '2267 9-TRK
   800-BPI '/WL
   Request Queued
   Waiting... 2 C's to Exit
   16 Mounted, MTA012 Used

3 Run BCAS PL
   Enter Field Tape Number: FT4
   (See Program BCASPL Source Listings C-3.2-3.5)
   Plotting Commencing
   End of DISSPLA 8.2 - 118997 Vectors Generated in 8
   Plot Frames.
   End of Execution
   CPU Time: 1:21:98
   Exit

4 Rewind 16:

5 Dismount 16:/R
   MTA012 Dismounted

6 K/N         (Logout)

7 Submit, Plot to DEC-10 I/O Window for Actual Plotting
   on Calcomp.
C-2 PROGRAM BCAS

* WRITTEN BY: RICHARD YUTKINS
* SYSTEM DEVELOPMENT CORP. MAY 15, 1981

SINSERT COMBLK
WRITE(1,1000)
1000 FORMAT('BCAS PROGRAM WORKING...')
CALL INITIAL
CALL CONTAB
10 CALL R7REC
   IF(C0F) CALL DONE
   CALL GORPCN
   CALL PROREC
   GO TO 10
END
**LABELED COMMON BLOCKS**

- **COMMON/PODATA**/IA*(64,32),LREC,PREC,AUX,IA(25),PAIXREC,NUMREC
  - **IA** - ARRAY CONTAINING CONVERTED AND FORMATTED DATA
  - **PRF** - PHYSICAL RECORD COUNTER
  - **LREC** - LOGICAL RECORD COUNTER
  - **PAIXREC** - MAXIMUM NUMBER OF REVOLUTIONS TO BE PROCESSED
  - **NUMREC** - NUMBER OF REVOLUTIONS COUNTED
  - **AUX** - OPTIONAL OUTPUT ARRAY
  - **NAUX** - NUMBER OF AUX ELEMENT USED

- **COMMON/TABLE**/TAB(0:255)
  - **TAB** - CONTAINS REVERSEBIT LOOKUP TABLE

- **COMMON/RORE**/CNFREC(RNUM,WSPC,WIR,ACP,CPMAX,CPMIN,CPM)
  - **CNFREC** - SINGLE LOGICAL RECORD ARRAY - CONTAINING THE FOLLOWING VARIABLES
  - **CP** - CLOCK PERIOD COUNT ARRAY
  - **RNUM** - CONSECUTIVE LOGICAL RECORD NUMBER
  - **WIR** - WIND DIRECTION
  - **WSP** - WIND SPEED (MPH)
  - **ACP** - ACP COUNT SINCE LAST ARP
  - **CPMAX** - MAXIMUM CLOCK Period PER LOGICAL RECORD
  - **CPMIN** - MINIMUM CLOCK Period PER LOGICAL RECORD
  - **CPM** - CLOCK PERIOD MEANS
**COMMON/PRINT/FRSTL*LFLAG*LOPT*EOF*RECYCL*FFLAG*HFLAG**

**DFLAG = LOGICAL OPTIONAL DUMP *TRUE.**
**FIRSTR = FIRST RECORD FLAG**

**HFLAG = LOGICAL TOP OF PAGE HEADING FLAG**
**RECYCL = LOGICAL FLG TRUE=ACP COUNT RECYCLED**
**FALSE=SAME REVOLUTION**
**LOPT = LOGICAL FLG TRUE=CALL TO SUB OPTICA**
**PFLAG = LOGICAL FLG TRUE=CALLS SUB PLTCHP**
**EOF = END-OF-FILE FLAG**

**COMMON/TAPE/TAPEID*COMMENT**
**TAPEID = TAPE ID SUPPLIED BY USER**
**COMMENT = 40 CHARACTERS CONTAINING USERS TAPE COMMENTS**

**COMMON/VARLIB/DAOCP*PRINTL**
**COMMON/BUFR1024**

**BUFF: ONE PHYSICAL UNFORMATTED RECORD**
**INTEGER=2 BUFFER(132*32)**
**INTEGER=2 PREC,MAXREV,NUMREV,LREC**
**INTEGER=2 NDREC,CP(24)**
**INTEGER=2 NAUX**
**INTEGER=2 NNUM,LSPO,LDIR,ACP,CPMAX,CPMIN,CPF,AUX**
**INTEGER=2 PRINTL**
**INTEGER=2 GACP**
**INTEGER=2 BUFR,TAPE=UNIT**
**REAL XCPN**
**CHARACTER=40 COMMENT**
**CHARACTER=15 TAPEID**

**EQUIVALENCE (NDREC,CP(1))**
**EQUIVALENCE (BUFF(11),BUFFER(11))**

**LOGICAL EDF,FRSTL*LOPT*LFLAG*RECYCL*PFLAG*HFLAG**
SUBROUTINE CONTAB

AO LIST
SINSEAT COMBK
LIST

FUNCTION: CREATE LOOKUP TABLE FOR REVERSED BYTE CONVERSION

INPUTS: COMMON BLOCK
OUTPUTS: COMMON BLOCK
CALLED FROM: MAIN
CALLS TO: ACME

C ROUTINE TO CREATE Lookup TABLE FOR REVERSE BIT CONVERSIONS
INTEGER=P+8+11+10
C
DATA PW/7,6,5,4,3,2,1,0/
GO 20 I=0,299
NUM=I
DO 10 J=1,2
10 IF(J.LT.0) G0 10
TAB(I)=TAB(I)+2**P(J)
CONTINUE
20 CONTINUE
C WRITE(1,2000)
C2000 FORMATE(3X,*LOOK-UP TABLE COMPLETED**/)
RETURN
END

C-11
SUBROUTINE RDREC

NO LIST
SIASSERT COMPLX
LIST

INTEGER#2 ALT

AL=1024
ASSIGN 75 TO ALT

CALL ISRMOS(0,BUFF,ALT)
CALL READA

PRECPREC=1
EOF=.FALSE.

C WRITE(1,33) BUFF
C 33 FORMAT(12R/,'B(16,3X)')
RETURN

END-OF-FILE

75 CONTINUE

EOF=.TRUE.
WRITE(1,2001)
2001 FORMAT(73X,'END-OF-FILE',/)
RETURN

END

SUBROUTINE CONFOR

NO LIST
SIASSERT COMPLX
LIST

FUNCTION: ROUTINE TO CONVERT REVERSED BIT TO FORMATTED ARRAY

INPUTS: COMMON BLOCK

OUTPUTS: COMMON BLOCK

CALLED FROM: MAIN
**FUNCTION: SETS UP SINGLE RECORD ARRAY OPTION DUMP**
*CALCULATE MEANS AND FIND MAX. AND MIN.*
*CP VALUES PER LOGICAL RECORD*

*INPUTS:* COMMON BLOCKS
*OUTPUTS:* COMMON BLOCKS
*CALLED FROM:* MAIN
*CALLS TO:* OPTIONAL DUMP
CALC ROUTINE OPTIONAL CALCULATION ROUTINE

*INTEGER=2 MLT(3) IACP IRNM*

LOGICAL LAST,EOR
DATA MUL/100,1.1/^

*** I= LOGICAL RECORD COUNTER INDEX
*** DO 50 I=1,32
    CP*AX=0
    CP*MIN=9999
    CPN=0
    LRFC=LREC+1
    XCPM=0.0
*** J= BYTE COUNTER
*** DO 10 J=1,64
    GNEREC(J)=IA(J, I)
*** CALCULATE MEANS, FIND MIN, MAX, CP VALUES
*** IF(J GT 54) GO TO 10
    CPMAX=M(54) =GNEREC(J) ,CPMAX)
    CP*MIN=M(54) =GNEREC(J) ,CP*MIN)
    XCPM=XCPM+GNEREC(J)
10 CONTINUE
*** CPM=(XCPM/54).0)+0.5
WSPC=0
WDIR=0
CALCULATE WIND SPEED AND DIRECTION

00 20 K=1
    WDIR=WDIR+(ONEREC(56)+K)*MULT(K))
    WSPD=WSPD+(ONEREC(59)+K)*MULT(K))
20 CONTINUE

FIND CONSECUTIVE RUN #

IRRH=IRRH+(ONEREC(55)+8)
RUNOR=(IRRH+ONEREC(56))

ACP COUNT SINCE LAST ARP

IAACP=IAACP+(ONEREC(63)+8)
ACP=ACP+(IAACP+ONEREC(64))

INITIALIZE CACP ON FIRST RECORD

CACP = PREVIOUS ACP VALUE

IF (.NOT. FIRSTR) GO TO 25
    FIRSTR=.FALSE.
    CACP=9999
25 CONTINUE

CHECK FOR ACP RECYCLE

SET HFLAG

IF (ACP*GE.ACP) HFLAG=.TRUE.
RECYCLE=.TRUE.

INCREMENT NMREV FOR EACH ACP RESTART

SET LASTR TO TRUE WHEN NMREV EQUALS MAX REV

EOR=.FALSE.
    LASTR=.FALSE.
    IF (.NOT. RECYCLE) GO TO 30
    EOR=.TRUE.
    NMREV+NMREV=1
    IF (NMREV*GT.MAXREV) LASTR=.TRUE.
30 CONTINUE

CALL OPTION
40 CONTINUE
    IF (LASTR) GO TO 42

SET UP PRINTL LINE
*PRINTL(1)=#NUM
PRINTL(2)=#DIR
PRINTL(3)=#SPO
PRINTL(4)=ACP
PRINTL(5)=ACPM
PRINTL(6)=CPMAX
PRINTL(7)=CPFIN

*** CHECK DUMP FLAG
   IF(.NOT.OFLAG) GO TO 42
   CALL DUMP
   42 CONTINUE

*** CHECK PLOT DUMP FLAG
   IF(.NOT.PFLAG) GO TO 46
   IF(.NOT.COR.OR.NUMREV.EQ.1) GO TO 45
   NFLAG=.FALSE.
   CALL PLTOMP
   NFLAG=.TRUE.
   45 CONTINUE
   IF(LASTR) NFLAG=.FALSE.
   CALL PLTOMP
   46 CONTINUE

*** SET OACP EQUAL TO ACP
   OACP=ACP

*** IF LASTR TRUE THEN ALL DONE
   IF(LASTR) CALL DONE

   50 CONTINUE

*** RETURN
   RETURN

END

*****************************************************************************

SUBROUTINE DUMP

NO LIST
SINERT CORBLK LIST

*****************************************************************************

FUNCTIONS: PRINT A SINGLE FORMATTED RECORD
* INPUTS: COMMON BLOCK
* OUTPUTS: LPT
* CALLED FROM: PRREC
* CALLED TO: ACNC

*** CHECK HEADING FLAG ***
IF(.NOT.,HFLAG) GO TO 20
WRITE(10,2000) TAPI,NUMREV,COMMENT
20 CONTINUE
WRITE(10,2001) (PRINTL(I),I=1,7)

*** FORMATS ***
2000 FORMAT(/,13L10/*20X"TAPE ID: "A15,
A/*20X"REVOLUTION NUMBER "I7,/s20x.40,
S/*10X"RECORD",6X"WIND",6X"VIND",
16X"AC",7X"CLOCK PERIOD COUNT",
A18X"NUMBER",4X"DIRECTION",1X"SPEED",
25X"COUNT",10DEGREES",1X",1X"(MPH)",
315X"MEANS",3X"(MAX.",4X"(MIN.")/
2001 FORMAT(10X,16.5X,13.8X,13.(5X,15))
***RETURN***
RETURN
END

SUBROUTINE INITIAL
NO LIST
INSERT COMBK LIST

FUNCTION: INITIALIZE COUNTERS OPEN TAPE UNIT
* INPUTS: COMMON BLOCKS
* OUTPUTS: COMMON BLOCKS
* CALLED FROM: MAIN

C-17
CALLS TO: NCME

*------------------------------------------------------------------------*
* SET RECORD COUNTERS TO ZERO
*------------------------------------------------------------------------*
INTEGER*2 ALT
CHARACTER*12 FRAME,PFIL,SPIL
CHARACTER*16 FILE
LOGICAL*4 FILE

*** SET RECORD COUNTERS TO ZERO
***
LPEC=0
PREC=0
AUX=0
MAXREV=0
NUMREV=0

   GO 2 II=1,13
   AUX(II)=0
  2 CONTINUE

*** SET FLAG DEFAULTS
***
CFLAG=.TRUE.
LOPT=.TRUE.
FIRSTR=.TRUE.
PFLAG=.TRUE.

*** OPEN R78
C    CALL CMS5(1,0,0,0,0)
     CALL INIT

*** REWIND TAPE DRIVE
***
IDRIVE=IUNIT+21

*** ENTER TAPE LABEL
***
   CONTINUE
   WRITE(1,2003)
2003 FORMAT(///,A10,*,A10,*)
READ(1,1000) TAPI

   FNAME=TAPI
   PFIL=*0_//FNAME(1:12)
   SPIL=*55_//FNAME(1:12)

*** REQUEST TAPE DUPP REPLY
   WRITE(1,200)

C-18
READ(1,100) IRELY
* IF(IRELY.EQ.1) GO TO 10
   OFLAG=.FALSE.
   GO TO 15
10 CONTINUE
*** CHECK IF DATA DUMP FILE NAME ALREADY EXIST
*   INQUIRE(FILE=FILENAME,EXIST=FILEF)
*   IF(FILEF) GO TO 70
*** OPEN DISK OUTPUT FILE
*   CPEN(15,FILE=FILENAME,STATUS="NEW",ACCESS="SEQUENTIAL",
       ARECL=132,ER=75)
*** REQUEST PLOT DATA DUMP
*  19 CONTINUE
*   WRITE(1,201)
   READ(1,100) JREPLY
*   IF(JREPLY.EQ.1) GO TO 20
   PFLAG=.FALSE.
   GO TO 25
20 CONTINUE
***** CHECK IF PLOT DATA FILENAME ALREADY EXIST
*   INQUIRE(FILE=FILENAME,EXIST=FILEF)
*   IF(FILEF) GO TO 70
*** OPEN DISK FILE FOR PLOT DATA OUTPUT
*   CPEN(11,FILE=FILENAME,STATUS="NEW",ACCESS="SEQUENTIAL",
       ARECL=256,ER=75)
***** CHECK IF SLICE_SUM DATA FILENAME ALREADY EXIST
*   INQUIRE(FILE=FILENAME,EXIST=FILEF)
*   IF(FILEF) GO TO 70
*** OPEN DISK FILE FOR SLIDING SUM DATA
*   CPEN(13,FILE=FILENAME,STATUS="NEW",ACCESS="SEQUENTIAL",
       ARECL=80,ER=75)

C-19
25 CONTINUE

*** ENTER MAX. NUMBER OF RECORDS TO BE PROCESSED

WRITE(1, 2004)
READ(1, 102) MAXREV

*** ENTER ANY COMMENTS

WRITE(1, 2005)
READ(1, 103) COMMENT

*** RETURN

RETURN

*** ERROR IN OPEN

70 CONTINUE

WRITE(1, 2006) FNAME
GO TO 5

75 CONTINUE

PRINT 1001

RETURN

100 FORMAT(A1)
102 FORMAT(I4)
103 FORMAT(A40)
200 FORMAT(/93X,*DO YOU WISH A DUMP OF THE TAPE *)
201 FORMAT(/93X,*DO YOU WANT DATA FOR PLOTS *)
1000 FORMAT(A15)
1001 FORMAT(/93X,*ERROR IN OPENING FILE*)/
2044 FORMAT(/93X,*ENTER MAX NUMBER OF REVOLUTIONS TO BE EXAMINED *)
2006 FORMAT(/93X,*FILE *,A15,* ALREADY EXIST*)

END

******************************************************************************

******************************************************************************

SUBROUTINE OCNE

NO LIST
SINERAT COMBL
******************************************************************************

LIST

FUNCTION: TERMINATE PAIN
INPUTS: COMMON BLOCKS

OUTPUTS: TTY

CALLED FROM: MAIN

CALLS TO: NONE

* *
WRITE(1,1000) LREC,PREC
UNIT=UNIT-21
REWIND UNIT
* *
IF(.NOT.GFLAG) GO TO 25
WRITE(1,2000) TAPID
CLOSE(UNIT=10)
* *
25 CONTINUE
IF(.NOT.PFLAG) GC TO 50
WRITE(1,2001) TAPID,TAPID
CLOSE(UNIT=11)
CLOSE(WAIT=13)
* *
90 CONTINUE
CALL EXIT
* *
SUBROUTINE PLTOMP
* *
NO LIST
SINSEIT COMBLX
LIST
* *
FUNCTION: OPTIONAL CALL DUMPS DATA INTO DISK FILE LOGICAL #11
* *
INPUTS: COMMON BLOCKS
* *
OUTPUTS: DISK FILE LOGICAL #11
* *
CALLED FROM: PROREC
* *
CALLS TO: NONE
* *
ICYCLE=1111

IF MFLAG TRUE WRITE HEADER INFO

IF (NOT MFLAG) GC TO 10
WRITE(11,2000) NUPREV,TAPID,COMMENT
RETURN

IF RECYLE TRUE WRITE END-OF-CYCLE DATA

10 CONTINUE

IF (NOT.ACCYLE) GO TO 20
WRITE(11,2001) ICYCLE,*AUX(KK),KK=1,NAUX)
RETURN

WRITE DATA RECORD

20 CONTINUE
WRITE(11,2001) PRINTL(JI),JI=1,7),*AUX(LJ),LJ=1,NAUX)
RETURN

FORMATS

2000 FORMAT(1X,17,A15,A40)
2001 FORMAT(20(I1,17))

END
G-3 PROGRAM DISPLAY

* WRITTEN BY: RICHARD TUTTINS
* SENEH DEVELOPMENT CORP. MAY 15, 1981

G-3.1 INITIALISE PLOTTING

CALL SUBR('16', 'CALCNP')

OPEN DATA FILES
CALL FLOP

READ IN COMMON BLOCK VARIABLE
CALL RECON

READ DATA FILS PLOTTING ARRAY AND CALL PLOT ROUTINE
CALL CALP
CALL BSHASL

CLOSE DEVICES
CALL DGHFPL
CLOSE(UNIT=20)
CLOSE(UNIT=21)
RETURN 16
CALL EXIT

SUBROUTINE FLOP

FUNCTION: USER INPUT FILE TAPE NUMER ROUTINE
OPEN CORRESPONDING DATA FILES.

INPUTS: TTY

OUTPUTS: TTY

CALLED FROM: MAIN

CALLS TO: NONE

DOUBLE PRECISION SPIL, SPILE

G-23
INTEGER FILE1(2), FILE2(2)

EQUIVALENCE (FILE1(1), IHN)
EQUIVALENCE (FILE2(1), IHN)
EQUIVALENCE (FILE1(1), FILE2)
EQUIVALENCE (FILE2(1), FILE2)

DATA FILE1/5N , SH , CHN/  
DATA FILE2/5N , SH , SHK/ 

5 CONTINUE

*** ACCEPT FIELD TAPE NUMBER

TYPE 200
ACCEPT 100, IHN
IHN=IHN

*** OPEN READ DATA FILE UNIT 0 20

OPEN (UNIT=20, DEVICE='DSK', ACCESS='SEQIN', FILE=FILE1,  
RECORDSIZE=256, IHN=90)

*** OPEN READING SUB DATA FILE UNIT 0 21

OPEN (UNIT=21, DEVICE='DSK', ACCESS='SEQIN', FILE=FILE2,  
RECORDSIZE=60, IHN=90)

RETURN

90 CONTINUE

*** ERROR IN OPEN

TYPE 201, IHN
GO TO 5

*** FORMATS ***

100 FORMAT (A5)
200 FORMAT (/, A5, 'ENTER FIELD TAPE NUMBER ', C)
201 FORMAT (/, A5, 'TAPE NUMBER ', A5, ' NOT FOUND')

END
C-3.2 SUBROUTINE PLOTE

INCLUDE 'COBJL/SCLIST'

FUNCTION: PLOT THE MEAN, MAX, AND MIN CLOCK PERIOD COUNTS
ALONG WITH WIND SPEED AND WIND DIRECTION

INPUTS: COMMON BLOCK

OUTPUTS: PLOTE

CALLED FROM: RESULT

CALLS TO: NONE

INTEGER ENTRY(10)

INITIALIZE LEVEL 10

CALL PLOT1(EPLOT)

SET LETTERING STYLES

CALL TRIPLEX
CALL BESSEL('STAND')
CALL BESSEL('L/CST')

SET PAGE SIZE TO 11. BY 8.5 AND PLOT AREA TO 8.0 BY 5.5

CALL PLOT5(2.75,1.0)
CALL PLOT5(19.,0.5)
CALL TITLE(0.,0.,100.,0.0,0,0.5)

SET EXTRA TICKS PER STEP ON X-AXIS INCREASING ALL Y-AXIS
 Horizontally HORIZONTAL

CALL TICKS(5)
CALL Ticks(5)
CALL TITLE(0.0)
CALL INTAX

SET GRACE MARGINS TO 0.0 AND SET SCALING PARAMETERS

CALL GRACE(0.0)
CALL GRAP(LRSV,LSTP,LREV,CPSV,CPSV,CPSV)

DRAW A GRID LINE EVERY OTHER STEP IN THE X DIRECTION
CALL GRID(-2,0)

CHANGE TO DOTTED LINE MODE. DRAW GRID LINE EVERY STEP IN X DIR.
CALL DOT
CALL GRID(1,0)
CALL RESET('DOT')

SET Y-AXIS SCALE FOR ACP CURVE PLOTS
CALL TGRAIS(CPSV,CPSV,CPSV,5.5,CPSLAB,100,0,0,0,0)

DRAW HEAD OF REVOLUTION LINE
CALL ELVNC(0,MEAN,75.0,MEAN,0)

SET HEIGHT OF CURVE HANKERS
CALL HEIGHT(0.67)

PLOT CURVE CPMAX,CPMIN
CALL CURVE(LS,CPMAX,NPT,5)
CALL CURVE(LS,CPMAX,NPT,5)

PLOT POINTS HIND SPEED

CHANGE LINE MODE
CALL CHDOT

CALL CURVE(LS,USPD,NPT,25)

PLOT HIND DIRECTION CURVE

CHANGE LINE MODE
CALL CHDOT
CALL CURVE(LR,HRIR,NPT,25)

RESET HEIGHT
CALL RESET('HEIGHT')

SHIFT X-ORIGIN BACK 1.5 INCHES TO DRAW SECONDARY Y-AXIS FOR HIND SPEED
CALL BSHIFT(-0.0,0.0)

SAVE TICK MARKS EVERY 3 STEP
CALL NTICKS(5)

SET NEW X-AXIS SCALING FOR WIND SPEED
CALL TURBS(VNSV,USTEP,USRV,5.5,USRLAB,100.0,0.0,0.0)

SHIFT X-AXIS BACK TO -2.0 INCHES FOR WIND DIRECTION AXIS
CALL BSHIFT(-1.6,0.0)

SET NEW X-AXIS SCALING FOR WIND DIRECTION
CALL TURBS(VNSV,USTEP,USRV,5.5,USRLAB,100.0,0.0,0.0)

PACK LINES FOR LEGEND
J=LINDEX(IPERAY,40,10)
IF(J.LE.5) TYPE 22, J
FORMAT (* LEGEND THICK J= ',I4)

PACK LINES
CALL LINES('HEATS CP5',IPERAY,1)
CALL LINES('WIND CP5',IPERAY,2)
CALL LINES('WIND CP5',IPERAY,3)
CALL LINES('WIND SPDS',IPERAY,4)
CALL LINES('WIND RND',IPERAY,5)

FIND HEIGHT AND WIDTH OF LEGEND AREA
IXHT=INDEX(IPERAY,9)
IWID=INDEX(IPERAY,5)

FIND COORDINATES OF LEGEND
ILC=0.0=I,6-IXHT
ILC=0.5=IXID-5

DRAW LEGEND
CALL LEGEND(IPERAY,5,ILC,6,0)

DRAW LEGENDS
CALL BENSAG(1510,100.0,0.0,7,0)
CALL BENSAG(1520,100.0,0.0,6,5)
CALL BENSAG(1530,100.0,0.0,6,0)
C-3.3 SUBROUTINE PLTRUC

INCLUDE 'CORE/HCLASS'

FUNCTION: PLOT VARIANCE AND MEAN OF REVOLUTION

INPUTS: COMMON BLOCK

OUTPUTS: PLOTTER

CALLED FROM: BLFMT

CALLS TO: NONE

**************************************************************************
INTEGER IMEMRT(40)

****** INITIALIZE LEVEL ONE

CALL MEMRT(UFLOT)

****** SET LETTERING STYLE

CALL TRIPAX
CALL BABELF('STAND')
CALL BIZALF('NL/CST')

****** SET PAGE SIZE TO 11. BY 8.5 AND PLOT AREA TO 8.0 BY 5.5

CALL PHYSIG(2.75, 1.0)
CALL PAGE(11.0, 8.5)
CALL TITLE(0.0, 0.0, 'Y'ALAB, 100, 0.0, 0.0, 5.5)

****** SET EXTRA TICKS PER STEP ON X-AXIS INTEGERIZE ALL X-AXIS

SUPPORT HORIZONTAL

CALL EICKS(5)
CALL TICKS(5)
CALL YMARK(0.0)
CALL INTAX

****** SET GRACE BARGEN TO 0.0 AND SET SCALING PARAMETERS

CALL GRACE(0.0)
CALL GRAP(LSET, LSTP, LREV, VARV, VARST, VARV)

****** DRAW A GRID LINE EVERY OTHER STEP IN THE X DIRECTION

C-28
CALL GRID(-2.0)

CHANGE TO DOTTED LINE MODE. DRAW GRID LINE EVERY STEP IN X DIR.

CALL DOT
CALL GRID(-1.0)
CALL RESET('DOT')

SET Y-AXIS SCALE FOR MCP COUNT PLOTS
CALL TGREAT(VARY,VARSET,VARAY,5.5,VARLAB,100.0,0.0,0.0)
DRAW HEART OF EVOLUTION LINE
CALL ELVEC(0.,REARD,75.0,REARD,0)

SET HEIGHT OF CURVE BANDERS
CALL HEIGHT(0.07)

PLOT VARIANCE
CALL CURVE(LB,VAR,NPT,1)

RESET HEIGHT
CALL RESET('HEIGHT')

DRAW RESIDUES
CALL RESSIG(RESS1,100.0,0.0,7.0)
CALL RESSIG(RESS2,100.0,0.0,6.5)
CALL RESSIG(RESS3,100.0,0.0,6.0)

END-OF-PLOT

RETURN
CALL ERPL(0)
RETURN

END

C-3.4 SUBROUTINE FLIII

INCLUDE 'COREL/FLIST'

FUNCTION: DERIVE DEVIATION FROM THE NOMINAL
SUN CLOCK PULSE NUMBER FROM 1 TO 4096

C-29
INPUTS: COMMON BLOCK

OUTPUTS: PLOTTER

CALLED FROM: BEARLY

CALLS TO: NONE

INITIALISE GLOBAL CHE

CALL BIGNFL(INPUT)

SET LAYOUT STYLE

CALL TRIPLE
CALL BEARLY('STAND')
CALL BEARLY('L/CUT')

SET PAGE SIZE TO 11. BY 8.5 AND PLOT AREA TO 8.0 BY 5.5

CALL PLOT (2.75, 3.0)
CALL PLOT (1.0, 0.5)
CALL TITLE(10.0, 0.0, 100, 0.0, 0.0, 5.5)

SET EXTRA TICKS PER STEP ON X-AXIS INTEGRATE ALL Y-AXIS

NUMBERING HORIZONTAL

CALL TICKS (S)
CALL TICKS (S)
CALL TICKS (0.0)
CALL TICKS (S)

SET GRACE MARGINS TO 0.0 AND SET SCALING PARAMETERS

CALL GRACE (0.0)
CALL GRAP (L1S, L1STP, L1SY, SC1PS, SC1PT, SC1PV)

DRAW A GRID LINE EVERY OTHER STEP IN THE X DIRECTION

CALL GRID (-2.0)

CHANGE TO DOTTED LINE SCOL. DRAW GRID LINE EVERY STEEP IN X DIRE.

CALL DOT
CALL GRID (1.0)
CALL RESUT('DOT')

SET Y-AXIS SCALE FOR 40 COUNT PLOTS
CALL IGSIS (SCFST, SCFST2, SCFST3, 5, 5, SCFST4, 100, 0, 0, 0, 0)
SET NORMAL LINES OF REVOLUTION CURVE

CALL CURVE (LS, SCFST, NPT, 0)
SET HEIGHT OF CURVE HANNESE
CALL HEIGHT (0.01)

PLOT SUB OF THE CLOCK PULSES
CALL CURVE (LS, SCFST, NPT, -1)
RESET HEIGHT
CALL RESET ('HEIGHT')

DRAW RESARCH
CALL RCESS (RCESS, 100, 0, 0, 0, 0, 0, 0, 0, 0, 0)
CALL RCESS (RCESS2, 100, 0, 0, 0, 0, 0, 0, 0, 0, 0)
CALL RCESS (RCESS3, 100, 0, 0, 0, 0, 0, 0, 0, 0, 0)

END-OF-PLOT
RETURN

CALL DSSPL (0)
RETURN

C-3.5

SUBROUTINE PLOT

INCLUDE ' COMMON/CLIST'

FUNCTION: PLOTS SLIDING SUN DATA GROUPS VS ACQ NUMBER
INPUTS: COMMON BLOCK
OUTPUTS: PLOTTER
CALLED FROM: RESRAL
CALLS TO: FOUR

INITIALIZE DSSPL (200)

INITIALIZE LEVEL CHE
CALL DSSPL (HPLOT)

C-31
SET LETTERING STYLE

CALL TRIPLE
CALL BASELF("STAND")
CALL HIALF("L/CST")

SET PAGE SIZE TO 11. BY 8.5 AND PLOT AREA TO 8.0 BY 5.5

CALL PHYSOR(2.75,1.0)
CALL PAGOR(11.,8.5)
CALL TITLE(6.,0.,ACPLAB,100.,0.,0.0,5.5)

SET EXTRA TICKS PER STEP ON X-AXES INTERSECT ALL Y-AXES
HORIZONTAL

CALL TICKS(0)
CALL TICKS(5)
CALL YAXES(0,0)
CALL INTAX

SET GRACE RANGE TO 0.0 AND SET SCALING PARAMETERS

CALL GRACE(0,0)
CALL GRAP(ACPSV,ACPSTV,ACPSTV,ACPSY,ACPSY,ACPSY,ACPSY)

DRAW A GRID LINE EVERY OTHER STEP IN THE X DIRECTION

CALL GRID(-2.0)

CHANGE TO DOTTED LINE RATE. DRAW GRID LINE EVERY STEP IN X DIR.

CALL DOT
CALL GRID(1.0)
CALL RESIT("DOT")

SET Y-AXIS SCALE FOR ACX COUNT PLOTS

CALL YBASE(ACPSV,ACPSY,ACPSY,ACPSY,5.5,SCPLAB,100.,0.,0.,0.,0.)

CLEAR INPUT AND FIND NUMBER OF LINES

J=LINES (EXPERY,200.,25)
IF (J.LT.6) TYPE 22, J
22 FORMAT ("LENGTH ERROR J = ",I4)

DRAW CURVES

DO 33 K=1,6

INDEX=INTS(K)/4

33 CONTINUE

SET HEIGHT OF CURVE MARKERS
CALL HEIGHT (0.07)

PLOT GROUP SBS
CALL STEP

CALL CURVE(NACP (1,K), CSC(1,K), OPTS (E), XMARK)
RESET HEIGHT
CALL HEIGHT (0.10)

FACE LINES IN LEGEND
CALL LINES(SGROUP (1,K), IPERAY, 5E)
CONTINUE

PLOT MAX. AND MIN. POINTS AND
INCREASE MARKER SIZE
CALL HEIGHT (0.10)

CALL CURVE(MAX, MIN, 6, -1)
CALL CURVE(MIN, MIN, 6, -1)
RESET HEIGHT
CALL RESET('HEIGHT')
CALL HEIGHT (0.10)

FACE LEGEND INTO MAX AND MIN
CALL LINES('MAXIMUM VALUES', IPERAY, 7)
CALL LINES('MINIMUM VALUES', IPERAY, 8)

CALL RESET('HEIGHT')

FIND HEIGHT AND WIDTH OF LEGEND AREA
EXPI=EXLEGED(IPERAY, 6)
EXPI=EXLEGED(IPERAY, 6)

FIND COORDINATES OF LEGEND
EXC=6.0-EXI
EXC=6.5-EXO

DRAW LEGEND
CALL LEGEND(IPERAY, 5, EXC, 6.0)
DRAW TAPE 10, INVT 0 CONVTPSEX

CALL RESLIB (RES1, 100, 0, 0, 7.0)
CALL RESLIB (RES2, 100, 0, 0, 6.5)
CALL RESLIB (RES3, 100, 0, 0, 6.0)

END-OP-NLOT
RETURN
CALL ENDF1 (0)
RETURN
END