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Final Report

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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 objective of this report.
A Traffic Alert and Collision Avoidance System Signal Environment Model (TCAS SEM) was developed to predict the time-average TCAS I and minimum TCAS II signal rates in a user-selected air traffic deployment. This document describes the TCAS SEM. Included are descriptions of the modeled systems, the data-storage and retrieval subsystems for engineering data, and the software structures of all component subsystems.
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To the extent possible, all abbreviations and symbols used in this report are taken from American Standards Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

During the past several years, the Electromagnetic Compatibility Analysis Center (ECAC) has supported the Federal Aviation Administration (FAA) by predicting the effects of various airborne Collision Avoidance Systems (CAS) on the existing FAA Air Traffic Control Radar Beacon System (ATCRBS) and the planned Mode S system.\(^1,2\) In FY-81, ECAC investigated the effects of an omnidirectional version of the Traffic Alert and Collision Avoidance System (TCAS) on ATCRBS and Mode S system performance in a hypothetical Los Angeles Basin air traffic deployment and in subsets of that deployment.\(^3,4\) For those air traffic deployments, it was predicted that TCAS activity would not degrade ATCRBS or Mode S ATC system performance; however, interference-limiting constraints resulted in undesired reductions in the protection volume of TCAS-equipped aircraft that were operating in densely populated airspace.

To maximize the protection area for TCAS-equipped aircraft operating in future high-density environments, the FAA proposed a new TCAS design. This design includes a directional, scanning antenna, improved Mode S tracking algorithms, a modified whisper-shout sequence (to maintain surveillance of


ATCRBS-equipped aircraft), and associated revisions to the interference limiting algorithm. The design was chosen to reduce the extent of interference limiting and thus allow TCAS-equipped aircraft to successfully perform the collision avoidance function in even the most congested airspace and also to reduce the potential for interference with ground-based ATC systems.

Three versions of TCAS have been proposed: Enhanced TCAS II, Minimum TCAS II (TCAS II M), and TCAS I. Enhanced TCAS is still in the design phase, and as such, is not addressed in this study. TCAS II M is capable of omnidirectional Mode S surveillance and limited directional ATCRBS surveillance. TCAS II M-equipped aircraft track nearby ATCRBS transponder-equipped aircraft by periodically eliciting replies using an ATCRBS-only interrogation format; nearby Mode S transponder-equipped aircraft are tracked by periodically eliciting replies using a Mode S interrogation format. The TCAS II M is designed for use in commercial aircraft. TCAS I, a less expensive version of TCAS, locates nearby aircraft, both ATCRBS- and Mode S-equipped, by periodically eliciting replies using an ATCRBS interrogation format. The TCAS I is designed for use in general aviation aircraft.

To investigate the effects of TCAS I and TCAS II M operations on ATCRBS and Mode S ATC performance, ECAC was requested to perform a simulation analysis, similar to the FY-81 Los Angeles Basin study. This analysis was performed using the TCAS Signal Environment Model (SEM). This model is used to predict the time-average rates at which TCAS signals are received at ATC transponders in a given deployment. These rates are then used in the

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DABS/ATCRBS/AIMS\textsuperscript{a} Performance Prediction Model (PPM)\textsuperscript{7} to merge the TCAS signal environment with signals due to ground-based ATC systems. The DABS/ATCRBS/AIMS PPM then predicts the performance of a selected interrogator-of-interest in the composite ATC and TCAS signal environment.

This document describes the TCAS SEM. Included are descriptions of the modeled systems, the data-storage and retrieval subsystems for engineering data, and the software structures of all equipment subsystems. The results of the FY83/84 TCAS SEM simulation exercise using Los Angeles Basin air traffic deployments are presented in the document cited in Reference 6.

1.2 OBJECTIVE

The objective of this effort was to document the TCAS Signal Environment Model (SEM) that was developed to predict time-averaged TCAS I and TCAS II M signal rates in a given air traffic deployment.

1.3 APPROACH

1.3.1 Design Rationale

The TCAS SEM was developed to be used in conjunction with the DABS/ATCRBS/AIMS PPM to predict the performance of ATCRBS and Mode S ATC systems in an environment including both TCAS and ATC system surveillance activity. The TCAS SEM simulates TCAS surveillance operation and predicts the time-averaged rates at which TCAS signals are received at all environmental ATC transponders. These rates are then accessed by the DABS/ATCRBS/AIMS PPM during a simulation exercise, and merged statistically, using Monte Carlo techniques, with the deterministically produced signal environment associated

\textsuperscript{a}The Discrete Address Beacon System (DABS) was renamed Mode S after the completion of the DABS/ATCRBS/AIMS PPM.

with ground-based ATC and surveillance operations. The DABS/ATCRBS/AIMS-PPM then predicts the performance of a user-selected interrogator-of-interest \( I_o \) in the composite ATC and TCAS signal environment.

This method of statistically merging the TCAS signal environment with the ATC environment is permissible since the time variations in TCAS signal activity are relatively small in comparison to variations in ground-based ATC signal activity. Specifically, ground-based ATC systems employ highly directional scanning antennas; consequently, there are periods when an aircraft is not within the mainbeam of a single interrogator, and periods when the same aircraft is simultaneously within the mainbeams of several interrogators. This phenomenon leads to large scan-to-scan signal rate variations.

The TCAS I and TCAS II M do not produce large time variations in signal activity. The proposed low power, active TCAS I transmits one ATCRBS interrogation/sequence per second on an omnidirectional antenna.\(^8\) To simplify the analysis, TCAS I is modeled in the TCAS SEM as transmitting one interrogation per second. TCAS II M transmits the ATCRBS interrogation sequence once per second on a wide-beam (BW < 130°) antenna which is electronically steered to four positions (forward, left-side, right-side, and aft). TCAS II M transmits Mode S interrogations on an omnidirectional antenna. The Mode S interrogation rate transmitted by a given TCAS II M-equipped aircraft is a function of the number of Mode S-equipped aircraft within approximately thirty nautical miles. Since the changes in air-traffic density throughout the LA Basin deployment have been shown to be negligible during the 10-scan (46 seconds) DABS/ATCRBS/AIMS simulation, TCAS rates are relatively constant. In view of these considerations, the compatibility of TCAS I and TCAS II M with ATCRBS and Mode S can logically be analyzed using this statistical approach.

1.3.2 Simulation Execution

The execution sequence for the two models is illustrated in Figure 1-1. The user first executes a 10-scan DABS/ATCRBS/AIMS PPM simulation to estimate the time-average rates at which ATC interrogations and suppressions arrive at each aircraft within a given deployment. These rates are then used within the TCAS SEM to estimate the mean reply efficiency and reply rate of each transponder. The TCAS SEM uses the transponder reply efficiency and reply rate to estimate TCAS II M Mode S surveillance activity. This is accomplished as follows. The TCAS II M surveillance protocol requires that a TCAS II M-equipped aircraft elicit a decodable Mode S reply once per second from all other Mode S-equipped aircraft within approximately 7 nmi, and at a rate which decreases monotonically with range for aircraft beyond 7 nmi. The efficiency with which a TCAS II M elicits decodable replies is related to the local fruit rate, which is a function of the local air traffic density and the local transponder reply rate. The number of interrogations required by a given TCAS II M to elicit a decodable reply therefore increases with increases in the local fruit rate.

This background signal environment must therefore be specified in order to accurately predict TCAS II M Mode S surveillance rates. With these input parameters, the TCAS SEM is exercised to simulate two minutes of real time\(^a\) to predict the time-averaged rates at which TCAS I and TCAS II M signals arrive at each transponder. The DABS/ATCRBS/AIMS PPM uses these TCAS signal rates as a basis with which to merge TCAS signals with those due to ground-based ATC systems.

1.3.3 Report Organization

The remainder of this report is divided into two sections and three appendixes. The modeled TCAS and ATC transponder systems are discussed in Section 2. Section 3 contains a tree diagram of the program control flow

\(^a\)This is a sufficient time to allow any model-induced transients to decay.
Figure 1-1. Analysis structure.
and detailed descriptions in Program Design Language (PDL) of each subroutine in the model. The PDL replaces the flow-chart method of documenting software and gives a more detailed and accurate description of the code. A PDL was written for the driver and each subroutine in the TCAS SEM, and each includes the following elements: Purpose, Inputs, Procedure, Outputs, Variables of Interest, and Process. The first four elements of the PDL contain general information about the program segment: its function, its inputs, the procedure by which it achieves its function, and its outputs. The last two elements contain specific information about the code and were provided to ease understanding and modification of the code by the programmer. Specifically included are a definition of the variables used in the program segment and pseudo-code that explains the coded listing in a nearly line-by-line fashion.

APPENDIX A contains a data dictionary containing all the common variables in the model. APPENDIX B lists a fully commented ASCII FORTRAN version of the model, and APPENDIX C illustrates the procedure for executing the model and a sample of its output.
**SECTION 2**

**MODELED SYSTEMS**

2.1 **INTRODUCTION**

This section contains a brief description of the technical characteristics and surveillance procedures, as modeled, of TCAS I and TCAS II M. This is followed by a description of the modeled ATC transponder systems.

2.2 **TCAS OPERATIONS AND TECHNICAL CHARACTERISTICS**

2.2.1 **TCAS II M**

TCAS II M is an airborne system that is designed to use existing ATCRBS and Mode S signal formats to perform the collision-avoidance function. TCAS II M tracks ATCRBS-equipped aircraft in its vicinity via the whisper-shout power management technique. Nearby Mode S-equipped aircraft are tracked via discrete Mode S transactions. The ATCRBS whisper-shout surveillance sequence is transmitted once per second. The Mode S transaction update frequency is related to the position of the Mode S equipped aircraft relative to the position of the TCAS II M. Mode S and ATCRBS surveillance procedures are discussed in detail below. TCAS II M characteristics are given in TABLE 2-1.

2.2.1.1 **Mode S Surveillance Process.** Initially, each Mode S aircraft is assumed to be in the null state. Upon detection of a squitter, the aircraft is placed in the squitter state. If a second squitter is received within 16 seconds of the first, the aircraft is placed in the acquisition state, unless the altitude separation is greater than 9000 feet, in which case the intruder aircraft remains in the squitter state. A target aircraft is purged from squitter processing if a second squitter reply is not received within 16 seconds of the first reply. These replies may be either replies elicited by another TCAS II M-equipped aircraft or unelicited replies.
TABLE 2-1
TCAS II M CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mode S</th>
<th>ATCRBS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Peak Radiated Power a</td>
<td>54 dBm</td>
<td>0.5</td>
</tr>
<tr>
<td>Sensitivity a</td>
<td>-77 dBm</td>
<td>0.75</td>
</tr>
<tr>
<td>Antenna Type 9</td>
<td>Omnidirectional</td>
<td>Directional (130°) b</td>
</tr>
</tbody>
</table>

aTransmitter power and sensitivities were assigned using a normal distribution.
bAt sum-difference crossover points.

While the aircraft is in the acquisition state, TCAS II M interrogates to determine if the aircraft should be placed in the roll-call or dormancy state. The number of interrogations transmitted during acquisition is a function of the TCAS II M ability to receive and correlate replies from the intruder Mode S aircraft. There are four acquisition trials, each consisting of six one-second scans. TABLE 2-2 shows the maximum number of failed interrogations allowed during each of the four trials. For example, during the first scan of the first trial, TCAS II M may transmit as many as four interrogations (one successful, three unsuccessful).

If two correlating replies are received during any trial sequence, the intruder aircraft is placed either in the dormancy state or in the roll-call state. The aircraft is placed in the dormancy state if TCAS II M estimates the "Time to Endanger" (TE = range/maximum closure rate) to be greater than 43 seconds; otherwise, the intruder is placed in the roll-call state.

If no replies are received during any one of the trials, the intruder aircraft is returned to the squitter state for a period not to exceed 40

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MAXIMUM NUMBER OF FAILED INTERROGATIONS ALLOWED DURING EACH SCAN OF THE ACQUISITION TRIALS

<table>
<thead>
<tr>
<th>Scan</th>
<th>Acquisition Trial</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
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<tr>
<td>1</td>
<td>3</td>
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<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

seconds. Upon the return of intruder aircraft to squitter state, a running sum, initialized at 0, is maintained. The sum is decremented by one for each succeeding scan that a squitter is not received and is incremented by an amount as shown in TABLE 2-3 for each scan that a squitter is received. The intruder is purged from the squitter state and placed into the null state when the value of the running sum becomes less than or equal to -40. It is transferred to the acquisition state whenever the running sum exceeds 0 unless the altitude separation is greater than 9000 feet.

TABLE 2-3

<table>
<thead>
<tr>
<th>Scan</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 (or more)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increment</td>
<td>20</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Aircraft assigned to the dormancy state are not interrogated. The aircraft remains in the dormancy state for a period of time equal to $T_E$ minus 40 seconds. After this time, the aircraft is placed in the squitter state.
If the aircraft is assigned to the roll-call state (i.e., the TE is less than 43 seconds), TCAS II M interrogates the intruder each second to update its track record. TABLE 2-4 shows the maximum number of interrogations permitted to elicit a decodable reply during each one-second scan. This is referred to as the ten-second roll-call sequence. If the entire ten-scan sequence elapses with no valid reply, interrogations to the intruder aircraft are terminated, and the aircraft is returned to the squitter state.

**TABLE 2-4**

<table>
<thead>
<tr>
<th>Maximum Number of Interrogations</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
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<tr>
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<td>3</td>
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<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>10</td>
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2.2.1.2 Whisper-shout ATCRBS surveillance. The current TCAS II M design employs a four-beam directional antenna on top of the aircraft and an omnidirectional antenna on the bottom of the aircraft. Each TCAS II M-equipped aircraft tracks ATCRBS-equipped aircraft via the whisper-shout power management technique shown in Figure 2-1.

This technique uses directional interrogations from each of the four beams of the top antenna. The interrogation sequence starts with a lower power interrogation level (26 dBm) and proceeds to higher power interrogation levels in 1-dB increments. A total of 83 whisper-shout interrogations are transmitted each second unless interference limiting adjustments are required. Interrogations are eliminated from the sequence in the order shown.
<table>
<thead>
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<th>INTERFERENCE LIMITING PRIORITY</th>
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<td>TOP S..I 49</td>
<td>1</td>
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<tr>
<td>ANTENNA S..I 48</td>
<td>5</td>
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<tr>
<td>S..I 47</td>
<td>9</td>
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<tr>
<td>FORWARD S..I 46</td>
<td>13</td>
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<td>DIRECTION S..I 45</td>
<td>17</td>
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<td>41</td>
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<tr>
<td>S..I 38</td>
<td>45</td>
</tr>
<tr>
<td>S..I 37</td>
<td>49</td>
</tr>
<tr>
<td>S..I 36</td>
<td>53</td>
</tr>
<tr>
<td>S..I 35</td>
<td>57</td>
</tr>
<tr>
<td>S..I 34</td>
<td>61</td>
</tr>
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<td>S..I 33</td>
<td>64</td>
</tr>
<tr>
<td>S..I 32</td>
<td>67</td>
</tr>
<tr>
<td>S..I 31</td>
<td>70</td>
</tr>
<tr>
<td>S..I 30</td>
<td>73</td>
</tr>
<tr>
<td>S..I 29</td>
<td>76</td>
</tr>
<tr>
<td>S..I 28</td>
<td>77</td>
</tr>
<tr>
<td>S..I 27</td>
<td>78</td>
</tr>
<tr>
<td>S..I 26</td>
<td>79</td>
</tr>
<tr>
<td>TOP S..I 45</td>
<td>2, 3</td>
</tr>
<tr>
<td>ANTENNA S..I 44</td>
<td>6, 7</td>
</tr>
<tr>
<td>S..I 43</td>
<td>10, 11</td>
</tr>
<tr>
<td>LEFT &amp; RIGHT DIRECTIONS S..I 42</td>
<td>14, 15</td>
</tr>
<tr>
<td>S..I 41</td>
<td>18, 19</td>
</tr>
<tr>
<td>S..I 40</td>
<td>22, 23</td>
</tr>
<tr>
<td>S..I 39</td>
<td>26, 27</td>
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<td>S..I 38</td>
<td>30, 31</td>
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<td>S..I 37</td>
<td>34, 35</td>
</tr>
<tr>
<td>S..I 36</td>
<td>38, 39</td>
</tr>
<tr>
<td>S..I 35</td>
<td>42, 43</td>
</tr>
<tr>
<td>S..I 34</td>
<td>46, 47</td>
</tr>
<tr>
<td>S..I 33</td>
<td>50, 51</td>
</tr>
<tr>
<td>S..I 32</td>
<td>54, 55</td>
</tr>
<tr>
<td>S..I 31</td>
<td>58, 59</td>
</tr>
<tr>
<td>S..I 30</td>
<td>62, 63</td>
</tr>
<tr>
<td>S..I 29</td>
<td>65, 66</td>
</tr>
<tr>
<td>S..I 28</td>
<td>68, 69</td>
</tr>
<tr>
<td>S..I 27</td>
<td>71, 72</td>
</tr>
<tr>
<td>S..I 26</td>
<td>74, 75</td>
</tr>
</tbody>
</table>

Figure 2-1. Whisper-shout interrogation sequence. (Page 1 of 2).
### TOTAL RADIATED INTERROGATION POWER (dBm)

| S.I  | 40  |
| S.I  | 39  |
| S.I  | 38  |
| S.I  | 37  |
| S.I  | 36  |
| S.I  | 35  |
| S.I  | 34  |
| S.I  | 33  |
| S.I  | 32  |
| S.I  | 31  |
| S.I  | 30  |
| S.I  | 29  |
| S.I  | 28  |
| S.I  | 27  |
| S.I  | 26  |
| S..I| 36  |
| S..I| 34  |
| S..I| 32  |
| S..I| 30  |

### INTERFERENCE LIMITING PRIORITY

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>20</td>
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<tr>
<td></td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>48</td>
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<tr>
<td></td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>60</td>
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<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>83</td>
</tr>
</tbody>
</table>

### RADIATED POWER (dBm)

<table>
<thead>
<tr>
<th></th>
<th>24</th>
<th>34</th>
<th>44</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>S..I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S..I</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S..I</td>
<td>34</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S..I</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S..I</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

**Notes:**

- "I" indicates total radiated power of $P_1$, $P_3$, and $P_4$ interrogation pulses.
- "S" indicates total radiated power of $P_1$ and $P_2$ suppression pulses.
- "S..I" means that the total radiated suppression power is 2 dB less than the total radiated interrogation power.
- "S..I" means that the total radiated suppression power is 3 dB less than the total radiated interrogation power.

Figure 2-1. (Page 2 of 2).
in Figure 2-1 if interference limiting adjustments are required. The interference limiting procedures are discussed in subsection 2.2.3.

Each successive interrogation in the sequence is preceded by a suppression. This suppression is used to prevent the more sensitive transponders from replying again. The suppression pulse is at a power level 2 or 3 dB lower than the accompanying interrogation. Partitioning the ATCRBS environment with respect to transponder sensitivity reduces the number of overlapping replies received by the TCAS II M receiver. The function of the transmission from the bottom antenna is to minimize false targets that are generated by multipath conditions.

2.2.2 TCAS I

TCAS I is a lower-cost, limited-performance version of TCAS that is compatible with TCAS II M operation. Its main functions are 1) to support surveillance for TCAS II M as well as ground air traffic control and (2) to maintain surveillance of nearby transponder-equipped aircraft. To support the surveillance function, TCAS I interrogates once per second using an ATCRBS Mode C format.\textsuperscript{10} The interrogation is transmitted on an omnidirectional antenna. The transmission power and interference limiting standards for TCAS I have been proposed but have not been formally adopted (see Reference 8).

2.2.3 TCAS/ATC Compatibility Design

Each TCAS II M unit incorporates interference limiting to ensure that TCAS II M signals will not interfere with other systems when operating in high-density airspace. TCAS II M controls its interrogation rate and/or power to minimize interference effects by conforming to a set of three specific inequalities. This ensures that all interference effects resulting from these

interrogations, together with the interrogations from all other TCAS II M airborne interrogators in the vicinity, are kept to a low level. The number of Mode S and ATCRBS interrogations made by a TCAS II M-equipped aircraft and the number of other TCAS II M-equipped aircraft within squitter range are computed. These computed quantities are used in the following three interference-limiting equations:

\[
\begin{align*}
I & \quad P(i) \quad 280 \\
S & \quad F \\
i = 1 & \quad 250 \text{ watts} \quad 1 + \text{NTA} \\
\end{align*}
\]

\[
\begin{align*}
I & \quad M(i) \quad F \quad 0.01 \text{ second} \\
S & \quad \quad i = 1 \\
\end{align*}
\]

\[
\begin{align*}
K & \quad P_A(k) \quad 80 \\
S & \quad F \\
k = 1 & \quad 250 \text{ watts} \quad 1 + \text{NTA} \\
\end{align*}
\]

The variables in these inequalities are defined as follows:

- \( I \) = the total number of Mode S interrogations transmitted in a 1-second period.
- \( i \) = the index number of the current Mode S interrogation; \( i = 1, 2, \ldots, I \).
- \( P(i) \) = the total radiated Mode S power (in watts) from the antenna for the \( i \)-th interrogation.
- \( \text{NTA} \) = the number of airborne TCAS II M interrogators that are detected by squitter.
- \( M(i) \) = the duration of the mutual suppression interval for the TCAS II M transponder associated with the \( i \)-th interrogation.
- \( K \) = the total number of ATCRBS interrogations in a 1-second period.
- \( k \) = the index number of the ATCRBS interrogation.
\[ k = 1, 2, \ldots, K. \]

\[ PA(k) = \text{the total radiated power (in watts) from the antenna for the } k\text{-th ATCRBS interrogation.} \]

The TCAS II M unit will determine once per second if the power and/or interrogation rate should be adjusted. Each TCAS II M varies the system parameters computed in inequalities (2-1), (2-2), and (2-3) to maximize the surveillance ranges for Mode S and ATCRBS aircraft, while limiting the total power and interrogation rate not to exceed set values.

At the beginning of each surveillance update interval (each second), the number of TCAS II M interrogators detected by squitter is used to evaluate the current right-hand limits in inequalities (2-1) and (2-3). The average values over a 16-second interval for the Mode S variables in the inequalities are also calculated. If the average value of the left-hand side of either inequality (2-1) or (2-2) equals or exceeds the current limit, both the Mode S and the ATCRBS surveillance parameters are modified to satisfy the inequalities.

The ATCRBS surveillance activity is modified by sequentially eliminating elements of the whisper-shout sequence. Each whisper-shout step is uniquely associated with a TCAS II M receiver Minimum Triggering Level (MTL) setting. Thus, the receiver sensitivity in ATCRBS surveillance periods is automatically tailored to match these power reductions.

Mode S surveillance activity is modified by adjusting Mode S interrogation power and/or squitter sensitivity. In evaluating these inequalities, 16-second averages of the Mode S parameters and current or anticipated values of the ATCRBS parameters are used. After the Mode S variables (power and/or squitter sensitivity) have been changed to satisfy the inequalities during the update interval, the only change allowed during the next 16 seconds is a reduction in the number of whisper-shout steps needed to satisfy inequality (2-3). This is designated the 16-second freeze.
2.3 ATC TRANSPONDER CHARACTERISTICS

Each transponder-equipped aircraft is represented by an antenna (omni-directional in azimuth), antenna cable, receiver/processor, and a transmitter. The (quantized) vertical antenna gain patterns were derived from measured data for the Boeing 727 antenna/airframe configuration. For modeling purposes, it is assumed that ATCRBS transponder-equipped aircraft are fitted with a single, bottom-mounted antenna, while Mode S transponder-equipped aircraft are fitted with both top- and bottom-mounted antennas. Polarization losses are neglected. The cable loss from the antenna terminals to the receiver/transmitter terminals is assumed to be 3 dB for the entire transponder population.

The receiver sensitivity and transmitter power output of each type of transponder are assigned statistically in accordance with measured data. For ATCRBS transponders, the values of receiver sensitivity range between -51 dBm and -90 dBm, with an average value of -74 dBm; the values of transmitter power range between 45 dBm and 65 dBm, with an average power of 57 dBm.

Mode S transponder-equipped aircraft receiver/transmitter characteristics are assigned using a normal probability distribution function. The receiver sensitivity distribution for Mode S transponder-equipped aircraft that are not TCAS II M-equipped are assigned using a mean value of -77 dBm with a standard deviation of 1.5 dB. The sensitivity distribution for Mode S transponder-equipped aircraft that are TCAS II M-equipped is constructed using a mean value of -77 dBm with a standard deviation of 0.5 dB. Reply power levels for the two populations of Mode S transponders are assigned in a similar way: an average reply power of 57 dBm for both populations with standard deviations of 1.5 dB for Mode S aircraft that are not TCAS II M-equipped, and 0.5 dB for

---

\(^a\)Patterns were supplied to ECAC by the FAA.

Mode S aircraft that are TCAS II M-equipped.

Transponders are subjected to a variety of signal formats from ATCRBS interrogators, Mode S interrogators, and TCAS interrogators. The reaction of a transponder receiver/processor and transmitter to each type of signal is, in general, different for Mode S and ATCRBS transponders. TABLE 2-5 lists the different types of signals that may be received at transponders, and the attendant receiver/processor and transmitter action.

### TABLE 2-5

**TRANSERONDER INTERROGATION PROCESSING AND DEAD TIMES**

<table>
<thead>
<tr>
<th>Transmission Type</th>
<th>Transponder Type</th>
<th>Receiver Dead Time (s)</th>
<th>Transmitter Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATCRBS Interrogation</td>
<td>ATCRBS</td>
<td>60</td>
<td>Reply</td>
</tr>
<tr>
<td>ATCRBS-Only Interrogation(^a)</td>
<td>ATCRBS</td>
<td>60</td>
<td>Reply</td>
</tr>
<tr>
<td>ATCRBS-Suppression</td>
<td>ATCRBS</td>
<td>35</td>
<td>Suppression</td>
</tr>
<tr>
<td>Mode S Interrogation</td>
<td>ATCRBS</td>
<td>35</td>
<td>Suppression</td>
</tr>
<tr>
<td>(All-Call and Roll-Call)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATCRBS Interrogation</td>
<td>Mode S</td>
<td>60</td>
<td>Reply</td>
</tr>
<tr>
<td>ATCRBS-Only Interrogation</td>
<td>Mode S</td>
<td>24</td>
<td>Suppression</td>
</tr>
<tr>
<td>ATCRBS Suppression</td>
<td>Mode S</td>
<td>35</td>
<td>Suppression</td>
</tr>
<tr>
<td>Mode S Interrogation</td>
<td>Mode S</td>
<td>192 (short reply)</td>
<td>Reply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>248 (long reply)</td>
<td></td>
</tr>
<tr>
<td>Mode S Interrogation</td>
<td>Mode S</td>
<td>20 (short interrogation)</td>
<td>Suppression</td>
</tr>
<tr>
<td>(not at transponder address)</td>
<td></td>
<td>32 (long interrogation)</td>
<td></td>
</tr>
<tr>
<td>Mode S All-Call Interrogation</td>
<td>Mode S</td>
<td>128</td>
<td>Reply(^b)</td>
</tr>
</tbody>
</table>

\(^a\)ATCRBS-only interrogations are transmitted by Mode S sensors and TCAS II M interrogators.

\(^b\)The probability of reply of Mode S transponders to Mode S All-Call Interrogation is controlled by data contained in the interrogation.
3.1 INTRODUCTION

The TCAS SEM is divided into a main driver program and 24 separate subroutines, each of which performs a specific function. Figure 3-1 shows the major functions of the model and identifies the subroutines that perform those functions. To the left of each subroutine shown on the diagram is a general description of the function(s) that it performs. The information contained in this section is presented in the form of PDLs (program design language) to be used in conjunction with the actual code of the TCAS SEM (APPENDIX B). The PDLs provide a detailed description of the variables and the logic of each subroutine.

3.2 OPERATIONAL DESCRIPTION

The DABS/ATCRBS/AIMS PPM and the TCAS SEM were designed in ASCII FORTRAN for use on the ECAC Sperry 1100/82 computer. The TCAS SEM is machine-dependent because of its use of system subroutines and system functions.

3.2.1 Input/Output Files

The DABS/ATCRBS/AIMS PPM creates an input disk file (See TABLE 3-1) for the TCAS SEM that contains average interrogation and suppression rates due to ground air traffic control for each aircraft in the deployment. The aircraft's position (latitude, longitude, and altitude), type (ATCRBS, Mode S, or TCAS II M), and its velocity (East-West, North-South, and vertical directions) are supplied by the LA Basin Model (Reference 3) using the format of TABLE 3-2. Using this information, the TCAS SEM simulates TCAS activity during a 120-second interval. At the end of the simulation, the TCAS SEM creates a disk file which includes the time-average rates at which TCAS signals arrive at each aircraft. The types of signal rates stored are listed in TABLE 3-3.
Driver
Set initial conditions

Compute total power sent over
N whisper-shout levels

Load ATCRBS whisper-shout arrays

Load aircraft deployment file

Time-independent algorithms:
Assign transponder characteristics

Load TCAS II M file; set squitter
phase

Load TCAS II M file

Estimate TCAS II M interference
limiting state

Compute TCAS I effects

Time-dependent algorithms:
Move aircraft; update track file

Load antenna coupling array

Estimate fruit at each TCAS II-M

Schedule Mode S discrete
interrogations

Compute smoothed parameters

Compute effects of TCAS Mode S
emissions

Compute effects of TCAS ATCRBS:
whisper-shout emissions

Make interference limiting
adjustments

Compute and display variables
of interest

Load files for rates to be used
in DABS/ATCRBS/AIMS PPM

Figure 3-1. Tree diagram of the TCAS SEM.
### TABLE 3-1

FORMAT OF INPUT FILE TO TCAS SIM FORMED BY DABS/ATCRBS/AIMS PPM

<table>
<thead>
<tr>
<th>Beginning Column</th>
<th>Length</th>
<th>Format</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>I10</td>
<td>Interrogation Rate due to ground ATC (per second)</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>I10</td>
<td>Suppression Rate due to ground ATC (per second)</td>
</tr>
</tbody>
</table>

### TABLE 3-2

FORMAT OF DEPLOYMENT FILE

<table>
<thead>
<tr>
<th>Beginning Column</th>
<th>Length</th>
<th>Format</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>I2</td>
<td>Latitude (Degrees)</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>I2</td>
<td>Latitude (Minutes)</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>I2</td>
<td>Latitude (Seconds)</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>A1</td>
<td>Hemisphere (N-S)</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>I3</td>
<td>Longitude (Degrees)</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>I2</td>
<td>Longitude (Minutes)</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>I2</td>
<td>Longitude (Seconds)</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>A1</td>
<td>Hemisphere (E-W)</td>
</tr>
<tr>
<td>19</td>
<td>8</td>
<td>F8.0</td>
<td>Altitude (feet msl)</td>
</tr>
<tr>
<td>36</td>
<td>4</td>
<td>A4</td>
<td>Type</td>
</tr>
<tr>
<td>41</td>
<td>6</td>
<td>F6.4</td>
<td>Westward Velocity (nmi/s)</td>
</tr>
<tr>
<td>48</td>
<td>6</td>
<td>F6.4</td>
<td>Northward Velocity (nmi/s)</td>
</tr>
<tr>
<td>55</td>
<td>8</td>
<td>F8.4</td>
<td>Upward Velocity (ft/s)</td>
</tr>
</tbody>
</table>
### TABLE 3-3

**FORMAT OF OUTPUT FILE GENERATED BY TCAS SIM TO BE USED AS INPUT TO DARS/ATCRBS/AIMS PPM**

<table>
<thead>
<tr>
<th>Beginning Column</th>
<th>Length</th>
<th>Format</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>15</td>
<td>I15</td>
<td>Mode S Misaddresses due to TCAS II M</td>
</tr>
<tr>
<td>26</td>
<td>15</td>
<td>I15</td>
<td>Mode S Suppressions due to TCAS II M</td>
</tr>
<tr>
<td>41</td>
<td>15</td>
<td>I15</td>
<td>Mode S Interrogations due to TCAS II M</td>
</tr>
<tr>
<td>56</td>
<td>15</td>
<td>I15</td>
<td>ATCRBS Interrogations due to TCAS II M</td>
</tr>
<tr>
<td>71</td>
<td>15</td>
<td>I15</td>
<td>ATCRBS Suppressions due to TCAS II M</td>
</tr>
<tr>
<td>86</td>
<td>10</td>
<td>F10.5</td>
<td>Mode S Addresses due to TCAS II M</td>
</tr>
<tr>
<td>98</td>
<td>10</td>
<td>F10.3</td>
<td>TCAS II M dead time</td>
</tr>
<tr>
<td>110</td>
<td>10</td>
<td>F10.3</td>
<td>TCAS I Interrogations to aircraft</td>
</tr>
</tbody>
</table>

3-4
3.2.2 Internal Data Structure

In order to connect each segment of the TCAS SEM, common blocks of data were designated to share information. The data dictionary in APPENDIX A describes each common variable and its units.

3.3 MODEL SUBROUTINE DESCRIPTIONS

The subroutines of the model are described in PDL form in this section, in the order in which they appear on the tree diagram of Figure 3-1. The PDLs are divided into Purpose, Inputs, Procedure, Outputs, Variables of Interest, and Process. This method of documentation provides a detailed description of each subroutine in a form that can be easily updated as modifications are made to the model.
3.3.1 Model Driver: CIRCAS

PURPOSE: To drive the TCAS SEM:

1. Set initial conditions and load aircraft files.
2. Calculate near time-independent effects of TCAS I (if desired) and TCAS II M emissions.
3. Calculate time-dependent effects of TCAS II M on the environment.
4. Record the results of the TCAS SEM on disk files to be used in the DABS/ATCRBS/AIMS PPM.

INPUTS: ATC files from DABS/ATCRBS/AIMS PPM, and transponder deployment information.

PROCEDURE: First, all the subroutines that set up the initial conditions of the simulation (e.g., whisper-shout power levels, number of aircraft in the deployment, etc.) are called. Next, a simulation of 120 seconds of the operation of the TCAS II M system is performed. During the simulation, the Mode S and ATCRBS interrogation and suppression rates due to TCAS II M interrogations is computed for all aircraft in the environment, along with the mutual suppression rate of each TCAS II M receiver. At the end of the simulation, the average value of Mode S and ATCRBS rates are computed and stored in external files to be used in conjunction with the DABS/ATCRBS/AIMS PPM.

OUTPUTS: ATC files for use in DABS/ATCRBS/AIMS PPM.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of TCAS II M-equipped aircraft</td>
<td>NUMTCA</td>
</tr>
<tr>
<td>Clock</td>
<td>ITIME</td>
</tr>
<tr>
<td>TCAS II M-equipped aircraft of interest</td>
<td>II</td>
</tr>
<tr>
<td>TCAS II M transmission indicator</td>
<td>LPLUS1</td>
</tr>
<tr>
<td>Print indicator</td>
<td>PRINT</td>
</tr>
<tr>
<td>TCAS I analysis indicator</td>
<td>T1</td>
</tr>
</tbody>
</table>
PROCESS:

1. Read in user's options (print option and TCAS I analysis option).
2. CALL INIT: Set initial conditions of all common block variables.
3. CALL ASPINT: Initialize array containing total whisper-shout power radiated.
4. CALL WSPWE: Load whisper-shout power levels for TCAS II M-equipped aircraft.
5. CALL INPUT: Load aircraft deployment from the transponder deployment file (usually the LA Basin Model) and interrogation and suppression rates from the DABS/ATCRBS/AIMS PPM.
6. CALL TRANSP: Assign power and sensitivity for each transponder.
7. CALL TSTART: Set squitter phase for each TCAS II M-equipped aircraft and a pointer file to locate TCAS II M-equipped aircraft in the aircraft characteristics file.
8. CALL LOAD: Compute heading of each TCAS II M; update MODE S track file (i.e., load array containing power, range, and bearing relationships between TCAS II M-equipped and all other aircraft within 50 nmi); and compute the air traffic densities about each TCAS II M, as well as the average density about all TCAS II M-equipped aircraft.
9. CALL PRESET: Approximate interference-limiting effects on each TCAS II M-equipped aircraft.
10. IF TCAS I analysis desired, THEN
    A. CALL TCAS1: Determine signal rates due to TCAS I ATCRBS surveillance.
11. END IF
12. LOOP over 120-second time interval, in one-second steps.
    A. CALL LOAD: At times 40, 80, and 120 seconds: update all aircraft positions; update MODE S track file and compute the air traffic densities about each TCAS II M-equipped, as well as the average density about any given TCAS II M-equipped aircraft.
    B. LOOP over all TCAS II M-equipped aircraft.
    1. CALL ANTGAN: Compute antenna elevation patterns between given TCAS II M-equipped aircraft and all other aircraft within 50 nmi of the TCAS II M.
2. IF time equals 1, 20, 40, 60, 80, 100, or 120 seconds, THEN
   a. CALL FRUITA: Compute the reply efficiency of each
      aircraft to the TCAS II M-equipped aircraft and the
      associated fruit rate to that efficiency.

3. END IF

4. CALL DISMOD: Schedule Mode S discrete interrogations.

5. CALL TCSMOT: Compute smooth (or average) TCAS II M
   emission powers and interrogation rates over the last 16-
   second interval.

6. IF TCAS II M transmitted Mode S interrogations THEN
   a. CALL DISINT: Compute Mode S effects from TCAS II M to
      all other aircraft in range of the TCAS II M.

7. END IF

8. IF time equals 1, 40, 80, or 120 seconds, THEN
   a. CALL ATMOD: Compute whisper-shout effects of
      TCAS II M on all other aircraft within range.

9. END IF

10. IF time is greater than three seconds, THEN
    a. CALL INTLI: Adjust TCAS II M characteristics to
       satisfy interference-limiting inequalities.

11. END IF

12. CALL STATS: Compute average rates from all TCAS II M-
    equipped aircraft to all other aircraft.

C. END LOOP

13. END LOOP

14. CALL FILES: Load rate files for use in the DABS/ATCRBS/AIMS PPM.

15. End.

Called by: None.

Subroutines called: INIT, ASPINT, WSPowe, INPUT, TRANSP, TSTART, LOAD,
PRESET, TCAS1 (optional), ANTGAN, FRUITA, DISMOD, TCSMOT, DISINT, ATMOD,
INTLI, STATS, FILES
3.3.2 Subroutine: INIT

 PURPOSE:  To set initial values of all common variables.

 INPUTS:  All common variables. (Refer to TCAS SEM Data Dictionary, APPENDIX A.)

 PROCEDURE:  Set each common variable to its initial value.

 OUTPUTS:  Initial values for all common variables.

 Called by:  CIRCAS

 Subroutines called:  None.
3.3.3 Subroutine: ASPINT

PURPOSE: To initialize the array containing the total power transmitted using N whisper-shout levels.

INPUTS: None.

PROCEDURE: A loop is performed over all whisper-shout levels. At each level, the total power transmitted by the top (in the front, sides, and back) and bottom antennas is computed and stored in the appropriate array.

OUTPUT: The array containing the sum of the whisper-shout power levels for N transmitted levels.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total power radiated with N levels</td>
<td>ATSUMP</td>
</tr>
</tbody>
</table>

PROCESS:

1. Define 1 dB and 2 dB.
2. Define the minimum levels transmitted by the top and bottom antennas in watts.
3. Set total sum power = 0 when no whisper-shout levels are sent.
4. LOOP over all 83 priority levels.
   A. Find the number of whisper-shout levels sent on the top antenna (front, right, left, and back lobes) and bottom antenna for a given priority level.
   B. Compute the total power transmitted by the top and bottom antennas, and store this value in the appropriate position in the sum power array.
5. END LOOP
6. Return.

Called by: CIRCAS
Subroutines called: None.
3.3.4 Subroutine: WSPOWER

PURPOSE: To load the 83 levels of ATCRBS whisper-shout interrogation power for the TCAS II M antennas and store them in arrays that correspond to the location of the antennas.

INPUTS: Number of whisper-shout (w-s) levels for the top antennas (total of 79 levels) which are located at the front (24 levels), sides (20 levels each side), and back (15 levels) of the aircraft and the number of levels for the bottom antenna (4 levels). These levels were obtained from the TCAS II M Minimum Operational Standards (MOPS) (Reference 5).

PROCEDURE: The 79 whisper-shout levels that can be transmitted by the TCAS II M top antenna (24 on the front, 20 on each side, and 15 on the back) and the 4 whisper-shout levels that can be transmitted by the bottom antenna are computed and stored in the appropriate arrays.

OUTPUTS: Four arrays containing whisper-shout power levels by location of antenna.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whisper-shout levels of:</td>
<td></td>
</tr>
<tr>
<td>Top-front antenna</td>
<td>IPOWF</td>
</tr>
<tr>
<td>Top-side antennas</td>
<td>IPOWS</td>
</tr>
<tr>
<td>Top-back antenna</td>
<td>IPOWB</td>
</tr>
<tr>
<td>Bottom antenna</td>
<td>IPOWBO</td>
</tr>
</tbody>
</table>

PROCESS:
1. Initialize the peak power for the top-front antenna to 49 dBm.
2. LOOP over the 24 whisper-shout power levels of the front antenna
   A. Calculate this power level by decreasing the peak power by 1 dB per level (starting at 49 dBm and decreasing to 26 dBm).
B. Calculate the total radiated power of the top-front antenna.

3. END LOOP

4. Initialize the peak power for the top-side antennas to 45 dBm.

5. LOOP over the 20 levels (each side) of the side antennas.
   A. Calculate this power by decreasing the peak power by 1 dB per level (from 45 to 26 dBm).
   B. Calculate the total radiated power of the side antennas.

6. END LOOP

7. Initialize the peak power for the top-rear antenna to 40 dBm.

8. LOOP over the 15 levels of the back antenna.
   A. Calculate these levels by decreasing the peak power by 1 dB per level (from 40 to 26 dBm).
   B. Calculate the total radiated power of the back antenna.

9. END LOOP

10. Initialize the peak power for the bottom antenna to 36 dBm.

11. LOOP over the 4 levels of the bottom antenna.
    A. Calculate these levels by decreasing the peak power by 2 dB per level (from 36 to 30 dBm).
    B. Calculate the total radiated power of the bottom antenna.

12. END LOOP

13. Calculate the total combined radiated power of all the antennas.


Called by: CIRCAS
Subroutines called: None.
3.3.5 Subroutine: INPUT

PURPOSE: Load the aircraft deployment array and the interrogation and suppression rate arrays, and determine the number of each type of aircraft.

INPUTS: Interrogation and suppression rates from the DABS/ATCRBS/AIMS PPM, and aircraft characteristics data from the Los Angeles Basin model which includes latitude (degrees, minutes, seconds), longitude (degrees, minutes, seconds), altitude (feet mean sea level), type of aircraft, longitudinal velocity (nautical miles per second, positive in the westerly direction), latitudinal velocity (nautical miles per second, positive in the northerly direction), and vertical velocity (feet per second, positive in the upward direction).

PROCEDURE: This subroutine reads interrogation and suppression rates and loads the rate arrays. It also reads the aircraft deployment file and loads the deployment array. During this process, the total number of aircraft is counted, as well as the number of each of the three types of aircraft (ATCRBS, Mode S, and TCAS II M).

OUTPUTS: Interrogation and suppression rates, the total number of aircraft, the number of each type of aircraft (ATCRBS, Mode S, and TCAS II M), and the aircraft deployment file which contains, for each aircraft, the latitude (radians), longitude (radians), altitude (feet mean sea level), type (ATCRBS, Mode S, or TCAS II M), westward velocity (nautical miles per second), northward velocity (nautical miles per second), and upward velocity (feet per second).
VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of aircraft</td>
<td>NAC</td>
</tr>
<tr>
<td>Number of ATCRBS-equipped aircraft</td>
<td>IATCR</td>
</tr>
<tr>
<td>Number of Mode S-equipped aircraft</td>
<td>IDAB</td>
</tr>
<tr>
<td>Number of TCAS II M-equipped aircraft</td>
<td>ITCA</td>
</tr>
<tr>
<td>Interrogation rates</td>
<td>IADJIN</td>
</tr>
<tr>
<td>Suppression rates</td>
<td>IADJSU</td>
</tr>
<tr>
<td>Aircraft deployment</td>
<td>TJFILE</td>
</tr>
<tr>
<td>Percentage of deployment</td>
<td>RATIO</td>
</tr>
</tbody>
</table>

PROCESS:

1. Set fraction of total deployment wanted (RATIO).
2. LOOP over all aircraft in model.
   A. Read in the interrogation and suppression rates from DABS/ATCRBS/AIMS PPM and store them in appropriate arrays.
   B. Read in the transponder deployment from the deployment file (usually the LA Basin Model).
   C. CALL RANN: Get a random number.
   D. IF random number greater than or equal to RATIO, THEN
      1. Eliminate this aircraft from deployment.
   E. ELSE
      1. CALL FASCFD: Convert aircraft type from ASCII to fielddata.
      2. CALL CNVRT: Convert aircraft type from fielddata to integer representation (0 indicates an ATCRBS transponder, 1 indicates Mode S, and 3 indicates TCAS II M).
      3. Convert latitude and longitude data from degrees, minutes, and seconds to radians.
      4. Determine whether the latitudes are north or south, and whether the longitudes are east or west.
      5. Load the position, type, and velocity in the aircraft characteristics file.
      6. Count the number of each type of aircraft.
      7. Store the interrogation and suppression rates.
1. END IF
2. END LOOP
3. Return.

Called by: CIRCAS
Subroutines called: CNVRT, RANN
System routines used: FASCFD
3.3.6 Subroutine: CNVRT

PURPOSE: To determine the type of each aircraft and convert it from field data to integer form.

INPUTS: Aircraft type (in field data form).

PROCEDURE: The aircraft type is passed to this subroutine as field data. This data is evaluated and an integer value that indicates whether the aircraft is ATCRBS-, Mode S-, or TCAS II M-equipped is assigned to the type variable. This value is then passed back to the calling routine.

OUTPUTS: Aircraft type (in integer form).

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft type</td>
<td>ITYPE</td>
</tr>
</tbody>
</table>

PROCESS:

1. CASE the six most significant bits of aircraft type OF
   A. 9: ITYPE = 1 (Mode S-equipped aircraft)
   B. 7:25: ITYPE = 3 (TCAS II M-equipped aircraft)
   C. Others: ITYPE = 0 (ATCRBS-equipped aircraft)

2. END CASE

3. Return.

Called by: INPUT

Subroutines called: None
3.3.7 Subroutine: RANN

PURPOSE: To generate a random number between zero and one.

INPUTS: None.

PROCEDURE: The first time this routine is performed, a large number is assigned to the "seed," which is the variable that is used to produce the random numbers. This seed is multiplied by an integer which is sufficiently large to cause an overflow of bits in the register holding the seed. The random number is obtained by shifting the bits back down such that the number is positive and no greater than one.

OUTPUTS: A random number having a value between zero and one.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random number between zero and one</td>
<td>RAN</td>
</tr>
</tbody>
</table>

PROCESS:

1. IF subroutine has not been run before THEN
   A. Set seed equal to a large integer value.
   B. Set flag that indicates subroutine has been run.
2. END IF
3. Multiply seed by a large integer value.
4. Produce random number by dividing the absolute value of the seed by (approximately) $2^{25}$, which corresponds to the largest integer value the computer is capable of retaining.
5. Return.

Called by: INPUT, TRANSP, TSTART, DISMOD, TSQUIT
Subroutines called: None
3.3.8 Subroutine: **TRANSP**

**PURPOSE:** To assign transmit power and receiver sensitivity characteristics for each transponder.

**INPUTS:** Number of aircraft in model; nominal Mode S power and sensitivity, and standard deviations from each; and nominal TCAS II M power and sensitivity levels with corresponding standard deviations.

**PROCEDURE:** A normal distribution of random numbers is generated and used to assign the transmitter powers and receiver sensitivities of each Mode S and TCAS II M aircraft in the environment. The transmitter power and sensitivity for each ATCRBS aircraft is assigned using measured data documented in Reference 9.

**OUTPUTS:** Transponder characteristic arrays: Transmission power levels for each aircraft and receiver sensitivity for each aircraft.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission power for each aircraft</td>
<td>JTRANS</td>
</tr>
<tr>
<td>Sensitivities for each aircraft</td>
<td>JSENS</td>
</tr>
</tbody>
</table>

**PROCESS:**

1. Set starting points for random number generator.
2. CALL RANDN: Set up array of pseudo-random numbers which follow a normal distribution and are used to predict Mode S power levels (nominal value is 27.0; standard deviation is 1.5).
3. CALL RANDN: Set up array of pseudo-random numbers which follow a normal distribution and are used to predict TCAS II M power levels (nominal value is 29.2; standard deviation is 0.5).
4. LOOP over all aircraft in model.
   A. IF ATCRBS-equipped aircraft THEN
   1. CALL RANN: Get a random number.
2. Use probability distribution from ATC-9 to determine transmission power.
3. Store transmission power.

B. ELSE IF Mode S-equipped aircraft THEN
   1. Calculate transmission power of Mode S-equipped aircraft using number from normal distribution.
   2. Store transmission power.

C. ELSE IF TCAS II M-equipped aircraft THEN
   1. Calculate transmission power using number from normal distribution.
   2. Store the transmission power.

D. END IF

5. END LOOP

6. Set starting points for random number generator.
7. CALL RANDN: Set up array of pseudo-random numbers that follow a normal distribution and are used to predict Mode S sensitivity levels.
8. CALL RANDN: Set up array of pseudo-random numbers that follow a normal distribution and are used to predict TCAS II M sensitivity levels.

9. LOOP over all aircraft
   A. IF ATCRBS-equipped aircraft THEN
      1. CALL RANN: Get a random number.
      2. Use probability distribution from ATC-9 to determine sensitivity level.
      3. Store the sensitivity.
   B. ELSE IF Mode S-equipped aircraft THEN
      1. Set sensitivity equal to number from normal distribution.
      2. Store the sensitivity.
   C. ELSE IF TCAS II M-equipped aircraft THEN
      1. Set sensitivity equal to number from normal distribution.
      2. Store predicted value.
   D. END IF
10. **END LOOP**

11. Return.

Called by: CIRCAS.

Subroutines called: RANN

System routines used: RANDN
3.3.9 Subroutine: TSTART

PURPOSE: To set up a pointer array that locates TCAS II M-equipped aircraft in the aircraft deployment file, and to set the squitter phase for each TCAS II M-equipped aircraft.

INPUTS: Aircraft deployment file.

PROCEDURE: A loop is performed over all aircraft to determine and store the number of TCAS II M-equipped aircraft and the pointer arrays used to locate the TCAS II M in the aircraft file.

OUTPUTS: Number of TCAS II M-equipped aircraft, TCAS II M pointer file, and squitter phase start time of each TCAS II M squitter phase.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of TCAS II M-equipped aircraft</td>
<td>NUMTCA</td>
</tr>
<tr>
<td>TCAS II M pointer array</td>
<td>1111</td>
</tr>
<tr>
<td>Squitter phase start time</td>
<td>TCST</td>
</tr>
</tbody>
</table>

PROCESS:

1. LOOP over all aircraft.
   A. IF TCAS II M THEN
      1. Count the aircraft.
      2. Store its location in the pointer file.
      3. CALL RANN: Get a random number.
      4. Calculate squitter phase start time using the random number.
   B. END IF
2. END LOOP
3. Return.
Called by: CIRCAS
Subroutines called: RANN
3.3.10 Subroutine: LOAD

PURPOSE: At times 0, 40, 80, and 120 seconds: to update all aircraft positions; to compute heading of each TCAS II M (at time = 0 only); to update Mode S track file; to load array containing power, range, and bearing relationships between TCAS II M-equipped aircraft and victim aircraft; and to compute the air traffic densities about each TCAS II M, as well as the average density about all TCAS II M-equipped aircraft.

INPUTS: Aircraft deployment file, number of TCAS II M-equipped aircraft, Mode S track file, TCAS II M pointer file, simulation time, and the number of aircraft.

PROCEDURE: First, the velocity of each aircraft is used to update its location in the environment. The following data is then calculated and stored in the appropriate arrays: the relative position of other aircraft to each TCAS II M, the aircraft that belong in the track file, the power received by each TCAS II M from other aircraft, and the local air traffic densities within 5, 10, and 30 nmi of each TCAS II M.

OUTPUTS: Updated aircraft deployment file, updated Mode S track file, updated TCAS II M environmental array, and air traffic density about each TCAS II M within 10 nmi.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft characteristics file</td>
<td>TJFILE</td>
</tr>
<tr>
<td>TCAS II M headings</td>
<td>THETA</td>
</tr>
<tr>
<td>Track file</td>
<td>ITRACK</td>
</tr>
<tr>
<td>TCAS II M environmental array</td>
<td>ICASFI</td>
</tr>
<tr>
<td>Density about each TCAS II M</td>
<td>DENS</td>
</tr>
</tbody>
</table>
Number of TCAS II M-equipped aircraft \( \text{NUMTCA} \)
Simulation time \( \text{ITIME} \)
TCAS II M pointer file \( \text{I111} \)
Number of aircraft \( \text{NAC} \)

**PROCESS:**

1. **IF** time does not equal zero **THEN**
   
   A. Calculate the new latitude by adding forty seconds times the latitudinal velocity to the old latitude \( x = x_{t-40} + 40V_x \).
   
   B. Calculate the new longitude by adding forty seconds times the longitudinal velocity to the old longitude \( y = y_{t-40} + 40V_y \).
   
   C. Calculate the new altitude by adding forty seconds times the upward velocity to the old altitude \( z = z_{t-40} + 40V_z \).
   
   D. Store these new positions.

2. **END IF**

3. **LOOP** over all TCAS II M-equipped aircraft
   
   A. Find the location of the TCAS II M in the general aircraft characteristics file.
   
   B. Compute the heading of the aircraft by finding the angle formed by the velocity components \( \theta = \arcsin \left( \frac{v_y}{(v_x^2 + v_y^2)^{1/2}} \right) \).
   
   C. Adjust the angle to fit into the coordinate system where north is at zero degrees, west is at 90, south is at 180, and east is at 270.
   
   D. If the aircraft is heading eastward, subtract the adjusted angle in 3.C from 360°. (The calculation in 3.C assumes westward motion.)
   
   E. Convert this angle to radians.
   
   F. Zero out local aircraft counters.
   
   G. Get the latitude (radians), longitude (radians), and altitude (statute miles) of the TCAS II M-equipped aircraft.
   
   H. **LOOP** over all aircraft
      
      1. Get the victim aircraft's latitude (radians), longitude (radians), and altitude (miles).
2. CALL HBAR: Compute the horizontal distance (miles) and angle (radians) between TCAS II M and victim aircraft.

3. Find the altitude difference (nmi) between the TCAS II M and victim aircraft.

4. Find the slant range (straight-line distance) between the two aircraft. (horizontal distance$^2$ + vertical distance$^2$)$^{1/2}$

5. IF victim aircraft is TCAS II M- or Mode S-equipped THEN
   a. IF the two aircraft are within 50 nmi of each other
      AND their difference in altitude is less than 9000 feet
      THEN
      1. Add the victim aircraft to the track file if it is not already there.
   b. ELSE
      1. Remove the victim aircraft from the track file if it is there.
   c. END IF

6. END IF

7. Determine the free space power loss (Power loss = 37.80 + 20log$_{10}$(1030) + 20log$_{10}$ slant range + 3.0 - 60.0) where 1030 is the interrogation frequency in MHz, the slant range is in nautical miles, 3.0 is the transponder cable loss in dB, 60.0 converts from kW to mW, and 37.80 is the constant adjustment factor to account for units of MHz and nmi).

8. Compute aircraft densities around each TCAS aircraft.

9. IF the two aircraft are separated by at least 50 nmi THEN
   a. Remove the victim aircraft from the TCAS II M environmental array.

10. ELSE
    a. Increment appropriate local aircraft counters if the victim is within 10 nmi of the TCAS II M.
b. Store the relative range, bearing, and power, and the type of victim aircraft in the TCAS II M environmental file.

11. END IF
   I. END LOOP
4. END LOOP
5. Return.

Called by: CIRCAS
Subroutines called: BEAR
3.3.11 Subroutine: BAR

PURPOSE: To calculate the horizontal distance and angle between the TCAS I or TCAS II M aircraft of interest and the victim aircraft (see Figure 3-2).

INPUTS: TCAS-equipped aircraft's latitude and longitude (in radians), the victim aircraft's latitude and longitude (in radians), and the radius of the earth (in statute miles).

PROCEDURE: The two-dimensional locations (latitude and longitude) of two aircraft are used to calculate the horizontal range and bearing relative to North using a flat earth approximation.

OUTPUTS: The horizontal distance between the two aircraft (in statute miles) and the bearing angle (measured from the north, in radians) between the two aircraft.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radius of the earth</td>
<td>RADIUS</td>
</tr>
<tr>
<td>TCAS latitude</td>
<td>TLAT</td>
</tr>
<tr>
<td>TCAS longitude</td>
<td>TTON</td>
</tr>
<tr>
<td>Victim latitude</td>
<td>RLAT</td>
</tr>
<tr>
<td>Victim longitude</td>
<td>RLLON</td>
</tr>
<tr>
<td>Distance between the two aircraft</td>
<td>DIST</td>
</tr>
<tr>
<td>Bearing angle between the two aircraft</td>
<td>BBARTX</td>
</tr>
</tbody>
</table>

PROCESS:

1. Calculate the difference in latitudes between the two aircraft.
2. Calculate the difference in longitudes between the two aircraft.
3. Calculate the longitude scaling factor (the cosine of the average of the two latitudes).
4. Scale the difference in longitudes (multiply it by the scaling factor).
Figure 3-2. Illustration of bearing calculations.
Section 3

5. Find the straight line distance between the two aircraft (the distance is the square root of the sum of the square of the difference in latitudes plus the square of the scaled difference in longitudes).

6. IF the difference in longitudes is less than one thousandth of a statute mile, THEN
   A. Set the difference in longitude to one thousandth of a statute mile to prevent division by zero in the bearing calculation.

7. END IF

8. Calculate the angle between the two aircraft (arctan (- difference in latitudes / scaled difference in longitudes)).

9. Adjust the axis so that due north is the zero point.

10. IF the angle is negative THEN
    A. Add 2π to it to make it positive.

11. END IF

12. Return.

Called by: LOAD, TCAS1
Subroutines called: None
3.3.12 Subroutine: **PRESET**

**PURPOSE:** To estimate the interference-limiting state of each TCAS II M-equipped aircraft.

**INPUTS:** Number of each type of aircraft, track file, TCAS II M environmental array, aircraft deployment file, and transponder characteristic arrays.

** PROCEDURES:** At the start of the simulation, the number of Mode S and TCAS II M-equipped aircraft within 35, 30, and 7.16 nmi of each TCAS II M aircraft are computed and used to estimate the number of aircraft in the squitter, acquisition, and roll-call states. Empirical estimates on the number of Mode S interrogations are made and used to preset the Mode S sensitivity and power levels according to the interference-limiting inequalities.

**OUTPUTS:** Adjusted transmission power and sensitivity levels for each TCAS II M-equipped aircraft.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of:</td>
<td></td>
</tr>
<tr>
<td>TCAS II M-equipped aircraft</td>
<td>NUMTCA, ITCA</td>
</tr>
<tr>
<td>Mode S-equipped aircraft</td>
<td>IDAB</td>
</tr>
<tr>
<td>Track file</td>
<td>ITRACK</td>
</tr>
<tr>
<td>TCAS II M environmental array.</td>
<td>ICASFI</td>
</tr>
<tr>
<td>Aircraft deployment file</td>
<td>TJFILE</td>
</tr>
<tr>
<td>Transmission power for each aircraft</td>
<td>JTRANS</td>
</tr>
<tr>
<td>Adjusted transmission power for TCAS II M</td>
<td>AMSP</td>
</tr>
<tr>
<td>Sensitivity levels for each aircraft</td>
<td>JSENS</td>
</tr>
<tr>
<td>Adjusted sensitivities for TCAS II M-equipped aircraft</td>
<td>SESIT</td>
</tr>
</tbody>
</table>
PROCESS:

1. LOOP over all TCAS II M-equipped aircraft.
   A. Reset squitter, acquisition, and roll-call target counters.
   B. Get altitude of TCAS II M.
   C. LOOP over all 500 tracks.
      1. Get aircraft number.
      2. If aircraft has been removed from file, go on to the next track.
      3. Get aircraft type.
      4. If ATCRBS-equipped aircraft, go on to the next track.
      5. Get slant range (nmi) between TCAS II M and victim.
      6. If slant range is over 35 nmi, go on to the next track.
      7. Increment the squitter count by one.
      8. If slant range is over 30 nmi, go on to the next track.
     10. Find the difference in the altitudes of the two aircraft.
     11. If the difference in the altitudes is over 9000 feet, go on to the next track.
     12. If the slant range is greater than 7.16 nmi, increment the number in acquisition range.
     13. If the slant range is less than or equal to 7.16 nmi, increment the number in roll-call range.
   D. END LOOP
   E. Multiply the squitter count by the ratio of TCAS II M-equipped aircraft to all the Mode S-equipped aircraft (all TCAS II M-equipped aircraft are Mode S-equipped) to find the total number of squitter targets.
   F. DO WHILE inequality (2-1) is not satisfied AND no more than seven adjustments have been made. (See Reference 6.)
      1. Make power and sensitivity adjustment.
      2. Compute interference-limiting equation.
   G. END WHILE
   H. Set up new array of sensitivities with adjustment calculated above.
I. Set up new array of transmission power with above adjustment.

2. END LOOP

3. Return.

Called by: CIRCAS

Subroutines called: None.
3.3.13 Subroutine: TCASI

PURPOSE: To determine the effects of deploying TCAS I-equipped (all Mode S-equipped aircraft are assumed to be TCAS I-equipped) aircraft in the environment.

INPUTS: Aircraft deployment file, antenna patterns, and sensitivity levels.

PROCEDURE: For all aircraft in the environment, the received power from each TCAS I aircraft is calculated. If the received power is greater than the receiver sensitivity, the number of TCAS I interrogations received is incremented by one.

OUTPUTS: The expected number of TCAS I interrogations per second received at each aircraft.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
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<tbody>
<tr>
<td>Aircraft deployment</td>
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<tr>
<td>Antenna patterns:</td>
<td></td>
</tr>
<tr>
<td>Top (transmitting)</td>
<td>ANTTOP</td>
</tr>
<tr>
<td>Bottom (transmitting)</td>
<td>ANTBOT</td>
</tr>
<tr>
<td>Bottom (receiving)</td>
<td>PASBOT</td>
</tr>
<tr>
<td>Top (receiving)</td>
<td>PASTOP</td>
</tr>
<tr>
<td>Sensitivity levels</td>
<td>JSENS</td>
</tr>
<tr>
<td>Expected number of TCAS I interrogations per second</td>
<td>ATCRAT</td>
</tr>
</tbody>
</table>

PROCESS:

1. LOOP over all aircraft, selecting only TCAS I-equipped aircraft.
   A. Get latitude, longitude, and altitude of TCAS I.
   B. LOOP over all aircraft.
      1. Get latitude, longitude, and altitude of victim aircraft.
      2. CALL BEAR: Get horizontal distance between two aircraft.
3. Find the difference in altitudes (nmi).
4. Determine the angle between the aircraft.
5. Using that angle, look up the antenna gains for top and bottom antennas.
6. Determine total gain (add TCAS I gain to victim gain).
7. Calculate free space power loss.
8. Using results from 1.R.6 and 1.R.7, find received power.
9. IF received power is above sensitivity level of victim (i.e., signal is detectable) THEN
   a. Count the interrogation at that aircraft.
10) END IF
C. END LOOP
2. END LOOP
3. Return.

Called by: CIRCAS
Subroutines called: BEAR
3.3.14 Subroutine: AMTGAN

PURPOSE: To store elevation antenna patterns between TCAS II M-equipped aircraft and victim aircraft.


PROCEDURE: The antenna coupling between each TCAS II M aircraft and all other aircraft is computed based on the elevation angle between the aircraft. The value of the antenna coupling is stored in the aircraft deployment file.

OUTPUTS: Aircraft deployment file.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft deployment file</td>
<td>TFILE</td>
</tr>
<tr>
<td>TCAS II M environmental file</td>
<td>ICASFI</td>
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<tr>
<td>TCAS II M pointer file</td>
<td>I111</td>
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<td>Antenna patterns:</td>
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<tr>
<td>Top (transmitting)</td>
<td>ANTTOP</td>
</tr>
<tr>
<td>Bottom (receiving)</td>
<td>PASTOP</td>
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<tr>
<td>Bottom (transmitting)</td>
<td>ANTBOT</td>
</tr>
<tr>
<td>Top (receiving)</td>
<td></td>
</tr>
</tbody>
</table>

PROCESS:

1. Find the location of the TCAS II M in the aircraft deployment file.
2. Get the altitude of the TCAS II M.
3. LOOP over all aircraft.

A. Reset the gain column of the aircraft deployment file.
B. IF the aircraft is within 50 nmi of the TCAS II M THEN
   1. Get the aircraft's altitude.
2. Get the slant range between the two.
3. Calculate the difference in their altitudes.
4. Calculate the horizontal distance between them.
5. Calculate the elevation angle between the two aircraft.
6. Look up the couplings at the calculated angles and interpolate to find a more exact approximation.
7. Store the couplings.

C. END IF

4. END LOOP

5. Return.

Called by: CIRCAS
Subroutines called: None.
3.3.15 Subroutine: FRUITA

PURPOSE: To determine the fruit received at the TCAS II M-equipped aircraft. To compute the reply efficiency for each aircraft.

INPUTS: Interrogation and suppression rates for each aircraft, TCAS II M environmental array, aircraft deployment file, TCAS II M-equipped aircraft identity, transmission power and sensitivities for each aircraft.

PROCEDURE: For all aircraft in the environment, the probability of reply is calculated from the dead time caused by all incoming interrogations and suppressions. The ATCRBS fruit rate due to a given aircraft is the product of the received ATCRBS interrogation rate times the probability of reply. The total fruit rate at each TCAS II M aircraft is found by summing the fruit rates contribution from all aircraft within range of the TCAS II M aircraft.

OUTPUTS: Fruit seen by TCAS II M, probability of reply for each aircraft.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interrogation rate for each aircraft</td>
<td>IADJIN</td>
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<tr>
<td>Suppression rate for each aircraft</td>
<td>IADJSU</td>
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<tr>
<td>TCAS II M environmental array</td>
<td>ICASFI</td>
</tr>
<tr>
<td>Aircraft deployment file</td>
<td>TJFILE</td>
</tr>
<tr>
<td>Interrogation and suppression totals from previous second</td>
<td>STAT</td>
</tr>
<tr>
<td>Misaddressed totals from previous second</td>
<td>MIS</td>
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<tr>
<td>TCAS II M identity</td>
<td>II</td>
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<tr>
<td>Transmission power for each aircraft</td>
<td>JTRANS</td>
</tr>
<tr>
<td>Sensitivity level for each aircraft</td>
<td>JSENS</td>
</tr>
<tr>
<td>Fruit level seen by TCAS II M-equipped aircraft</td>
<td>FRUIT</td>
</tr>
<tr>
<td>Probability of reply for each aircraft</td>
<td>PREP</td>
</tr>
</tbody>
</table>
PROCESS:

1. IF at the beginning of a new search cycle THEN
   A. LOOP over all aircraft.
      1. Save misaddressed totals from last second.
      2. Save interrogation totals from last second.
      3. Save suppression totals from last second.
   B. END LOOP
2. END IF
3. Locate the TCAS II M aircraft in the list of aircraft.
4. Zero out fruit counter for the TCAS II M.
5. LOOP over all aircraft.
   A. If victim aircraft is out of range of the TCAS II M, go on to the next aircraft.
   B. Find the type of the victim aircraft.
   C. Get number of interrogations victim received during the previous second.
   D. Get suppressions of victim from previous second.
   E. IF ATCRBS-equipped aircraft THEN
      1. Set suppression time to 35 microseconds.
      2. Set dead time due to interrogations to 60 microseconds.
   F. ELSE
      1. Set suppression time to 20 microseconds.
      2. Set interrogation dead time to 24 microseconds.
   G. END IF
   H. Calculate the total dead time due to interrogations.
   I. Calculate the total dead time due to ground ATC, TCAS II M suppressions, and TCAS II M misaddresses.
   J. Sum the above to find the total dead time.
   K. Estimate and store the probability of reply for that aircraft.
   L. Compute antenna coupling between victim and TCAS II M-equipped aircraft.
   M. Get propagation loss between TCAS II M-equipped aircraft and victim aircraft from TCAS II M environmental file.
N. Add this power to the transmission power of the victim in dBm plus a constant adjustment factor.

O. Make further adjustments if victim aircraft is TCAS II M-equipped.

P. Add this power to the gain to get total power.

Q. IF total power is greater than the TCAS II M-equipped aircraft's sensitivity, THEN
   1. Compute and store the fruit received at TCAS II M-equipped aircraft from victim aircraft.

R. END IF

6. END LOOP

7. Return.

Called by: CIRCAS

Subroutines called: None.
3.3.16 Subroutine: **DISMOD**

**PURPOSE:** To schedule Mode S discrete interrogations.

**INPUTS:** Adjusted TCAS II M sensitivities, TCAS II M environmental file, TCAS II M identity, aircraft deployment file, fruit level seen by each TCAS II M, adjusted TCAS II M power levels, misaddresses, total interrogations received by each aircraft, maximum interrogation failures allowed for each scan of each acquisition trial, aircraft sensitivities, Mode S track file, TCAS II M pointer file, simulation time, and aircraft transmission powers.

**PROCEDURE:** Each aircraft in the track file of the TCAS II M is examined and its state is determined. Using statistical methods, this subroutine schedules discrete Mode S interrogations and simulates the development of target track states. The victim aircraft are moved from state to state as necessary and the various timers are adjusted as necessary.

**OUTPUTS:** Mode S replies received at each TCAS II M-equipped aircraft, Mode S addresses to each aircraft, Mode S interrogation counter, number of victim aircraft in dormancy, acquisition counter, dormancy counter, roll call counter, squitter state counter, null state counter, number of aircraft TCAS II M has of interest in roll call, top or bottom antenna indicator, victim aircraft identity, the number of TCAS II M transmissions, and the Mode S track file.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted TCAS II M sensitivities</td>
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<tr>
<td>Interrogation rate at each TCAS II M</td>
<td>DRATE</td>
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<tr>
<td>TCAS II M environmental file</td>
<td>ICASFI</td>
</tr>
<tr>
<td>TCAS II M identifier</td>
<td>II</td>
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<tr>
<td>Type of each aircraft</td>
<td>IJFILE</td>
</tr>
<tr>
<td>Aircraft deployment file</td>
<td>TJFILE</td>
</tr>
</tbody>
</table>

3-40
Fruit level seen by each TCAS II M
Adjusted TCAS II M power levels
Misaddresses
Addressed rate to each aircraft
Total number of interrogations received
Maximum interrogation rate in roll call
Maximum failed interrogations/scan
Trial 1
Trial 2
Trial 3
Trial 4 and above
Mode S interrogation rate count
Number of aircraft in dormancy state
Acquisition counter
Dormancy counter
Roll call counter
Squitter state counter
Null state counter
Number of aircraft in roll call
Aircraft sensitivities
Indicates where TCAS II M transmitted
Victim aircraft
TCAS II M transmissions
Mode S track file
TCAS II M pointer file
Elapsed time in simulation
Aircraft transmission powers

PROCESS:
1. IF at the beginning of a search cycle THEN
   A. Zero out counters for roll call, dormancy, acquisition, and null states, as well as the interrogation, suppression, and misaddress counter arrays.
2. END IF
3. Set the number of Mode S tracks to 500.
4. Zero out the interrogation counter at the TCAS II M.
5. Locate TCAS II M in aircraft characteristics file.
6. Find the altitude of the TCAS II M in statute miles.
7. Initialize the number of interrogations sent by TCAS II M to zero.
8. Initialize the number of other TCAS II M-equipped aircraft detected by the given TCAS II M to zero.
9. LOOP over the 500 tracks.
   A. Skip if there is no aircraft in this track.
   B. Get identity of aircraft in track.
   C. Determine the floating point and integer averages of the number of interrogations received by the victim aircraft.
   D. Find the difference between the floating point and integer averages.
   E. CALL RANN: Get a random number.
   F. IF the random number is greater than the fractional portion of the average THEN
      1. Add one to the integer average.
   G. END IF
   H. IF the integer average is less than one THEN
      1. Set it equal to one.
   I. END IF
   J. .Find the altitude of the victim aircraft in statute miles.
   K. Find the absolute difference in the altitudes of the two aircraft.
   L. Get the slant range between the two aircraft.
   M. Find the victim aircraft type.
   N. Skip the rest of this loop if victim is ATCRBS-equipped.
   O. Get the received power at the victim aircraft from the TCAS II M transmissions.
   P. Find the interrogation power of the TCAS II M.
   Q. Find the reply power of the victim.
R. Determine the antenna gains of the TCAS II M-equipped aircraft and the victim aircraft and sum them to find the total gain.

S. The total interrogation power is the quantity found in 9.P plus the total gain.

T. The total reply power is the quantity found in 9.Q plus the total gain.

U. IF the victim aircraft is TCAS II M-equipped AND its reply power is above the sensitivity of the TCAS II M THEN
   1. CALL TSQUIT: Count the TCAS II M-equipped aircraft detected by squitter and set the squitter start time.

V. END IF

W. IF the fruit seen by the TCAS II M-equipped aircraft is less than 100 THEN
   1. Set the fruit level to 100.

X. END IF

Y. Find the probability of clear reception of the victim aircraft's reply signal by the TCAS II M-equipped aircraft using a curve-fitting technique. (The probability of clear reception depends on the received power and the fruit level seen by the TCAS II M. The curves were supplied by Lincoln Laboratory and are sinusoidal in nature on the intervals under consideration.)

Z. Find the maximum relative velocity of the two aircraft.

AA. Find the Time to Endanger (TE = range/maximum relative velocity).

BB. Set the decode indicator to zero (false).

CC. Get the trial, scan, clock, and state values from the Mode S track file.

DD. IF the victim's reply power is below the TCAS II M-equipped aircraft's transponders instantaneous sensitivity THEN
   1. Set the probability of decode to zero.

EE. END IF
IF the victim's reply power is below the TCAS II M sensitivity OR the victim is currently in the null state THEN
1. Set the number of squitters received equal to zero.
2. Increment the null state counter by one.
3. CALL RANN: Get a random number.
4. IF the random number is less than the probability of decode AND the aircraft is in the null state THEN
   a. Increment the number of received squitters by one.
END IF

IF the TCAS II M received one squitter from the victim THEN
a. Place the aircraft in the squitter state.
b. Set the timer to 16 seconds. (This is the time during which a second squitter must be received in order for the aircraft to be placed in a higher state).

ELSE
a. Place the aircraft in the null state.
b. Set the timer to zero.
c. Set the scan number to zero.
d. Set the trial to zero.
e. Set the acquisition correlating reply indicator equal to zero.

END IF

ELSE IF the aircraft is in the squitter state THEN
1. Decrement the timer by one.
2. Increment the squitter state counter by one.
3. IF the sequence of scans has begun THEN
   a. IF on the first scan THEN
      1. Set the clock increment to 20.
   b. ELSE IF on the second scan THEN
      1. Set the clock increment to 16.
   c. ELSE IF on the third scan THEN
      1. Set the clock increment to 8.
   d. ELSE IF on the fourth scan THEN
      1. Set the clock increment to 4.

END IF
Section 3

1. Set the clock increment to 2.

2. IF the random number is less than the probability of decode THEN
   a. Add the clock increment to the timer.
   b. Set the decode indicator to one (true).
   END IF

3. IF the clock has reached or exceeded zero THEN
   a. Put the victim aircraft in the acquisition state.
   b. Set the scan indicator to zero.
   c. Proceed to the next trial.
   d. IF the trial number is greater than four THEN
      1. Set the trial to four.
   END IF

4. END IF

5. END LOOP

6. CALL RANN: Get a random number.

7. IF the random number is less than the probability of clear reply THEN
   1. Add the clock increment to the timer.
   END IF

8. END IF

9. IF the timer has reached or exceeded zero THEN
   1. Put the victim aircraft in the acquisition state.
   2. Set the scan indicator to zero.
3. Proceed to the next trial.
4. IF the trial number is greater than four THEN
   a. Set the trial number to four.
5. END IF
6. Zero out the clock.

m. ELSE IF the timer is less than or equal to -40 THEN
   1. Place the aircraft in the null state.
   2. Set the trial and scan indicators to zero.
   3. Zero out the clock.
   4. Set the acquisition reply indicator to zero.

n. END IF
4. ELSE IF the timer is greater than or equal to -1 THEN
   a. Set the number of squitters received to zero.
   b. LOOP over one less than the average number of TCAS II M interrogations.
      1. CALL RANN: Get a random number.
      2. IF the random number is less than the probability of decode THEN
         a. Set the decode indicator to one (true),
         b. Add one to the number of squitters received.
         c. END LOOP
   3. END IF
   c. END LOOP
d. CALL RANN: Get a random number.
e. IF the random number is less than the probability of clear reply THEN
   1. Add one to the number of squitters received.
f. END IF
g. IF the number of squitters received is not equal to zero THEN
   1. IF a squitter has been correctly decoded AND the altitudes of the two aircraft differ by more than 9000 feet THEN
      a. Set the clock to 16 seconds.
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2. ELSE
   a. Place the victim aircraft in the acquisition state.
   b. Increment the trial number if it is less than four.
   c. Set the clock to zero.
3. END IF
   h. END IF
5. ELSE
   a. Set the clock to zero.
   b. Place the aircraft in the null state.
   c. Set the trial and scan indicators to zero.
   d. Set the acquisition reply indicator to zero.
6. END IF
   H H. ELSE IF the victim aircraft is in the acquisition state THEN
   1. Increment the scan indicator.
   2. Increment the acquisition counter.
   3. IF all six scans of the trial sequence have been completed THEN
      a. Place the victim aircraft in the squitter state.
      b. Set the scan back to zero.
      c. Set the clock to zero.
      d. Set the acquisition reply indicator to zero.
   4. ELSE
      a. Look up the number of failed interrogations allowed during this scan.
      b. IF the number of failed interrogations is not equal to zero THEN
         1. Set the correlating reply counter to zero.
         2. DO WHILE the TCAS II M has received less than two correlating replies AND the maximum number of failures has not been exceeded.
            a. CALL RANN: Get a random number between zero and one.
b. Increment the TCAS II M transmission counter by one.

c. Determine from which TCAS II M antenna the victim aircraft received the interrogation.

d. Add one to the Mode S interrogation rate counter.

e. Increment the TCAS II M interrogation rate counter.

f. IF the interrogation power received by the victim is greater than or equal to its sensitivity THEN

1. Increment the Mode S address counter.

2. IF the random number is less than the probability of the TCAS II M receiving a correlating reply THEN

   a. Increment the correlating reply counter.

3. END IF

4. IF the TCAS II M has received two correlating replies THEN

   a. Set the scan and trial indicators to zero.

   b. Reset the acquisition reply indicator.

   c. IF the time to endanger is greater than 43 seconds THEN

      1. Place the victim aircraft in the dormancy state.

      2. Set the clock to the time to endanger minus 43 seconds.

      3. Increment the dormancy counter.
d. ELSE

1. Place the victim aircraft in the roll call state.
2. Set the clock to zero.

e. END IF

5. END IF

g. END IF

4. END WHILE

5. IF the TCAS II M-equipped aircraft received one and only one reply during the scan THEN

a. IF this was the final scan OR a reply was received during a previous scan THEN

1. IF the time to endanger is greater than 43 seconds THEN

a. Set the trial, scan, and reply indicators to zero.

b. Place the victim aircraft in the dormancy state.

c. Set the clock to the time to endanger minus 43 seconds.

d. Add one to the dormancy counter.

2. ELSE IF a reply was received during a previous scan (but the time to endanger is within 43 seconds) THEN

a. Place the aircraft in the roll call state.

b. Set the clock to zero.

c. Set the scan, trial, and reply indicators to zero.

3. END IF

b. ELSE (if this wasn't the final scan and no other replies have been received)

1. Set the reply indicator to one.

c. END IF

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6. END IF
   c. END IF
5. END IF
II. ELSE IF the victim aircraft is in the roll call state THEN
   1. Increment the scan indicator.
   2. Increment the roll call counter.
   3. IF all ten roll call scans have been completed THEN
      a. Place the victim aircraft in the squitter state.
      b. Set the clock to 16 seconds.
      c. Set the trial, scan, and reply indicators to zero.
   4. ELSE
      a. Find the maximum number of interrogations allowed.
      b. DO UNTIL a correlating reply is received.
         1. CALL RANN: Get a random number.
         2. Increment the TCAS II M interrogation counter.
         3. Determine the TCAS II M antenna from which the victim received the interrogation.
         4. Add one to the Mode S interrogation rate counter.
         5. Add one to the roll call interrogation counter.
         6. IF the interrogation power the victim aircraft received is above its sensitivity level THEN
            a. Add one to the Mode S address counter.
            b. IF the random number is below the probability of a correlating reply THEN
               1. Set the scan indicator to zero.
               2. IF the time to endanger is greater than 40 seconds THEN
                  a. Place the aircraft in dormancy.
                  b. Increment the dormancy counter.
                  c. Set the clock to the time to endanger minus 40 seconds.
               3. END IF
            c. END IF
   7. END IF
c. END UNTIL

5. END IF

JJ. ELSE IF the victim aircraft is in the dormancy state THEN

1. Decrement the clock.
2. Increment the dormancy counter.
3. IF there is no time left on the clock THEN
   a. Place the aircraft in the squitter state.
   b. Set the clock to 16 seconds.
   c. Set the trial, scan, and reply indicators to zero.
4. END IF

KK. END IF

LL. Store the clock, state, scan, trial, and reply information.

MM. Total the number of TCAS II M interrogations made.

10. END LOOP

11. Return.

Called by: CIRCAS

Subroutines called: RANN, TSQUIT
3.3.17 Subroutine: TSQUIT

PURPOSE: To count the number of TCAS II M-equipped aircraft detected by squitters and to set the squitter phase.

INPUTS: TCAS II M identity, victim aircraft (also TCAS II M-equipped) identity, number of TCAS II M-equipped aircraft, TCAS II M pointer file, elapsed time in simulation, probability of reply for each aircraft, and the TCAS II M squitter phase.

PROCEDURE: The number of TCAS II M aircraft that are detected by squitter (NTADS) at each TCAS II M aircraft is incremented by one when the received power of the squitter is greater than the receiver sensitivity, the probability of reception of a pulse is sufficiently high, and the TCAS II M aircraft is not currently in the squitter file. The NTADS is decremented if the TCAS II M aircraft is in the squitter file and the elapsed time since the reception of the last squitter is greater than 20 seconds.

OUTPUTS: Number of TCAS II M-equipped victim aircraft detected, and the squitter phase for the given TCAS II M.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCAS II M identity</td>
<td>II</td>
</tr>
<tr>
<td>Victim aircraft identity</td>
<td>K</td>
</tr>
<tr>
<td>Number of TCAS II M detected</td>
<td>NOW</td>
</tr>
<tr>
<td>Number of TCAS II M-equipped aircraft</td>
<td>NUMTCA</td>
</tr>
<tr>
<td>TCAS II M pointer file</td>
<td>I111</td>
</tr>
<tr>
<td>Elapsed time in simulation</td>
<td>ITIME</td>
</tr>
</tbody>
</table>
Probability of reply for each aircraft PRRP
TCAS II M squitter phase TCST

PROCESS:

1. Get the identity of the k-th TCAS II M aircraft.
2. Initialize time of last squitter if necessary.
3. Get time of last received squitter from squitter file.
4. Compute elapsed time since last received squitter (At).
5. IF time=1 THEN
   A. Add to the squitter all TCAS II M aircraft that are detected and have a probability of reply greater than a random number.
   B. Count the number of aircraft detected by squitter.
6. ELSE IF At>20 and k-th TCAS is in the squitter file, THEN
   A. Decrement the number of TCAS detected by squitter by 1.
   B. Delete k-th aircraft from the squitter file.
7. ELSE IF At = 0, 10, or 20 and the k-th TCAS is not in the squitter files, THEN
   A. IF the received power is greater than the sensitivity, THEN
      1. Increment the number of TCAS detected by squitter by 1.
      2. Add k-th TCAS to squitter file.
   B. END IF
8. END IF
9. RETURN

Called by: DISMOD
Subroutines called: RANN
3.3.18 Subroutine: TCSNOT

PURPOSE: To produce time-averaged values of the emission powers and interrogation rates of all TCAS II M-equipped aircraft over a 16-second smoothing period.

INPUTS: Total interrogations transmitted by each TCAS II M-equipped aircraft during the past second, TCAS II M-equipped aircraft, adjusted TCAS II M transmission power, TCAS II M pointer file, simulation time, and transmission powers of all aircraft.

PROCEDURE: For each TCAS II M aircraft, the Mode S interrogation power and interrogation rates are stored for the previous 16 seconds of the simulation. The average power and rates are calculated using the stored values. If the simulation time is less than 16 seconds, the averages are computed for the entire simulation time.

OUTPUTS: Smoothed emission power and interrogation rate.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCAS II M identity</td>
<td>II</td>
</tr>
<tr>
<td>Total interrogations transmitted by each TCAS II M</td>
<td>DRATE</td>
</tr>
<tr>
<td>Adjusted TCAS II M transmission power</td>
<td>AMSP</td>
</tr>
<tr>
<td>Smoothed emission power</td>
<td>TIS</td>
</tr>
<tr>
<td>Smoothed interrogation rate</td>
<td>TPS</td>
</tr>
<tr>
<td>TCAS II M pointer file</td>
<td>I111</td>
</tr>
<tr>
<td>Elapsed time in simulation</td>
<td>ITIME</td>
</tr>
<tr>
<td>Transmission power of each aircraft</td>
<td>JTRANS</td>
</tr>
<tr>
<td>Values of all TCAS II M emission powers and interrogation rates for the past 16 seconds</td>
<td></td>
</tr>
</tbody>
</table>

3-54
PROCESS:


2. IF at the beginning of a new search cycle THEN
   
   A. Determine which column of the array holding all values of the interrogation rates and emission powers for the last sixteen seconds will be replaced with the new values.

   B. IF simulation time is at least sixteen seconds, THEN
      1. Set smoothing period to sixteen seconds.

   C. ELSE
      1. Set smoothing period to simulation time.

   D. END IF

3. END IF

4. Round the interrogation rate to the nearest integer and store the rounded value in the array holding the values from the last sixteen seconds.

5. Compute the power emitted by the TCAS II M-equipped aircraft at its last transmission and store this as an integer value in the array holding the values from the last sixteen seconds.

6. Zero out the last smoothed values for this particular TCAS II M.

7. LOOP over smoothing time interval.

   A. Sum the interrogation rates divided by the length of the time interval to produce the time-averaged rate.

   B. Sum the emission powers divided by the length of the time interval to produce the time-averaged rate.

8. END LOOP

9. Return.

Called by: CIRCAS

Subroutines called: None.
3.3.19 Subroutine: **DISINT**

**PURPOSE:** To compute Mode S addressed and misaddressed rates at each aircraft.

**INPUTS:** Mode S interrogations transmitted by each TCAS II M-equipped aircraft, the TCAS II M-equipped aircraft identity, number of aircraft in deployment, number of ATCRBS-equipped aircraft in deployment, adjusted TCAS II M emission power, transponder characteristic files, array that indicates whether the TCAS II M transmitted on the top or bottom antenna, the number of TCAS II M transmissions, the number of TCAS II M-equipped aircraft, TCAS II M pointer file, and the simulation time.

**PROCEDURE:** For all aircraft within range of the TCAS II M, the received power from each TCAS II M aircraft is calculated. A misaddress is counted if the received power is above the victim sensitivity, and an addressed interrogation is counted for each Mode S-equipped aircraft.

**OUTPUTS:** Mode S misaddresses and addresses to each aircraft, total addresses each aircraft received during entire simulation, and total addresses each aircraft received during previous search cycle.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total interrogations transmitted by each aircraft</td>
<td>CBRATE</td>
</tr>
<tr>
<td>TCAS II M identity</td>
<td>II</td>
</tr>
<tr>
<td>Number of aircraft in deployment</td>
<td>NAC</td>
</tr>
<tr>
<td>Number of ATCRBS-equipped aircraft</td>
<td>IATCR</td>
</tr>
<tr>
<td>Adjusted TCAS II M emission power</td>
<td>AMSP</td>
</tr>
<tr>
<td>Misaddresses at each aircraft</td>
<td>MIS</td>
</tr>
<tr>
<td>Mode S interrogations transmitted during previous search cycle</td>
<td>DRATE</td>
</tr>
<tr>
<td>Total interrogations each aircraft received during entire simulation</td>
<td>UPRATE</td>
</tr>
<tr>
<td>Sensitivity levels of all aircraft</td>
<td>JSENS</td>
</tr>
</tbody>
</table>
PROCESS:


2. LOOP over all aircraft.
   A. Skip all aircraft not within range of TCAS II M.
   B. Get antenna couplings between TCAS II M-equipped and victim aircraft.
   C. Get victim aircraft type.
   D. LOOP over all TCAS II M transmissions
      1. Determine which TCAS II M antenna transmitted the interrogation.
      2. Determine on which antenna the victim aircraft received the TCAS II M signal.
      3. Sum the gains associated with the two antennas above to determine the total gain.
      4. Get the free space propagation loss from the TCAS II M environmental file.
      5. Get the TCAS II M transmission power in watts and kilowatts.
      6. Calculate the total power loss in dB and add it to the total gain to determine the power received at the victim aircraft.
      7. If this power is greater than the victim sensitivity, count a misaddress.

E. END LOOP
3. END LOOP

4. IF at end of search cycle, THEN
   A. LOOP over all aircraft.
      1) IF not ATCRBS-equipped aircraft THEN
         a. Increment Mode S interrogation counter.
      2. END IF
      3. Add new Mode S addresses to all past addresses to get total for simulation.
      4. Set address rate equal to interrogation counter.
      5. Zero out interrogation counter.
   B. END LOOP

5. END IF

6. Return.

Called by: CIRCAS
Subroutines called: None.
3.3.20 **Subroutine: ATMOD**

**PURPOSE:** To determine the TCAS II M whisper-shout interrogation rate at each aircraft.

**INPUTS:** TCAS II M top antenna sum patterns, TCAS II M top antenna difference patterns, TCAS II M environmental file, antenna couplings between TCAS II M and victim aircraft, TCAS II M identity, number of aircraft in deployment, sensitivity level of all aircraft, TCAS II M pointer file, TCAS II M interrogations to ATCRBS-equipped aircraft, TCAS II M-produced ATCRBS suppressions, TCAS II M interrogations to Mode S, TCAS II M-produced Mode S suppressions, simulation time, transmission power levels of all aircraft, whisper-shout truncation, and elevation antenna patterns for all five TCAS II M antennas.

**PROCEDURE:** For each aircraft within 50 nmi of the given TCAS II M, the received power of each whisper-shout interrogation and suppression is computed. The number of suppressions received at the victim is incremented whenever the received power is greater than the victim receiver sensitivity, and the number of interrogations received is incremented when the received power is greater than the sensitivity and a suppression did not occur.

**OUTPUTS:** TCAS II M interrogations to ATCRBS, TCAS II M-produced ATCRBS suppressions, TCAS II M interrogations to Mode S, TCAS II M-produced Mode S suppressions.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCAS II M top antenna sum patterns</td>
<td>AZPAT</td>
</tr>
<tr>
<td>TCAS II M top antenna difference patterns</td>
<td>DIFPAT</td>
</tr>
<tr>
<td>TCAS II M environmental file</td>
<td>ICASFI</td>
</tr>
<tr>
<td>Antenna couplings between TCAS II M-equipped and victim aircraft</td>
<td>IJFILE</td>
</tr>
</tbody>
</table>

3-59
TCAS II M identity
Number of aircraft in deployment
Sensitivity levels of all aircraft
TCAS II M pointer file
TCAS II M interrogations to ATCRBS
TCAS II M-produced ATCRBS suppressions
TCAS II M interrogations to Mode S
TCAS II M-produced Mode A suppressions
Simulation time
Transmission power of all aircraft
Whisper-shout truncation
Truncation sequence:
  Back antenna
  Bottom antenna
  Front antenna
  Side antennas

PROCESS:

1. Get location of TCAS II M.
2. LOOP over all aircraft.
   A. Skip if aircraft is out of TCAS II M range.
   B. Find victim aircraft type.
   C. Find relative bearing (in degrees) between two aircraft.
   D. Get sensitivity of victim aircraft.
   E. Get antenna couplings.
   F. Find free space propagation loss between the two aircraft.
   G. Get transmission power of TCAS II M in watts.
   H. Find the total power without antenna gains (TCAS II M transmission power - free space propagation loss - cable losses).
   I. IF the received signal is undetectable (less than -84 dBm) THEN
      1. END LOOP
   J. END IF
   K. Find gain at victim antenna.
I. Get integer designating 90 degree sector between TCAS II M and victim.

M. LOOP over five TCAS II M antennas.

1. IF integer designating 90 degree sector being analyzed is greater than 36 (360 degrees) THEN
   a. Set it equal to 36 (360 degrees).
2. ELSE IF integer designating 90 degree sector being analyzed is less than zero THEN
   a. Add 36 (360 degrees) to it to make it positive.
3. ELSE IF integer designating 90 degree sector equals zero THEN
   a. Set it equal to one (10 degrees).
4. END IF
5. Get sum antenna pattern.
6. Get difference antenna pattern.
7. Move to next 90-degree sector if next antenna is not a front antenna.
8. Set drop between whisper-shout emissions to 3 dB.
9. LOOP over all whisper-shout levels.
   a. IF analyzing bottom antenna THEN
      1. Get whisper-shout power from array IPRBOT.
   b. ELSE IF analyzing top front antenna THEN
      1. Get whisper-shout power from array IPRF.
   c. ELSE IF analyzing right side antenna THEN
      1. Get whisper-shout power from array IPRS.
   d. ELSE IF analyzing rear antenna THEN
      1. Get whisper-shout power from array IPRB.
   e. ELSE (left side antenna)
      1. Get whisper-shout power from array IPRS.
   f. END IF
   g. IF the amount of power cut in interference limiting exceeds or equals the whisper-shout power for the given antenna THEN
      1. END LOOP
h. **END IF**

i. Subtract the level being analyzed from the total number of levels to get the total attenuation.

j. Find the interrogation power by subtracting the attenuation from the total power.

k. Find the suppression power by subtracting the whisper-shout power drop from the interrogation power.

l. If at the first level of the sequence, set the suppression power to -100 dBm.

m. Decrement the whisper-shout power drop by one.

n. **IF** the whisper-shout power drop is less than one dB **THEN**
   1. Set the whisper-shout power drop equal to 3 dB.

o. **END IF**

p. **IF** the whisper-shout power drop is equal to 1 dB AND the victim aircraft is ATCRBS-equipped **THEN**
   1. Set the whisper-shout power drop to 3 dB.

q. **END IF**

r. Find the total antenna gain by adding the appropriate TCAS II M gain to the victim aircraft gain.

s. Find the sum interrogation power by summing the TCAS II M sum antenna gain, the interrogation power, and the total antenna gain.

**t. Sum** the interrogation power, the TCAS II M difference antenna pattern, and the total antenna gain to find the interrogation difference power.

u. Sum the suppression power, the sum antenna pattern, and the total antenna gain to find the suppression sum power.

v. Zero out the omnidirectional antenna's interrogation power.

w. **IF** analyzing bottom front antenna **THEN**
   1. Set omnidirectional power equal to the sum of the total power and the total antenna gain.
2. IF at first level of whisper-shout THEN
   a. Subtract 19 dB from the omnidirectional power.
   b. IF victim aircraft is an ATCRBS-equipped aircraft THEN
      1. Set omnidirectional suppression power to -110 dBm.
   c. ELSE
      2. IF at first level of whisper-shout THEN
      d. END IF
3. ELSE IF at second whisper-shout level THEN
   a. Subtract 17 dB from omnidirectional interrogation power.
   b. Set omnidirectional suppression power 3 dB lower than omnidirectional interrogation power.
4. ELSE IF at third whisper-shout level THEN
   a. Subtract 15 dB from omnidirectional interrogation power.
   b. Set omnidirectional suppression power 3 dB lower than omnidirectional interrogation power.
5. ELSE IF at last whisper-shout level THEN
   a. Subtract 13 dB from omnidirectional interrogation power.
   b. Set omnidirectional suppression power 3 dB lower than omnidirectional interrogation power.
6. END IF
7. Set difference interrogation power, sum interrogation power, and sum suppression power to zero.
8. IF omnidirectional suppression power is greater than or equal to victim sensitivity THEN
   a. Add a suppression at victim in Mode S suppressions array if victim is Mode S- or TCAS II M-equipped, or in ATCRBS suppressions array if victim is ATCRBS-equipped.

9. ELSE IF omnidirectional interrogation power is greater than or equal to victim sensitivity THEN
   a. Add an interrogation at the victim aircraft to the ATCRBS interrogations array or the Mode S/TCAS II M interrogations array, depending on whether the victim is Mode S/TCAS II M-equipped or ATCRBS-equipped.

10. END IF

x. ELSE

1. IF sum suppression power is greater than or equal to victim sensitivity THEN
   a. Add a suppression at victim in Mode S suppressions array if victim is Mode S- or TCAS II M-equipped, or in ATCRBS suppressions array if victim is ATCRBS-equipped.

2. ELSE IF sum interrogation power is greater than difference interrogation power AND sum interrogation power is greater than or equal to victim sensitivity THEN
   a. Add an interrogation at the victim aircraft to the ATCRBS interrogations array or the Mode S/TCAS II M interrogations array, depending on whether the victim is Mode S/TCAS II M-equipped or ATCRBS-equipped.

3. END IF

y. END IF

3-64
10. END LOOP

3. END LOOP

4. Return.

Called by: CIRCAS

Subroutines called: None.
3.3.21 Subroutine: INTLII

PURPOSE: To adjust TCAS II M power and sensitivity as necessary to ensure that the three interference limiting inequalities are satisfied.

INPUTS: Adjusted sensitivity levels of TCAS II M-equipped aircraft, TCAS II M identity, adjusted power levels of TCAS II M, sensitivity levels of all aircraft, number of TCAS II M-equipped aircraft detected, smoothed emission powers, smoothed interrogation rates, TCAS II M pointer file, elapsed time, and transmission power of all aircraft.

PROCEDURE: Interference-limiting adjustments are made to satisfy the following three inequalities:

\[ \sum_{i=1}^{250} \frac{P(i)}{280} < \frac{1 + NTA}{1} \]  \hspace{2cm} (2-1)

\[ \sum_{i=1}^{250} M(i) < 0.01 \text{ second} \] \hspace{2cm} (2-2)

\[ \sum_{k=1}^{250} \frac{PA(k)}{80} < \frac{1 + NTA}{1} \] \hspace{2cm} (2-3)

The symbols in the above equations were described in Section 2. Figure 3-2 illustrates the logic flow of the interference-limiting process.

OUTPUTS: Adjusted sensitivity level of TCAS II M, adjusted power level of TCAS II M, 16-second freeze counter, inequality (2-3) satisfaction indicator, total ATCRBS power radiated, peak ATCRBS power, whisper-shout truncation, and number of TCAS II M-equipped aircraft detected.
Figure 3-3. Interference-limiting algorithm flow diagram.
VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted sensitivity levels of TCAS II M-equipped aircraft</td>
<td>SESIT</td>
</tr>
<tr>
<td>TCAS II M identity</td>
<td>II</td>
</tr>
<tr>
<td>Adjusted power levels of TCAS II M</td>
<td>AMSP</td>
</tr>
<tr>
<td>16-second freeze counter</td>
<td>IRESET</td>
</tr>
<tr>
<td>Whisper-shout steps allowed for each TCAS II M</td>
<td>NWSL</td>
</tr>
<tr>
<td>TCAS II M</td>
<td></td>
</tr>
<tr>
<td>Peak ATCRBS power</td>
<td>PMAX</td>
</tr>
<tr>
<td>Total ATCRBS power radiated</td>
<td>TPOW</td>
</tr>
<tr>
<td>Sensitivity levels of all aircraft</td>
<td>JSENS</td>
</tr>
<tr>
<td>Number of TCAS II M-equipped aircraft detected</td>
<td>NOW</td>
</tr>
<tr>
<td>Smoothed emission powers</td>
<td>TIS</td>
</tr>
<tr>
<td>Smoothed interrogation rates</td>
<td>TPS</td>
</tr>
<tr>
<td>TCAS II M pointer file</td>
<td>I111</td>
</tr>
<tr>
<td>Elapsed time</td>
<td>ITIME</td>
</tr>
<tr>
<td>Transmission power of all aircraft</td>
<td>JTRANS</td>
</tr>
<tr>
<td>Return Point Indicator</td>
<td>IRETRN</td>
</tr>
</tbody>
</table>

PROCESS:

2. Decrement 16-second freeze counter.
3. Compute right-hand side of Equations 1 and 3 (RSEQ1, RSEQ3).
4. Eliminate whisper-shout (w-s) steps to satisfy Equation 3.
   A. IF the sum of the power over all whisper-shout steps is greater than RSEQ3, THEN
      1. IF number of whisper-shout level (NWSL) = 0, THEN
         a. Set return indicator to 0.
         b. Return.
      2. END IF
   3. Remove 1 w-s level.
   4. Go to step 5.
B. **END IF**

5. Check 16-second freeze clock.

6. **IF** freeze clock > 0, **THEN**
   1. Set return indicator to 1
   2. Return.

7. **ELSE**
   A. Check Equations 1 and 2.
   B. Compute total Mode S power transmitted.
   C. Compute total w-s power transmitted.
   D. Compute total Mode S + w-s power.
   E. Compute total self-suppression deadtime.

F. **IF** Equation 1 and Equation 2 are satisfied, **THEN**
   1. **IF** Mode S range is greater than ATCRBS range, **THEN**
      a. Check to see if all w-s levels are used.
      b. Compute total w-s power radiated with 1 additional w-s level.
      c. **IF** Equation 3 is satisfied with new total w-s power, **THEN**
         1. **IF** Equations 1 and 2 are satisfied with one additional w-s step, **THEN**
            a. Add 1 w-s level.
            b. Go to Step 7.
         2. **ELSE**
            a. Set return indicator to 3.
            b. Return.
      3. **END IF**
   
   d. **END IF**

2. **END IF**

3. **IF** Instantaneous Mode S power is less than maximum Mode S power and instantaneous sensitivity is greater than minimum sensitivity, **THEN**
   a. Increase Mode S power by 1 dB.
   b. Decrease sensitivity by 1 dB.
   c. Reset freeze counter.
d. Set return indicator to 4.
e. Return.

4. ELSE
   a. Set return indicator to 5.
   b. Return.

5. END IF

G. ELSE

1. IF Mode S range is greater than ATCRBS range, THEN
   a. Decrease Mode S power by 1 dB.
   b. Increase sensitivity by 1 dB.
   c. Reset freeze counter.
   d. Set return indicator to 6.
   e. Return.

2. ELSE
   a. Delete 1 w-s level
   b. Go to step 7.

3. END IF

H. END IF

8. END IF

9. Return

10. End

Called by: CIRCAS

Functions called: HIATPW
3.3.22 FUNCTION HIATPW

PURPOSE: This function determines the highest whisper-shout power sent when a total of N whisper-shout steps are transmitted.

INPUTS: Number of whisper-shout levels used.

PROCEDURE: The highest power transmitted over the top antenna in the front lobe is determined using Figure 2-1 and the number of whisper-shout steps transmitted by a given TCAS II M aircraft.

OUTPUT: Highest whisper-shout power transmitted.

VARIABLES OF INTEREST

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest transmitted power</td>
<td>HIATPW</td>
</tr>
<tr>
<td>Number of whisper-shout levels sent</td>
<td>NWSL</td>
</tr>
</tbody>
</table>

PROCESS:

1. Use of number of whisper-shout levels sent to find the highest priority level sent.
2. IF the highest priority sent > 79, THEN
   Find the highest power level sent on the top antenna.
3. ELSE
   Find the highest power level (in dBm) sent on the bottom antenna.
4. END IF
5. Convert the power level to watts.
6. Return.

Called by: INTLI
Subroutines called: None.
3.3.23 Subroutine: **STATS**

**PURPOSE:** To write out the TCAS II M parameters of interest after each second.

**INPUTS:** All common variables of interest.

**PROCEDURE:** At the end of each second, the TCAS II M variables of interest are written for each TCAS II M aircraft. The mean values of the variables of interest are computed by averaging over all TCAS II M aircraft in the environment.

**OUTPUT:** TCAS II M statistics.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft ID</td>
<td>I111</td>
</tr>
<tr>
<td>TCAS II M ID</td>
<td>II</td>
</tr>
<tr>
<td>Probability of Reply</td>
<td>PREP</td>
</tr>
<tr>
<td>Number of fruit received</td>
<td>FRUIT</td>
</tr>
<tr>
<td>Number of TCAS II M detected by squitter</td>
<td>NOW</td>
</tr>
<tr>
<td>Mode S interrogation rate</td>
<td>DDATE</td>
</tr>
<tr>
<td>Number of Mode S acquisition interrogators</td>
<td>ACQSUM</td>
</tr>
<tr>
<td>Number of Mode S roll-call interrogators</td>
<td>ROLSUM</td>
</tr>
<tr>
<td>Number of Mode S misaddresses received</td>
<td>MIS</td>
</tr>
<tr>
<td>Number of aircraft in the track file</td>
<td>NACTRIC</td>
</tr>
<tr>
<td>Number of aircraft in the null state</td>
<td>NULL</td>
</tr>
<tr>
<td>Number of aircraft in the squitter state</td>
<td>MSQ</td>
</tr>
<tr>
<td>Number of aircraft in the acquisition state</td>
<td>MAQ</td>
</tr>
<tr>
<td>Number of aircraft in the roll-call state</td>
<td>MROL</td>
</tr>
<tr>
<td>Number of aircraft in the dormant state</td>
<td>MDOR</td>
</tr>
<tr>
<td>Number of whisper-shout steps sent</td>
<td>NWSSL</td>
</tr>
<tr>
<td>Total Mode S and ATCRBS power sent</td>
<td>TPOW</td>
</tr>
<tr>
<td>Maximum Mode S power transmitted</td>
<td>MAXMSP</td>
</tr>
</tbody>
</table>
Mode S freeze counter IRESET
Interference limiting condition indicator IRTRN

PROCESS:

1. IF First TCAS II M aircraft in file, THEN
   a. Write heading.
   b. Clear array containing averaged values.
2. END IF
3. Convert specific real-valued variables to integer format.
4. Write out variables of interest.
5. Compute the sum of each variable of interest over all TCAS II M aircraft.
6. IF Last TCAS II M aircraft in file, THEN
   a. Compute the average for the variables of interest.
   b. Write the average value for the variables of interest.
7. END IF
8. Return.

Called by: CIRCAS
Subroutines called: None.
3.3.24 Subroutine: FILES

**PURPOSE:** To create an output disk file to be used as input data to the DABS/ATCRBS/AIMS PPM which will determine net effects of deploying TCAS systems in the environment.

**INPUTS:** Total interrogations received by each TCAS II M, number of aircraft, number of whisper-shout levels each TCAS II M-equipped aircraft uses, Mode S addresses and misaddresses, ATCRBS and Mode S interrogations and suppressions due to TCAS II M, and TCAS I interrogations at each aircraft.

**PROCEDURE:** In a loop over all TCAS II M aircraft, the total amount of mutual suppression time (due to receiver turn-off during interrogations) is calculated. The following quantities for each aircraft are output to a disk file: Mode S addresses and misaddresses, Mode S and ATCRBS interrogations and suppressions due to TCAS II M emissions, TCAS I interrogations, and TCAS II M mutual suppression time.

**OUTPUTS:** Mode S addresses and misaddresses, ATCRBS and Mode S interrogations and suppressions due to TCAS II M emissions, TCAS I interrogations, and total amount of TCAS II M suppression time.

**VARIABLES OF INTEREST**

<table>
<thead>
<tr>
<th>Description</th>
<th>Variable Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total TCAS II M suppression time</td>
<td>AMTSUP</td>
</tr>
<tr>
<td>Mode S misaddresses</td>
<td>MIS</td>
</tr>
<tr>
<td>Mode S addresses</td>
<td>ADDRESS</td>
</tr>
<tr>
<td>ATCRBS interrogations</td>
<td>IATIN</td>
</tr>
<tr>
<td>ATCRBS suppressions</td>
<td>IATSU</td>
</tr>
<tr>
<td>Mode S interrogations</td>
<td>IDABN</td>
</tr>
<tr>
<td>Mode S suppressions</td>
<td>IDABS</td>
</tr>
<tr>
<td>TCAS I interrogations</td>
<td>ATCRAT</td>
</tr>
</tbody>
</table>
Total interrogations received by TCAS II M DRATR
Number of aircraft NAC
Number of whisper-shout levels used by NWSL
Each TCAS II M

PROCESS:
1. Set TCAS II M counter to zero.
2. LOOP over all aircraft.
   A. IF TCAS II M-equipped aircraft THEN
      1. Increment TCAS II M counter.
      2. Calculate total TCAS II M suppression time in microseconds using above counter to locate correct TCAS II M in arrays
         (Suppression time = 60.0 times the number of whisper-shout steps TCAS II M is using + 100.0 times total interrogations received by TCAS II M transponder).
   B. ELSE
      1. Set total TCAS II M suppression time to zero.
   C. END IF
   D. Write the following quantities to output file: Mode S addresses and misaddresses, Mode S and ATCRBS interrogations and suppressions due to TCAS II M emissions, TCAS I interrogations, and total TCAS II M suppression time.
3. END LOOP
4. Return.

Called by: CIRCAS
Subroutines called: None.
APPENDIX A
TCAS SHM DATA DICTIONARY

The following data dictionary describes each common variable for understanding the code.
<table>
<thead>
<tr>
<th>VARIABLE NAME</th>
<th>NUMBER OF ELEMENTS</th>
<th>TYPE</th>
<th>Labeled Common Block</th>
<th>Subroutines</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACQSUM</td>
<td>1</td>
<td>REAL</td>
<td>ROLACQ</td>
<td>DISMOD, INT, STATS</td>
<td></td>
<td>MODE S INTERROGATION COUNTER</td>
</tr>
<tr>
<td>ADDRESS</td>
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**Notes:***
- The table represents a portion of the data from the document.
- The columns include descriptions of variables, their types, and number of elements.
- Units are also specified, indicating the nature of the data.

**Units:**
- 10x HORIZONTAL MILES
- 40x RADIANS
- 10**9**
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<td>CAS</td>
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<td>TEXT</td>
<td>83</td>
<td>REAL</td>
<td>XUAT, XUAT, TCASI</td>
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<tr>
<td>TFS</td>
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<td>NOXAR, NOXAR, TCASI</td>
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<tr>
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<td>1</td>
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<td>DIP, DIP, TCASI</td>
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<tr>
<td>TIT</td>
<td>1</td>
<td>REAL</td>
<td>NOXAR, INPUT, TCASI</td>
<td></td>
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<tr>
<td>TON</td>
<td>1</td>
<td>REAL</td>
<td>LOAD, LOAD, TCASI</td>
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<td>TFOA</td>
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<td>INIT, INIT, TCASI</td>
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<tr>
<td>TFS</td>
<td>83</td>
<td>REAL</td>
<td>DIP, DIP, TCASI</td>
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</tr>
<tr>
<td>URAKE</td>
<td>NOXAR</td>
<td></td>
<td>DIP, DIP, TCASI</td>
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</tbody>
</table>

*NOXAR is the number of aircraft in the deployment.*
APPENDIX B

TCAS SEM LISTING

The following is a compiled ASCII FORTRAN listing of the TCAS SEM. The program segments appear in alphabetical order.
SUBROUTINE ANTGAN

THE PURPOSE OF THIS SUBROUTINE IS TO STORE ELEVATION ANTENNA PATTERNS BETWEEN TCAS AND VICTIM AIRCRAFT.

**************INPUTS / OUTPUTS ***************

1. COMMON BLOCKS / VARIABLES.

2. COMMON ITCOATA(DZ,83), IDENS(83).

3. COMMON/ANTO/PASTOP(19), PASOT(19).

4. PARAMETER CR20 = 57.296, CONVERTS ANGLES FROM RADIANS TO DEGREES.

5. DEFINE FLO(I,J,K) = BITS(K,I+1,J).

6. HAVE A TCAS AIRCRAFT.

7. IM = II1(II1).

8. ALTI = TJFILE(EN,q), 3/6076.0, ALTITUDE OF TCAS A/C IN NAUTICAL MILES.

9. DD 201 K=1,MAC.

10. IF(IN.EQ.X)GO TO 201, A/DONE'T DO COUPLING CALCULATIONS OF A/C WITH ITSELF.

11. IF(ICASFI(I,1,0)=0.0)GO TO 201, A/SKIP IF A/C OUT OF RANGE.

12. ALTI = TJFILE(EN,q), 3/6076.0, ALTITUDE OF VICTIM A/C IN NAUTICAL MILES.

13. C = FLD(00+ICASFI(I,1,1))/10.0, SLANT RANGE BETWEEN TCAS I/M & VICTM.

14. ARG = 90-DIST, A/DIFFERENCE IN ALTITUDES IN NAUTICAL MILES.

15. C = (ALTI-ALTS)/2, A/HORIZONTAL DISTANCE BETWEEN A/C.

16. ARG = (ATAN(ARG))*P29, A/VERTICAL ANGLE (DEGREES).

17. include restart list.

18. parameter (nuair = 328).

19. logical print, when false, will suppress all write statements in the model.

20. dimension tjfile(nuair,8), ijfile(nuair,8), icasfi(83,nuair,1).

21. common iit1(83), idens(83), iden(nuair), idabn(nuair).

22. common/tjfile,iijfile(nuair,8),icasisfi(83,nuair,1).

23. common/anto/pastop(19), pastot(19).

24. common/anto/pastop(19), pastot(19).

25. parameter (r20 = 57.296).

26. convert angles from radians to degrees.

27. define flod(i,j,k) = bits(k,i+1,j).

28. have a tcas aircraft.

29. im = ii1(ii1).

30. alti = tjfile(enq), 3/6076.0, altitude of tcas a/c in nautical miles.

31. do 201 k=1,mac.

32. if(in.eq.x)go to 201, a/don't do coupling calculations of a/c with itself.

33. if(icasfi(i,1,0)=0.0)go to 201, a/skip if a/c out of range.

34. alti = tjfile(en,q), 3/6076.0, altitude of victim a/c in nautical miles.

35. c = fld(00+icasfi(i,1,1))/10.0, slant range between tcas i/m & victim.

36. b = (alti-alt2).

37. c = (atan(arg))*p29, a/vertical angle (degrees).

38. d = sqrt(c-c - b*b).

39. theta = (atan(arg))*p29, a/vertical angle (degrees).
### ANTGAN

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C</td>
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<tr>
<td>2</td>
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<tr>
<td>46</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>THETA1 = ABS((THETA + 90) / 10)</td>
</tr>
<tr>
<td>48</td>
<td>THETA2 = ABS((THETA - 90) / 10)</td>
</tr>
<tr>
<td>49</td>
<td>THETA2 = THETA2 + 1</td>
</tr>
<tr>
<td>50</td>
<td>GN1 = ANTOP(I) + ((THETA1 + 1) * TCAS II TOP ANTENNA GAIN)</td>
</tr>
<tr>
<td>51</td>
<td>THETA2 = THETA2 + 1</td>
</tr>
<tr>
<td>52</td>
<td>GN2 = PASTOP(I) + ((THETA2 + 1) * TCAS II TOP ANTENNA GAIN)</td>
</tr>
<tr>
<td>53</td>
<td>THETA2 = THETA2 + 1</td>
</tr>
<tr>
<td>54</td>
<td>GN3 = ANTOP(I) + ((THETA1 + 1) * TCAS III TOP ANTENNA GAIN)</td>
</tr>
<tr>
<td>55</td>
<td>THETA2 = THETA2 + 1</td>
</tr>
<tr>
<td>56</td>
<td>GN4 = PASTOP(I) + ((THETA2 + 1) * TCAS III TOP ANTENNA GAIN)</td>
</tr>
<tr>
<td>57</td>
<td>THETA2 = THETA2 + 1</td>
</tr>
<tr>
<td>58</td>
<td>P = FLD(I+10) * ICASP(i+1)</td>
</tr>
<tr>
<td>59</td>
<td>THETA2 = THETA2 + 1</td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>C STORE COUPLINGS AS INTEGER VALUES. THE SYSTEM FUNCTION, IFIX, BELOW.</td>
</tr>
<tr>
<td>62</td>
<td>C CONVERTS THE FLOATING POINT NUMBERS TO INTEGERS FOR STORAGE.</td>
</tr>
<tr>
<td>63</td>
<td>C</td>
</tr>
<tr>
<td>64</td>
<td>C</td>
</tr>
<tr>
<td>65</td>
<td>FLD(00:09, IFILE(K,8)) = IFIX(GN1+10)</td>
</tr>
<tr>
<td>66</td>
<td>FLD(00:09, IFILE(K,8)) = IFIX(GN2+10)</td>
</tr>
<tr>
<td>67</td>
<td>FLD(10:16, IFILE(K,8)) = IFIX(GN3+10)</td>
</tr>
<tr>
<td>68</td>
<td>FLD(20:26, IFILE(K,8)) = IFIX(GN4+10)</td>
</tr>
<tr>
<td>69</td>
<td>201 CONTINUE</td>
</tr>
<tr>
<td>70</td>
<td>RETURN</td>
</tr>
<tr>
<td>71</td>
<td>END</td>
</tr>
</tbody>
</table>

END FTM 247 DCONNECT 66 DBANK 31405 COMMON
Appendix B

** ASPI NT **

*ASPI NT A.ASPI NT A.ASPI NT

FTN 111111 A 05/30/85 13:14(44)

1. SUBROUTINE ASPI NT
   B ATCRBS SUM POWER INITIALIZE
   2. * THIS SUBROUTINE INITIALIZE THE ARRAY CONTAINING THE TOTAL RADIATE POWER
   3. * FROM N-W-S POWER LEVELS IN WATTS.
   4. *
   5. *************************************************************** INPUTS / OUTPUTS **************************************************************
   6. *
   7. * COMMON BLOCKS / VARIABLES
   8. *
   9. * INPUTS / OUTPUTS DESCRIPTION
   10. *
   11. ILMS / ATSUMP TOTAL RADIATED FROM N-W-S LEVELS
   12. *
   13. INCLUDE ILMS.
   14. *
   15. DEFINE SUM(N) = (ONGDB**N - 1)/(ONGDB - 1)
   16. DEFINE SUML(N) = (THODB**N - 1)/(THODB - 1)
   17. *
   18. ONGDB = 10.***(-11)  @ DEFINE 1 DB
   19. THODB = 10.**(1.2)  @ DEFINE 2 DB
   20. PTOPLD = 10.**(4 24. -30.)/10.2)  @ 24 DBM -30 DB TO GET WATTS
   21. PRTOLD = 10.**(10. -30.)/10.2)  @ 30 DBM -30 DB TO GET WATTS
   22. ATSUMPOF = 0.
   23. *
   24. LOOP OVER ALL 83 W-S LEVELS.
   25. *
   26. DO 10 IPRI=1,83
   27. *
   28. DETERMINE # OF W-S LEVELS SENT ON THE TOP (FRONT, 2 SIDES, AND BACK)
   29. AND BOTTOM ANTENNAS
   30. *
   31. IF( IPRI LE. 63 ) THEN
   32. NFRNT = 24 - (IPRI + 2)/4.
   33. * NSIDE = 20 - (IPRI + 1)/4
   34. * NLSIDE = 20 - (IPRI + 1)/4
   35. NBACK = 15 - (IPRI - 1)/4
   36. NDOT = 4
   37. ELSE IF(IPRI LE. 75) THEN
   38. NFRNT = 29 - (IPRI + 1)/3
   39. NSIDE = 25 - (IPRI)/3
   40. NLSIDE = 25 - (IPRI + 1)/3
   41. NBACK = 0
   42. NDOT = 4
   43. ELSE IF (IPRI LE. 80) THEN
   44. NFRNT = 80 - IPRI
   45. NSIDE = 0
   46. NLSIDE = 0
   47. NBACK = 0
   48. NDOT = 4
   49. ELSE
   50. NFRNT = 0
   51. NSIDE = 0
   52. NLSIDE = 0
   53. NBACK = 0
   54. NDOT = 84 - IPRI
   55. END IF
   56. *
   57. COMPUTE ATSUMP IN WATTS USING THE PROPERTIES OF A GEOMETRIC PROG

B-4
*** ASPIN ***

2 58
1 55
1 60
1 61
1 62 10 CONTINUE
63 RETURN
64 END

END FTN 177 IBANK 47 DBANK 335 COMMON

DHOG,P *** ANTGAN ***
Appendix B

**ATMUO**

**A.PPS**

**ATMOD**

**A.ATMO**

**JCHJO**

**F~**

**1**

**1.**

**A**

**51**

**18 WOUIINEX 'ATMOD**

**2.**

**C**

**3.**

**C**

**THIS SUBROUTINE**

**DETERMINES**

**THE EFFECTS**

**OF**

**TCAS**

**WHISPER - SHOUT**

**C**

**INTEGRATION**

**AT**

**ALL**

**AIRCRAFT.**

**S.**

**C**

**6.**

**C**

**INPUTS**

**OUTPUTS**

**I~I~**

**I&**

**I*h****

**7.**

**C**

**a.**

**C**

**COMMON**

**GLOCkS**

**I**

**VARIAbLES**

**9.**

**C**

**INPUTS**

**OUTPUTS**

**DESCRIPTION**

**10.**

**C**

**11.**

**C**

**ANTENN**

**I**

**AZPAT**

**S**

**CAS-**

**I ICASFI**

**YCAS, It**

**TOP**

**ANTENNAS**

**12.**

**C**

**-OZFPAT DIFFERENCE PATTERNS**

**OF**

**TCAS**

**It**

**9-110TTOR**

**13.**

**C**

**ANTENNAS**

**1'.**

**C**

**CAS-**

**ICASFI**

**YCAS 11**

**N ENVIRONMENT**

**FILE**

**15.**

**C**

**11**

**TCAS**

**It**

**IDENTITY**

**16.-**

**C**

**IJFtLE**

**ANTENNA COUPLINGS**

**BETWEEN**

**ICAS AND**

**VCTM**

**17.**

**C**

**MAC**

**NUM8ER**

**OF**

**ATOC**

**RAFT**

**IN**

**DEPLOYMENT-**

**18.-**

**C**

**SENS-**

**I**

**JSENS**

**SENSITIVITY LEVEL**

**OF ALL**

**AIRCRAFT**

**19.**

**C**

**20.**

**C**

**LATIN-**

**IATIN-**

**TCASII**

**M-PRODUCEO**

**ATCRSS**

**SUPPRESSIONS**

**Z1.**

**C**

**14TSU**

**1ATSU-**

**TCAS--II M-PRODUCEO**

**ATCRSS**

**SUPPRESSIONS**

**Z2.**

**C**

**IOARN-**

**LOA81**

**TCAS-=II**

**M INTERROGATIONS TO MODE-5**

**23-**

**C**

**DB**

**IDASS1*8**

**TCAS-**

**H-PRODUCE0 NODE S SUPPRESSIONS**

**24.**

**C**

**TEMP**

**ITIME**

**ELAPSED TIME**

**25.-**

**C**

**TRAXM**

**I**

**JIRANS TRANSMISSION= POWER**

**LEVELS**

**OF ALL-A/C**

**26.**

**C**

**ILMS_**

**I**

**NWSL**

**OF-W5S**

**LEVELS**

**SENT**

**27. C**

**WSHOUT**

**I**

**IP~d-**

**ANTENNA PATTEANSt**

**BACK**

**ANTENNA-**

**28. C**

**53.**

**INCLUDE**

**RESTART*LIST**

**1.-I**

**-PARAMETER- (NUAUSE**

**743)**

**2.1 C**

**3.1 C**

**THE -LOGICAL**

**VARIABLE PRINT.**

**WHEN FALSE,**

**WILL**

**SUPPRESS ALL**

**WRITE**

**STATEMENTS**

**IN**

**THE MODEL.**

**5.1 C**

**6.1 LOGICAL**

**POrSMIO.PINTLIPTCSMT,-PATMODPoISINgPFILES.PFRUIT.PSTATS**

**7.1 COMMON**

**/PRT3LI**

**POISMOPPNTLIsPTCSMTgPATMO0.PDISINgPFILES*PFRUIT.**

**'1.1**

**2 PSTATS**

**10.1 DIMENSION**

**IJILE(NUAIRod)v**

**IAFILE(NUAIRP&)f ICASFI(S3*NUAINP1)**

**11.1 COMON**

**ITCOATAI**

**1111C(33)o**

**0EN5C83)o**

**12.1**

**?**

**-IATINCNUAIR)* IATSUCNUAIR)o**

**10ASN(NUAIR)o**

**IDABSCNUAIR)**

**13.1 EQUIVALENCE**

**CTJFILEPTJFILE**

**14.1 COMMON**

**ICAS**

**iCASFI;**

**TJFILEP MAC**

**15. COMMON**

**/ILMS/**

**NWSL(*3)P**

**AMSP(83)v INESET(83)p ATSUMP(0:83)o**

**2.1**

**2 IRETRto TPOW**

**36. INCLUDE**

**WSHOUT.'LIST-**

**1.1 COMMON**

**IW~tIOUTI**

**IPRF(24)p**

**IPRS(40)* IPRB(15)o IPRSOT(4),**

**2.1**

**1 IPOWFC2'.)p IPOWS(41)o IPOWB(1S)f IPOW&OCA)**

**37. INCLUOE**

**TkMPoLIST**

**1.1 COMMON**

**/TEMPI**

**ITIHE**

**B-6
Appendix B

35. INCLUD TMAX,LST
3.1 COMMON /TAXA/ JTRANS(HUAIR)
3V. INCLUD SNF5,LIST
1.1 COMMON /SENSJ JSENS(HUAIR)
40.
41. INTEGER SAI
42.
43. DATA (NUM1), (1 = 1, 3) /4, 26, 20, 15, 20/ 55.
44. T = 1111(11)
45.
46. S3 = 200 JJ = 1, MUS
1 IF (ICASPT(F[1,][J] + 0.0) GO TO 200 & SKIP IF A/C IS OUT OF RANGE
1 47.
1 48.
1 49. C
1 50. C
1 51. C
1 52. C
1 53. C
1 54. C
1 55. C
1 56. C
1 57. C
1 58. C
1 59. C
1 60. C
1 61. C
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1 65. C
1 66. C
1 67. C
1 68. C
1 69. C
1 70. C B-7
### ATMOD

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<td>4</td>
<td>ELSE IF (KP.EQ.2) THEN</td>
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<tr>
<td>5</td>
<td>INAX = [IPRS (LATT) + 1]</td>
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<tr>
<td>6</td>
<td>ELSE IF (KP.EQ.3) THEN</td>
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<tr>
<td>7</td>
<td>INAX = IPRS (LATT+2)</td>
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<tr>
<td>8</td>
<td>ELSE IF (KP.EQ.4) THEN</td>
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<tr>
<td>9</td>
<td>INAX = IPRS (LATT+2)</td>
</tr>
<tr>
<td>10</td>
<td>ELSE</td>
</tr>
<tr>
<td>11</td>
<td>INAX = IPRS (LATT+2)</td>
</tr>
<tr>
<td>12</td>
<td>END IF</td>
</tr>
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</table>

**C** CHECK TO SEE IF NUMBER OF LEVELS CUT EXCEEDS PRIORITY LEVEL:

<table>
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<th>Line</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>IF (LATT.EQ.1) INAX = -100.</td>
</tr>
<tr>
<td>5</td>
<td>A FIRST INT. SUPPRESSION IS MADE AT A LOWER POWER LEVEL</td>
</tr>
<tr>
<td>6</td>
<td>A SUPPRESSION DOWN COUNTER.</td>
</tr>
<tr>
<td>7</td>
<td>ISKIP = ISKIP - 1</td>
</tr>
<tr>
<td>8</td>
<td>IF (ISKIP.EQ.1) ISKIP = 3</td>
</tr>
<tr>
<td>9</td>
<td>IF ((ISKIP.EQ.1) AND (ETYP.EQ.0)) ISKIP = 5</td>
</tr>
<tr>
<td>10</td>
<td>GNCoup = GMT + GV</td>
</tr>
<tr>
<td>11</td>
<td>ATenna COUPLINGS BETWEEN ICAS II &quot;H AND VICTIM AIRCRAFT</td>
</tr>
<tr>
<td>12</td>
<td>SPWRT = PWR + SHIFT + GNCoup</td>
</tr>
<tr>
<td>13</td>
<td>OPWRT = PWR + [PFRY] + GNCoup</td>
</tr>
<tr>
<td>14</td>
<td>SAMPWR = PWS + [SHIFT + GNCoup]</td>
</tr>
<tr>
<td>15</td>
<td>OpWRT = 0.</td>
</tr>
<tr>
<td>16</td>
<td>IF (KP.EQ.1) THEN</td>
</tr>
<tr>
<td>17</td>
<td>OPWRT = &quot;GNCoup&quot;</td>
</tr>
<tr>
<td>18</td>
<td>IF (LATT.EQ.1) THEN</td>
</tr>
<tr>
<td>19</td>
<td>OPWRT = &quot;GNCoup&quot; - 19</td>
</tr>
<tr>
<td>20</td>
<td>Else IF (LATT.EQ.2) THEN</td>
</tr>
<tr>
<td>21</td>
<td>OPWRT = &quot;GNCoup&quot; - 10</td>
</tr>
<tr>
<td>22</td>
<td>End IF</td>
</tr>
<tr>
<td>23</td>
<td>Else</td>
</tr>
<tr>
<td>24</td>
<td>OPWRT = -100</td>
</tr>
<tr>
<td>25</td>
<td>Else</td>
</tr>
<tr>
<td>26</td>
<td>OPWRT = 0.</td>
</tr>
<tr>
<td>27</td>
<td>End IF</td>
</tr>
<tr>
<td>28</td>
<td>ELSE IF (KP.EQ.3) THEN</td>
</tr>
<tr>
<td>29</td>
<td>Else IF (KP.EQ.4) THEN</td>
</tr>
<tr>
<td>30</td>
<td>End IF</td>
</tr>
</tbody>
</table>

C IF (PATHMOD)

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>WRITEX=9999</td>
</tr>
<tr>
<td>92</td>
<td>IF (OMPWR.GE.SEn) THEN</td>
</tr>
<tr>
<td>93</td>
<td>COUNT SUPPRESSIONS</td>
</tr>
<tr>
<td>94</td>
<td>IF (ETYP.EQ.0) THEN</td>
</tr>
<tr>
<td>95</td>
<td>10ABS(IJ) = 10ABS(IJ) + 1</td>
</tr>
<tr>
<td>96</td>
<td>ELSE</td>
</tr>
<tr>
<td>97</td>
<td>-1</td>
</tr>
<tr>
<td>98</td>
<td>ELSE</td>
</tr>
<tr>
<td>99</td>
<td>IATSU(IJ) = IATSU(IJ) + 1</td>
</tr>
<tr>
<td>100</td>
<td>END IF</td>
</tr>
<tr>
<td>101</td>
<td>ELSE IF (OMPWR.GE.SEn) THEN</td>
</tr>
</tbody>
</table>
*** ATMOD ***

1) IF (KYP .EQ. 0) THEN  
2 COUNT INTERROGATIONS 
3 IATIN(IJ) = IATIN(IJ) + 1 
4 ELSE 
5 IOABS(IJ) = IOABS(IJ) + 1 
6 END IF 
7 ELSE IF (PATHMOD) 
8 1 WRITE (*,998) IJ, IBS, HSEC, SMPWR, SMPWRSEM, SPFWR 
9 998 FORMAT* PAT 998 $($3-2x,F10.5=2(15.5X),4(F10.3,5X)) 
10 IF (SMPWRSEM .GE. SEN) THEN  
11 COUNT SUM SUPPRESSIONS 
12 IATSU(IJ) = IATSU(IJ) + 1 
13 ELSE 
14 IOABS(IJ) = IOABS(IJ) + 1 
15 END IF 
16 ELSE IF (SMPWR.GT.SPFWR).AND.(SMPWR.GE.SEM) THEN 
17 C COUNT SUM INTERROGATIONS 
18 IF (KYP.NE.0) THEN 
19 IDARM(IJ) = IDARM(IJ) + 1 
20 ELSE 
21 IATIN(IJ) = IATIN(IJ) + 1 
22 END IF 
23 END IF 
24 179 ELSE 
25 CONTINUE 
26 180 CONTINUE 
27 ELSE 
28 ITOT = IATSU(IJ) + IOABS(IJ) + IDARM(IJ) + IATIN(IJ) 
29 IF (ITOT .GT. 0) THEN 
30 WRITE(*,16) IJ, IATSU(IJ), IOABS(IJ), IDARM(IJ), IATIN(IJ) 
31 ELSE 
32 16 FORMAT* ATMOD: II-IJ, IATSU,IDARM,IOABS,IATIN 
33 ELSE 
34 200 CONTINUE 
35 ELSE 
36 RETURN 
37 ELSE 
38 DEBUG INIT(IATSU, IDARM, IOABS, IATIN) 
39 END 
40 END 
41 59 COMMON IBANK 197 D4ANK 72R23 COMMON 
42 "HDGP *** BEAR *** B-9
**BEAT**

SUBROUTINE BEAT

1. CALCULATES HORIZONTAL DISTANCE IN NMI AND ANGLE IN RADIANS BETWEEN 'CAS AND VICTIM AIRCRAFT.
2. COMMON/BEAR/TLAT,TLON,RLAT,RLON,DIST,BEARTX
3. RADIUS OF THE EARTH IN NMI:
4. RADIUS = 3441.0
5. DIFFERENCE IN LATITUDES AND LONGITUDES OF TWO AIRCRAFT IN RADIANS:
6. OLAT = TLAT - RLAT
7. DOLN = TLON - RLON
8. COSINE OF THE AVERAGE LATITUDE (SCALING FACTOR FOR LONGITUDE):
9. CS = COS (0.5*(RLAT + TLAT))
10. SCALED DIFFERENCE IN LONGITUDES:
11. DOLN = DOLN*CS
12. DISTANCE BETWEEN TWO AIRCRAFT IN NMI CALCULATED USING THE PYTHAGOREAN THEOREM:
13. DIST = RADIUS * SQRT(DLAT*DLAT + DOLN*DOLN)
14. CHECK DIFFERENCE IN LONGITUDES TO PREVENT DIVISION BY ZERO IN THE BEARING CALCULATION:
15. IF (ABS(DOLN*RADIUS) .LT. 0.001) DOLN = 0.001/RADIUS
16. CALCULATE THE ANGLE BETWEEN THE TWO AIRCRAFT:
17. BEARTX = ATAN (-DLAT/DOLN)
18. ADJUST THE AXIS:
19. BEARTX = -BEARTX + 1.5707964
20. MAKE SURE THAT THE ANGLE IS GIVEN AS A POSITIVE VALUE:
21. IF (DOLN .LE. 0.0) BEARTX = BEARTX + 3.1415927
22. RETURN
23. END
CIRCASSAFRONT NASA CIRCASSAFRONT

This module is the driver for the TCAS signal environment model. IT
specifically accesses subroutines that:
1. Load aircraft files
2. Set transponder characteristics
3. Schedule TCAS II M emissions
4. Compute TCAS effects
5. Include restart list
   parameter (NUAIR = 743)
6. The logical variable print, when false, will suppress all write
   statements in the model.
7. Logical POISMD/PINTL/PTCSMT/PATMOD/POISIM/FILES/PFRUIT/PSTATS
   common /PTNL/ POISMD/PINTL/PTCSMT/PATMOD/POISIM/FILES/PFRUIT/
   PSTATS
8. Dimension TJFILE(NUAIR), TFILE(NUAIR), ICASF(83), NUAIN, 1
9. COMMON /TDOA/ 1111(63), DENS(83),
10. IATIN(NUAIR), IATSU(NUAIR), IDABN(NUAIR), IDABD(NUAIR)
11. EQUIVALENCE (TJFILE, IJFILE)
12. COMMON FCAS/ICASF/, TFILE, NAC, II, PRINT
13. Include BBEAR/LIST
14. COMMON FBEAR/TLAT, TLON, RLAT, RLON, DIST, BEARTR
15. Include DPLYMT/LIST
16. COMMON IJPLYMT/ IACR, IDAB, ITCA, RATIO
17. Include TCAALAR
18. COMMON FCAS/ NUCTA
19. Include TEMP/LIST
20. COMMON /TEMP/ TIME
21. Logical T1
22. Loads files, sets initial conditions, computes near time-independent
   TCAS II effects
23. Read in print options from 1st line of file 7
24. Read(7,15)/ISMT= RATIO= TI/POISMD/PINTL/PTCSMT/PATMOD/POISIM?
   2 FILES/PFRUIT
25. WRITE(6,25) TI/POISMD/PINTL/PTCSMT/PATMOD/POISIM/FILES/PFRUIT
26. Format(13x,5.0,1x,8(1x,1x))
27. Format* options*: +d(13x,1x,1x)*/
28. Write(6,9) The total situation time ="/ISMT= RATIO="/RATIO
29. Call init 0 initialize all common variables
30. Call ASPINT 0 initialize ACRS sum power array
31. Call input 0 load aircraft file and rates
32. Call transp 0 load A/C emission characteristics
33. Call TSTART 0 set TCAS II M squitter phase
34. Call load 0 load TCAS tables
CALL PRESET & APPROXIMATE INTERFERENCE EFFECTS
41. IF (T1) CALL TCAS & COMPUTE TCAS I EFFECTS
42. C
43. C
44. C
45. C
46. C
47. C
48. C
49. C
50. C
51. C
52. C
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90. C
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93. C
94. C
95. C
96. C
97. C
98. C
99. C
100. C

DO 100 ITIME = 1, ISINT & SIMULATION CLOCK
MOVE AND RELOAD TCAS II M TABLES EVERY 40 SECONDS
IF(MOD(ITIME, 40) .EQ. 0) CALL LOAD
1

DO 6 II = 1, NUMTCAS & COMPUTE TCAS II EFFECTS (II IS TCAS ID)
1
LOAD TOP AND BOTTOM ANTENNA COUPLINGS BETWEEN TCAS II M AND ALL
OTHER AIRCRAFT
2
CALL ANTAG
2
COMPUTE FRUIT RATE AT TCAS II M EVERY 20 SECONDS. FRUIT RATES ARE
2
USED TO DETERMINE EFFECTS ON DETECTION PERFORMANCE.
2
IF ( (ITIME .EQ. 1) .OR. (MOD(ITIME, 20) .EQ. 0) ) CALL FRUITA
2
CALL OISMO (LPLUS1)
2
COMPUTE SMOOTH VALUES OF TCAS II M INTERROGATION RATES AND
2
TRANSMISSION-POWER LEVELS.
2
CALL TCMSHT
2
COMPUTE MODE S EFFECTS
2
IF (LPLUS1 .NE. 0) CALL DISINT
2
COMPUTE WHISPER-SHOUT EFFECTS FROM TCAS II M TO ALL OTHER AIRCRAFT
2
IF ( (ITIME .EQ. 1) .OR. (MOD(ITIME, 40) .EQ. 0) ) CALL ATMOD
2
ADJUST TCAS II M CHARACTERISTICS TO SATISFY INTERFERENCE-LIMITING
2
INEQUALITIES
2
IF (ITIME .GE. 5) CALL INLI
2
CALL STATSE (CIRCAS)
2
CONTINUE
2

1000 CONTINUE
1
CALL FILES & LOAD RATE FILES FOR ATC MODEL
1
END
SUBROUTINE CNVRT (K)

THIS SUBROUTINE DETERMINES THE AIRCRAFT TYPES

DEFINE FLD(I,J,K) = BITS(K,J+1,J)  

IF (FLD(0,6,K) .EQ. 9) THEN  
   K=1  
ELSE IF (FLD(0,6,K) .EQ. 25) .OR. (FLD(0,6,K) .EQ. 7)) THEN  
   K=3  
ELSE  
   K=0  
END IF

RETURN

END
1. SUBROUTINE DISINT

2. THE PURPOSE OF THIS SUBROUTINE IS TO COMPUTE MISADRESSED RATES AND ADDRESSED RATES AT EACH AIRCRAFT.

3. **************INPUTS / OUTPUTS **************

4. COMMON BLOCKS / VARIABLES

5. INPUTS OUTPUTS DESCRIPTIONS

6. ATE / DRATE TOTAL INTERROGATIONS RECEIVED BY EACH TCAS II M

7. CSA / ID TCAS II M IDENTITY

8. MAC NUMBER OF AIRCRAFT IN DEPLOYMENT

9. NUMS / IAMSP ADJUSTED TCAS II M EMISSION POWER

10. MISAD / MIS MISADRESSES AT EACH AIRCRAFT

11. ONT / DINT/ DINTADDRESS RATE TO EACH AIRCRAFT

12. UPRATE / UPRATE TOTAL NUMBER OF INTERROGATIONS RECEIVED

13. SENS / JSENS SENSITIVITY LEVELS OF ALL AIRCRAFT

14. SETA / SADDRESS NUMBER OF ADDRESSES

15. SINT / SINTB INDICATES ANTENNA ON WHICH TCAS II M TRANSMITTED

16. LPLUS NUMBER OF TCAS II M TRANSMISSIONS

17. TCAA / NMTCACA NUMBER OF TCAS II M A/C

18. ITC出台 / ITFILE TCAS II M POINTER FILE

19. ITEMP / ITIME ELAPSED TIME

20. TRAX / JTRANS TRANSMISSION POWER FOR ALL AIRCRAFT

21. JSENS SENSITIVITY LEVELS FOR ALL AIRCRAFT

22. INCLUDE RESTART.LIST

23. PARAMETER (NUAIR = 328)

24. THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.

25. LOGICAL PRINT

26. DIMENSION ITFILE(NUAIR,8), ITFILE(NUAIR,8), ICASP(83,NUAIR,B)

27. COMMON / IDMNT(NUAIR), JI4MT(NUAIR), UPRATE(NUAIR)

28. COMMON / SENS, JSENS(NUAIR)

29. COMMON / SSETA1, ADDR(NUAIR)

30. COMMON / IRESET(100)

31. COMMON / IRESET(100)

32. INTEGER SA

33. DEFINE FLG(I,J,K) = B1TS(K,I*J+J)

B-14
**Appendix B**

```plaintext
*** DISINT ***

47. C    SA = I111(I1)     & TCAS II M IDENTITY
48. C    DD 7 N = 1, NAC & LOOP OVER ALL AIRCRAFT
1 50. C    IF (MQ.EQ.5A) GO TO 7 & SKIP IF OUT OF TCAS IIM RANGE
1 51. C    IF (N.EQ.5A) GO TO 7 & DO NOT PICK TCAS IIM AS VICTIM
1 52. C    GET ANTENNA COUPLINGS BETWEEN TCAS II M AND VICTIM AIRCRAFT.
1 54. C    THE FACTOR OF 2**27 SHIFTS BITS UP AND THEN BACK DOWN AGAIN TO RECOVER
1 55. C    THE SIGN BIT.
1 56. C
1 57. C    KG1=(FLO(00,09),JFILE(N,B),(2**27)) & TCAS II M TOP ANTENNA GAIN
1 58. C    KG2=KGN1/(2**27)
1 59. C    GN1=KGN1/10.4471.9 & TOTAL POWER VICTIM-RECEIVE
1 60. C    KG2=KGN2/10.
1 61. C    KG3=(FLO(18,09),JFILE(N,B),(2**27)) & TCAS II M BOTTOM ANTENNA GAIN
1 62. C    KG4=KGN1/10.
1 63. C    KG3=KGN3/10.4471.9 & POWER LOSS (FREE SPACE).
1 64. C    KG1=(FLO(27,09),JFILE(N,B),(2**27)) & VICTIM BOTTOM ANTENNA GAIN
1 66. C    IQ=QLD(34,2,ICASFI(I1,N,1)) & VICTIM AIRCRAFT TYPE
1 67. C    DO 6 M=1,LPLUS & LOOP OVER ALL TCAS IIM INTERROGATIONS.
1 68. C
2 69. C    IF (ITOD(N),EQ.1) GS = GN1 & TRANSMIT TOP.
2 70. C    IF (ITOD(N),EQ.3) GS = GN3 & TRANSMIT BOTTOM.
2 71. C
2 72. C    GV = GN2 & TOTAL ANTENNA COUPLING.
2 73. C    IF (CGM.GT.GN2) AND (IQ.NE.0) GV = GN4 & POWER LOSS (FREE SPACE).
2 74. C    GN0 = GS + GV & TRANSMISSION POWER (KWATTS).
2 75. C    IPRM = FLO(17,10,ICASFI(I1,N,1)) & POWER LOSS (FREE SPACE).
2 76. C    ATRANS = IPRM/(ATRANS+1000). & TOTAL POWER AT VICTIM.
2 77. C    CTRANS = ATRANS*1000. & TOTAL POWER AT VICTIM.
2 78. C    RVR=P-(PRM+10)+ALOG10(ATRANS)-3.0 & TOTAL POWER VICTIM RECEIVED IS GREATER THAN VICTIM SENSITIVITY.
2 79. C    IF (POW.GE.JSENS(N)) MIS(N) = MIS(N) + 1 & COUNT A MISADDRESS AT VICTIM.
2 80. C
2 81. C    IF TOTAL POWER VICTIM RECEIVED IS GREATER THAN VICTIM SENSITIVITY, CHECK ARRAYS FOR PROPER SQUITTER COUNTING AND MISADRESSED RATE.
2 82. C
2 83. C    IF (ITOD(N),EQ.1) GS = GN1 & COMPUTE AVERAGES AFTER ALL
2 84. C    IF (ITOD(N),EQ.3) GS = GN3 & PICK A VICTIM AIRCRAFT.
2 85. C
2 86. C    IF (ITOD(N),EQ.1) GS = GN1 & COMPUTE AVERAGES AFTER ALL
2 87. C
2 88. C
2 89. C
2 90. C
2 91. C
2 92. C
2 93. C
2 94. C
2 95. C
2 96. C
2 97. C
2 98. C
2 99. C
2 100. C
2 101. C
2 102. C
2 103. C
2 104. C
2 105. C
```

B-15
*** DISINT ***
106.   END

END FTM 334 IBANK 92 DBANK 33736 COMMON
**DISMOD**

**BPFS: 6, DISMOD:D3MDD.**

**FM: 11R1**

**02/27/85-16:35(25)***

**SUBROUTINE DISMOD(ILPLUS1)**

---

**THE PURPOSE OF THIS SUBROUTINE IS TO SCHEDULE MODE S DISCRETE INTERROGATIONS.**

---

*************** INPUTS / OUTPUTS ***************

**COMMON BLOCKS / VARIABLES**

**INPUTS / OUTPUTS**

**DESCRIPTION**

1. ADJSFES / SESIT / ADJUSTED TCAS II: M SENSITIVITIES
2. RATE / ORATE / INTERROGATION RATE AT EACH TCASII
3. CAS / ICASFI / TCAS II: M ENVIRONMENTAL FILE
4. II / IDENTIFIER / TCAS II: M IDENTIFIER
5. IJFILE / TYPE OF EACH AIRCRAFT
6. TFTJFILE / AIRCRAFT CHARACTERISTICS FILE
7. FRUIT / FRUIT / FRUIT-LEVEL SEEN BY EACH TCAS II:
8. IJMS / ANSP / ADJUSTED TCAS II: M POWER LEVELS
9. MISAD / MIS / MISADRESSES
10. ONT / DINIRAT / ADDRESSED RATE TO EACH AIRCRAFT
11. UPRATE / UPRATE / TOTAL NUMBER OF INTERROGATIONS ROD
12. RCLACQ / ITRAK / MAXIMUM-INTERROGATION RATE IN ROLL
13. ROLACQ / AGSOM / MODE 5 INTERROGATION RATE COUNT
14. DORSUM / # TCAS II: M IN DORMANCY STATE
15. MCAF / AGUITION-COUNTER / TCAS II: M ACQUISITION COUNTER
16. MODR / DORMANCY COUNTER / TCAS II: M DORMANCY COUNTER
17. ROLC / ROLL CALL COUNTER / TCAS II: M ROLL-CALL COUNTER
18. SQT/ SQUIRTER STATE COUNTER / TCAS II: M SQUIRTER STATE COUNTER
19. NULM / NULL STATE COUNTER / TCAS II: M NULL STATE COUNTER
20. RLSUM / NUMBER OF AIRCRAFT IN ROLL CALL / TCAS II: M ROLL-CALL COUNCIL
21. SENS / JSEMS / AIRCRAFT SENSITIVITIES
22. SINT / ITOB / INDICATES WHERE TCAS II: M TRANSMITTED DATA
23. LPLUS / TCAS II: M TRANSMISSIONS
24. SURV / ITRAN / TCAS II: M TRACK FILE
25. TCFI / ITIF / TCAS II: M TRANSMISSIONS
26. TRAF / ITM / TCAS II: M TRANSMISSIONS
27. TRAK / TRAK / TCAS II: M TRANSMISSIONS
28. OR/: OR/TCAS II: M TRANSMISSIONS
29. IN / PRINT / TCAS II: M TRANSMISSIONS
30. IMPR / PRINT / TCAS II: M TRANSMISSIONS
31. ORI / ORI / TCAS II: M TRANSMISSIONS
32. IS / IS / TCAS II: M TRANSMISSIONS
33. IS / IS / TCAS II: M TRANSMISSIONS
34. IS / IS / TCAS II: M TRANSMISSIONS
35. IS / IS / TCAS II: M TRANSMISSIONS
36. IS / IS / TCAS II: M TRANSMISSIONS
37. IS / IS / TCAS II: M TRANSMISSIONS
38. IS / IS / TCAS II: M TRANSMISSIONS
39. IS / IS / TCAS II: M TRANSMISSIONS
40. IS / IS / TCAS II: M TRANSMISSIONS
41. IS / IS / TCAS II: M TRANSMISSIONS
42. IS / IS / TCAS II: M TRANSMISSIONS
43. IS / IS / TCAS II: M TRANSMISSIONS
44. IS / IS / TCAS II: M TRANSMISSIONS
45. IS / IS / TCAS II: M TRANSMISSIONS
46. IS / IS / TCAS II: M TRANSMISSIONS

---

**INCLUDE RESTART.LST**

**PARAMETER (NUAIR = 320)**

---

**THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.**

---

**LOGICAL PRINT**

7. DIMENSION TJFILE(NUAIR,8), ITFILE(NUAIR,8), ICASFI(3,NUAIR)
8. COMMON /ITDATA/ ITIT(83), DENS(83)
9. COMMON /ITM/ JATN(NUAIR), JATSU(NUAIR), IDABS(NUAIR), IDABS(NUAIR)
10. EQUIVALENCE (TJFILE,TJFILE)
11. COMMON /ICASFI/TJFILE/NACII, ICASFI/TJFILE/NACII, ICASFI/TJFILE/NACII
12. COMMON/ADJSFES/SESIT(83)
13. COMMON/RESTART/RESTART
14. COMMON/OUT/OUT(NUAIR), UPRATE(NUAIR)

---

**B-17**
1 106. ALI = TFILE(K,3)/5200.        # ALTITUDE OF VICTIM A/C
1 107. ADAL = ASL(A2+AL1)           # ALTITUDE DIFFERENCE BETWEEN TWO A/Cs
1 108. SR = FLD10+9*ICASPI(I,2)+10.  # SLANT RANGE BETWEEN TWO A/Cs
1 109. ICASPI = FLD5+2*ICASPI(I,1)  # A/C TYPE
1 110. IF (ITMP.EQ.0) GO TO 20      # ELIMINATE ATCR58 A/C
1 111. RVPR = FLD10*ICASPI(I,1)     
1 112. ATRANS = JTRANS(1)/100000.  
1 113. CTRANS = 10000.+ATRANS      
1 114. RVPR1 = -(RVPR/10.) + 10.*ALOG10(ATRANS) - 3.0
1 115. 1 - 10.*ALOG10(CTRANS/AMSP(III))  
1 116. BRTRANS = JTRANS(K,1)/100000.
1 117. RVPR2 = -(RVPR/10.) + 10.*ALOG10(BTRANS) - 0.7 - 0.3 = 3.0
1 118. C
1 119. C REPLY POWER OF NODE S AND TCAS II M TRANSPONDERS DIFFERS BY 2.2 DB.
1 120. C
1 121. IF (JFILE(K,3).EQ.0) RVPR2 = RVPR2 - 2.2
1 122. IGN1 = (FLOAO+9+JFILE(K,3)+2*K2)/10.
1 123. IGN2 = (FLOAO+9+JFILE(K,3)+2*K2)/10.
1 124. IGN3 = (FLOAO+9+JFILE(K,3)+2*K2)/10.
1 125. IGN4 = (FLOAO+9+JFILE(K,3)+2*K2)/10.
1 126. GN1 = FLOAT(IGN1/10.)*ALOG10(EUIT(I)) - 4.7 - 1.9
1 127. GN2 = FLOAT(IGN2/10.)*ALOG10(EUIT(I)) - 4.7 - 1.9
1 128. GN3 = FLOAT(IGN3/10.)*ALOG10(EUIT(I)) - 4.7 - 1.9
1 129. GN4 = FLOAT(IGN4/10.)*ALOG10(EUIT(I)) - 4.7 - 1.9
1 130. GS = GN1
1 131. if (GN3.GT.GN1) GS = GN3
1 132. GV = GN2
1 133. if (GN4.GT.GN2) GV = GN4
1 134. GNGUP = GS + GV
1 135. PW1 = RVPR1 + GNGUP
1 136. PWR = RVPR2 + GNGUP          # INTERROGATION POWER
1 137. C
1 138. C IF VICTIM A/C IS TCAS II M-EQUIPPED AND ITS REPLY POWER IS ABOVE THE SENSITIVITY OF THE TCAS INTERROGATOR OF INTEREST, RUN SUBROUTINE TSQUIT.
1 139. C
1 140. C IF (((ITMP.EQ.3).AND.(PWR.GE.JSENS(III)))) CALL TSQUIT
1 141. C
1 142. C THE NEXT SEGMENT OF CODE FINDS THE PROBABILITY OF CLEAR RECEPTION OF THE VICTIM'S REPLY SIGNAL BY THE TCAS II M AIRCRAFT USING A CURVE-FITTING TECHNIQUE. THE CURVES WERE SUPPLIED BY LINCOLN LABORATORY AND MAY BE CONSIDERED SINUSOIDAL IN NATURE FOR THE INTERVAL UNDER CONSIDERATION.
1 143. C
1 144. C IF (FRUIT(II).LE.O) FRUIT(II) = 100.
1 145. C SHIFT = 3. + 10.*ALOG10(FRUIT(II)/11000)
1 146. C OIXX = 69.
1 147. C ORHO = OIXX + SHIFT
1 148. C PW = (-ORHO + PWR)/2*5.1459 - T
1 149. C PDC = 0.5 + 0.5*Sin(PW)
1 150. C IF (PW.LT.(ORHO - T)) PDC = 0.0
1 151. C IF (PW.GT.(ORHO + 8.)) PDC = 1.0
1 152. C POC = 0.95 + POC
1 153. C OIXX = -72
1 154. C ORHO = OIXX + SHIFT
1 155. C PWR = PWR + 1.0
1 156. C T = 25.
1 157. C IF (POW.GT.ORHO) T = 32.
1 158. C
*** DISHOD ***

1. \( PW = (\text{GRND} + \text{POW}) \times 2^{+3.14159} / T \)
2. \( \text{POD1} = 0.5 + 0.25 \times \sin (\text{PW}) \)
3. IF \( \text{POW} < \text{GRND} - 7 \) THEN \( \text{POD1} = 0.0 \)
4. IF \( \text{POW} > \text{GRND} + 8 \) THEN \( \text{POD1} = 1.0 \)
5. \( \text{POD1} = 0.95 \times \text{POD1} \)

UPDATE NODE S TARGET STATUS AND SCHEDULE INTERROGATIONS

165. \( V = 600 \times \)
166. IF \( \text{UFLD(K,3)} \) THEN \( V = V + 300 \)
167. \( \text{IF (UFLD(K,3))} \) THEN \( V = V + 300 \)
168. \( \text{TE} = \text{INT}((\text{SRP} \times 3600) / V) \)
169. \( \text{ITAL} = 0 \)
170. \( \text{KTRIAL} = \text{FLD}(22.3, \text{ITRACK}[3,3]) \)
171. \( \text{KSCAN} = \text{FLD}(25.4, \text{ITRACK}[3,3]) \)
172. \( \text{ICLOCK} = \text{FLD}(10.6, \text{ITRACK}[3,3]) \times (2^{+28}) \)
173. \( \text{ISQUIT} = \text{FLD}(29.4, \text{ITRACK}[3,3]) \)
174. \( \text{ISTATE} = \text{FLD}(16.4, \text{ITRACK}[3,3]) \)
175. IF \( \text{POW} \leq \text{SESIT} + 3 \) THEN \( \text{POD1} = 0.0 \)
176. IF \( \text{ISTATE} = 0 \) THEN \( \text{ICONT} = 0 \)
177. \( \text{ICLOCK} = \text{ICLOCK} - 1 \)
178. ELSE \( \text{ICLOCK} = \text{ICLOCK} - 1 \)
179. IF \( \text{ISTATE} = 0 \) THEN \( \text{ICLOCK} = \text{ICLOCK} - 1 \)
180. ELSE IF \( \text{ISTATE} = 1 \) THEN \( \text{ICLOCK} = 16 \)
181. ELSE \( \text{ICLOCK} = \text{ICLOCK} - 1 \)
182. \( \text{KSTEP} = 20 \)
183. ELSE IF \( \text{KTRIAL} = 0 \) THEN \( \text{KSTEP} = 16 \)
184. ELSE IF \( \text{KTRIAL} = 1 \) THEN \( \text{KSTEP} = 8 \)
185. ELSE IF \( \text{KTRIAL} = 2 \) THEN \( \text{KSTEP} = 4 \)
186. ELSE \( \text{KSTEP} = 2 \)
187. \( \text{KSTEP} = 2 \)
188. \( \text{KSTEP} = 2 \)
189. \( \text{KSTEP} = 2 \)
190. \( \text{KSTEP} = 2 \)
191. \( \text{KSTEP} = 2 \)
192. \( \text{KSTEP} = 2 \)
193. \( \text{KSTEP} = 2 \)
194. \( \text{KSTEP} = 2 \)
195. \( \text{KSTEP} = 2 \)
196. \( \text{KSTEP} = 2 \)
197. \( \text{KSTEP} = 2 \)
198. \( \text{KSTEP} = 2 \)
199. \( \text{KSTEP} = 2 \)
200. \( \text{KSTEP} = 2 \)
201. \( \text{KSTEP} = 2 \)
202. \( \text{KSTEP} = 2 \)
203. \( \text{KSTEP} = 2 \)
204. \( \text{KSTEP} = 2 \)
205. \( \text{KSTEP} = 2 \)
206. \( \text{KSTEP} = 2 \)
207. \( \text{KSTEP} = 2 \)
208. \( \text{KSTEP} = 2 \)
209. \( \text{KSTEP} = 2 \)
210. \( \text{KSTEP} = 2 \)
211. \( \text{KSTEP} = 2 \)
212. \( \text{KSTEP} = 2 \)
213. \( \text{KSTEP} = 2 \)
214. \( \text{KSTEP} = 2 \)
215. \( \text{KSTEP} = 2 \)
216. \( \text{KSTEP} = 2 \)
217. \( \text{KSTEP} = 2 \)
218. \( \text{KSTEP} = 2 \)
219. \( \text{KSTEP} = 2 \)
220. \( \text{KSTEP} = 2 \)
221. \( \text{KSTEP} = 2 \)
222. \( \text{KSTEP} = 2 \)
223. \( \text{KSTEP} = 2 \)
END IF

DO 9101 L = 1, N

CALL RANN (RAN)

IF (RAN .LT. POC) THEN

ICLOCK = ICLOCK + KSTEP

IALTY = 1

END IF

IF (ICLOCK .GE. 0) THEN

ISTATE = 2

KSCAN = 0

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

GO TO 9102

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) THEN

ICLOCK = ICLOCK + KSTEP

ISTATE = 2

KSCAN = 0

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

ELSE IF (ICLOCK .LE. -40) THEN

ISTATE = 0

KTRIAL = 0

KSCAN = 0

ICLOCK = 0

END IF

CONTINUE

IF (ICLOCK .GE. -1) THEN

ICONT = 0

DO 201 L = 1, (N-1)

CALL RANN (RAN)

IF (RAN .LT. POC) THEN

IALTY = 1

ICONT = ICONT + 1

GO TO 210

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .GT. 1.700) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF

CONTINUE

CALL RANN (RAN)

IF (RAN .LT. POC) ICONT = ICONT + 1

CONTINUE

IF (ICONT .NE. 0) THEN

IF (IALTY .LT. EQ. 1) THEN

ICLOCK = 16

ELSE

ISTATE = 2

KTRIAL = KTRIAL + 1

IF (KTRIAL .GE. 4) KTRIAL = 4

ICLOCK = 0

END IF

END IF

ELSE

ICLOCK = 0

ISTATE = 0

END IF
*** DISMOD ***

235. Call Ranneram
236. if (lcoun< eq. 2) then
237. kscan = kscan + 1
238. endif
239. if (ktrial .eq. 2) then
240. istate = 1
241. a scan = 0
242. iclock = 0
243. isqit = 0
244. else
245. c itril-sub gives max permissible misses--a function of trial & scan
246. if (ktrial .eq. 1) then
247. itry = itril1(kscan)
248. endif
249. if (ktrial .eq. 2) then
250. itry = itril2(kscan)
251. endif
252. if (ktrial .eq. 3) then
253. itry = itril3(kscan)
254. endif
255. if (ktrial .eq. 4) then
256. itry = itril4(kscan)
257. endif
258. if (itry .ne. 0) then
259. lcoun = 0
260. lcoun = lcoun + itry
261. endif
262. if ((lcoun < eq. 2) .and. (lcoun .le. itry)) then
263. call ranneram
264. endif
265. endif
266. endif
267. endif
268. endif
269. endif
270. endif
271. endif
272. endif
273. endif
274. endif
275. endif
276. endif
277. endif
278. endif
279. endif
280. endif
281. endif
282. endif
283. endif
284. endif
285. endif
286. endif
287. endif
288. endif
289. endif
290. endif
291. endif
292. endif
293. endif
294. endif
295. endif
296. endif
297. endif
298. endif
299. endif
300. endif
301. endif
302. endif
303. endif
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305. endif
306. endif
307. endif
308. endif
309. endif
310. endif
311. endif
312. endif
313. endif
314. endif
315. endif
316. endif
317. endif
318. endif
319. endif
320. endif
321. endif
322. endif
323. endif
324. endif
325. endif
326. endif
327. endif
328. endif
329. endif
330. endif
331. endif
332. endif
333. endif
334. endif
335. endif
336. endif
337. endif
338. endif
339. endif
340. endif
341. endif
342. endif
343. endif
344. endif
345. endif
346. endif
347. endif
348. endif
349. endif
350. endif
351. endif
352. endif
Appendix B

*** DISMOD ***

7 342. ISTATE = 3
7 343. ICLOCK = 0
7 344. KSCAN = 0
7 345. KTRIAL = 0
7 346. ISQIT = 0
7 347. END IF
7 348. ELSE
7 349. ISQIT = 1
7 350. END IF
7 351. END IF
7 352. END IF
7 353. END IF
7 354. ELSE IF (ISTATE.EQ.3) THEN
7 355. KSCAN = KSCAN + 1
7 356. MROL = MROL + 1
7 357. IF (KSCAN .GT. 10) THEN
7 358. ISTATE = 1
7 359. ICLOCK = 16
7 360. KTRIAL = 0
7 361. KSCAN = 0
7 362. ISQIT = 0
7 363. ELSE
7 364. ITRY = ITRY + 1
7 365. DO 401 L = 1, ITRY
7 366. CALL RAN(RAND)
7 367. IPLUS = IPLUS + 1
7 368. ITOR(IPLUS + 1) = 3
7 369. IF (INT(GS).EQ.INT(GM1)) ITOB(IPLUS+1) = 1
7 370. ROLSUM = ROLSUM + 1
7 371. C
7 372. DDATE(II) = DDATE(II) + 1
7 373. C
7 374. IF (PNI .GE. PDI ) THEN
7 375. DIMTRAT(K) = DIMTRAT(K) + 1
7 376. IF (RAN.LE.RDI ) THEN
7 377. KSCAN = 0
7 378. IF (TE.GT.40) THEN
7 379. DORSUM = DORSUM +1
7 380. ICLOCK = TE - 40
7 381. END IF
7 382. GO TO 402
7 383. END IF
7 384. END IF
7 385. END IF
7 386. 401 CONTINUE
7 387. 402 CONTINUE
7 388. END IF
7 389. ELSE IF (ISTATE.EQ.4) THEN
7 390. ICLOCK = ICLOCK - 1
7 391. END IF
7 392. IF (ICLOCK.EQ.0) THEN
7 393. ISTATE = 1
7 394. ICLOCK = 16
7 395. KTRIAL = 0
7 396. KSCAN = 0
7 397. ISQIT = 0
7 398. END IF
7 399. END IF
1 400. FLD(I0,I8,TRACK(II,IF)) = ICLOCK

B-23
*** DISMOD ***

1 401. FLD(E4*ITRACK(I1,I1)) = ISTATE
1 402. FLD(22*ITRACK(I1,I1)) = RTRIAL
1 403. FLD(29*ITRACK(I1,I1)) = KSCAN
1 404. FLD(39*ITRACK(I1,I1)) = 11SG
1 405. FLD(39*1*ITRACK(I1,I1)) = 0
1 406. LPLUS = LPLUS + IPLUS
1 407. LPLUS1 = LPLUS
1 408. 20 CONTINUE
1 409. RETURN
1 410. END

END FTN 1253 IBANK 240 DBANK 75362 COMMON
**DOT/FAA/PM-85/22**

---

**FILES**

```
02/27/85-16:35(39)
```

---

**SUBROUTINE FILES**

```
 THE FUNCTION OF THIS SUBROUTINE IS TO CREATE A FILE TO BE USED AS INPUT DATA TO THE DABS/ATCRBS/AIMS PPP WHICH WILL DETERMINE THE EFFECTS OF DEPLOYING TCAS SYSTEMS IN THE ENVIRONMENT.

*************** INPUTS / OUTPUTS ***************

**COMMON BLOCKS / VARIABLES**

```
ATE / DRATE TOTAL INTERROGATIONS REC'D BY TCAS IIM
CAS / NAC NUMBER OF AIRCRAFT
ILMS / KARR NUMBER OF N-S LEVELS TCAS IIM IS USING
MISAD / MIS MODE S MISSADDRESSES
SETA / ADDRESS MODE S ADDRESSES
TCDATA / IATIN ATCRBS INTERROGATIONS DUE TO TCAS II M
IATSU ATCRBS SUPPRESSIONS DUE TO TCAS II M
IDAN MODE S INTERROGATIONS DUE TO TCAS II M
IDABS MODE S SUPPRESSIONS DUE TO TCAS II M
TCRAT1 / ATCRAT TCAS I INTERROGATIONS AT EACH AIRCRAFT
```

---

**INCLUDE RESTARTLIST**

```
PARAMETER (NUAIR = 32)
```

---

**THE LOGICAL VARIABLE PRINT WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.**

---

**LOGICAL PRINT**

```
DIMENSION TFILE(NUAIR), IFILE(NUAIR), ICASFI(83,NUAIR)
COMMON /TCDATA/ I11(83), DENS(83)
COMMON /IATIN(NUAIR), IATSU(NUAIR), IDAN(NUAIR), IDABS(NUAIR)
COMMON /CAS/ ICASFI, TFILE, NAC, II, PRINT
COMMON /ILMS/KCARR(83), ANSP(83), RSETT(83)
COMMON /ATE/DRATE(83)
COMMON /SETA/ADDRESS(NUAIR)
COMMON /SENS/JSENS(NUAIR)
COMMON /TCA/NUMTCA
COMMON /TEMP/ATIME
COMMON /TCRAT/ATCRAT(NUAIR)
```

---

```
DO 2023 KE = 1, NAC
```  

```
IF (TFILE(KE).LT.3) THEN
```

```
    KF = KE + 1
```

```
ELSE
```

```
    AMSUP = 0.
```

```
ENDIF
```

```
WRITE (10,2025) HES(KE), IDABS(KE), IDAN(KE), IATIN(KE),
```

```
**2025** FORM (10x,5f15.5,4x,5f10.3,2x,5f10.3)
```  

---

B-25
*** FILES ***
1  47.  2023 CONTINUE
1  48.  C
   49.  RETURN
   50.  END

END FTN 64 IBANK 107 DBANK 32975 COMMON
SUBROUTINE FRUITA

THE PURPOSE OF THIS SUBROUTINE IS TO COMPUTE FRUIT RECEIVED AT EACH TCAS AIRCRAFT, AND TO COMPUTE THE PROBABILITY OF REPLY FOR EACH AIRCRAFT.

*************** INPUTS / OUTPUTS ***************

** COMMON BLOCKS / VARIABLES **

** INPUTS **

** OUTPUTS **

** DESCRIPTION **

** INPUTS **

** OUTPUTS **

** DESCRIPTION **

** INCLUDE RESTART-LIST **

PARAMETER (NUAIR = 328)

** THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL. **

** LOGICAL PRINT **

** DIMENSION TJFILE(NUAIR,8), IJFILE(NUAIR,8), ICASFI(N3,NUAIR,1) **

** COMMON /TCDATA/ I11(N3), DENS(N3), ICASFI(N3,NUAIR,1) **

** EQUVALENCE (TJFILE,IJFILE) **

** COMMON /CAS/ ICASFI, IJFILE, NAC, IU PRINT **

** INTEGER STAT, I,NUAIR, NMIS(NUAIR), COMMON/RATE/IADJIN(NUAIR), IADJSU(NUAIR), IDABS(NUAIR) **

** COMMON/FRUIT/FRUIT(83) **

** COMMON/MISAD/MIS(NUAIR) **

** COMMON/TPREPL/PREPL(NUAIR) **

** COMMON/TRAX/TRANS(NUAIR) **

** COMMON/SENS/SENS(NUAIR) **

** IF (II.EQ. 1) THEN 2 AT THE BEGINNING OF EACH NEW SEARCH **
### Appendix B

#### FRUITA

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DO I = 1, MUAIR</td>
</tr>
<tr>
<td>2</td>
<td>KWIN(I) = MUS(I)</td>
</tr>
<tr>
<td>3</td>
<td>IF (IJFILE(I,4) .EQ. 0) THEN</td>
</tr>
<tr>
<td>4</td>
<td>STAT(1,I) = IATIN(I)</td>
</tr>
<tr>
<td>5</td>
<td>STAT(2,I) = IATSU(I)</td>
</tr>
<tr>
<td>6</td>
<td>ELSE</td>
</tr>
<tr>
<td>7</td>
<td>STAT(1,I) = IDABN(I)</td>
</tr>
<tr>
<td>8</td>
<td>STAT(2,I) = IDABS(1)</td>
</tr>
<tr>
<td>9</td>
<td>END IF</td>
</tr>
<tr>
<td>10</td>
<td>CONTINUE</td>
</tr>
<tr>
<td>11</td>
<td>END IF</td>
</tr>
<tr>
<td>12</td>
<td>DO 6000 IQ = 1, MAC</td>
</tr>
<tr>
<td>13</td>
<td>C</td>
</tr>
<tr>
<td>14</td>
<td>CHECK THAT VICTIM AIRCRAFT IS WITHIN RANGE:</td>
</tr>
<tr>
<td>15</td>
<td>IF = FL(34.2,ICASFI(I,Q-1).EQ.0)</td>
</tr>
<tr>
<td>16</td>
<td>ITY = FLD(34.2,ICASFI(I,Q-1)).EQ.0</td>
</tr>
<tr>
<td>17</td>
<td>PLUS = STAT(2-IQ)</td>
</tr>
<tr>
<td>18</td>
<td>IF (ITY .EQ. 0) THEN</td>
</tr>
<tr>
<td>19</td>
<td>DEDT = PLUS + 0.000060</td>
</tr>
<tr>
<td>20</td>
<td>ASUP = 0.000035</td>
</tr>
<tr>
<td>21</td>
<td>ELSE</td>
</tr>
<tr>
<td>22</td>
<td>DEDT = PLUS + 0.000024</td>
</tr>
<tr>
<td>23</td>
<td>ASUP = 0.000020</td>
</tr>
<tr>
<td>24</td>
<td>END IF</td>
</tr>
<tr>
<td>25</td>
<td>C TOTAL SUPPRESSION TIME DUE TO GROUND ATC (IAOJSU) AND TCAS II M</td>
</tr>
<tr>
<td>26</td>
<td>C</td>
</tr>
<tr>
<td>27</td>
<td>DEADT = IAOJSU(IQ) + 0.000060 + DEDI</td>
</tr>
<tr>
<td>28</td>
<td>DEAD = IAOJSU(IQ) + 0.000035 + PLUS*0.000035 + KWIN(I)*ASUP</td>
</tr>
<tr>
<td>29</td>
<td>DEAD = DEAD + DEADS</td>
</tr>
<tr>
<td>30</td>
<td>C</td>
</tr>
<tr>
<td>31</td>
<td>CHECK THAT VICTIM AIRCRAFT IS WITHIN RANGE:</td>
</tr>
<tr>
<td>32</td>
<td>IF = FL(34.2,ICASFI(I,Q-1).EQ.0)</td>
</tr>
<tr>
<td>33</td>
<td>ITY = FLD(34.2,ICASFI(I,Q-1)).EQ.0</td>
</tr>
<tr>
<td>34</td>
<td>PLUS = STAT(2-IQ)</td>
</tr>
<tr>
<td>35</td>
<td>IF (ITY .EQ. 0) THEN</td>
</tr>
<tr>
<td>36</td>
<td>DEDT = PLUS + 0.000060</td>
</tr>
<tr>
<td>37</td>
<td>ASUP = 0.000035</td>
</tr>
<tr>
<td>38</td>
<td>ELSE</td>
</tr>
<tr>
<td>39</td>
<td>DEDT = PLUS + 0.000024</td>
</tr>
<tr>
<td>40</td>
<td>ASUP = 0.000020</td>
</tr>
<tr>
<td>41</td>
<td>END IF</td>
</tr>
<tr>
<td>42</td>
<td>C</td>
</tr>
<tr>
<td>43</td>
<td>C</td>
</tr>
<tr>
<td>44</td>
<td>C</td>
</tr>
<tr>
<td>45</td>
<td>C</td>
</tr>
<tr>
<td>46</td>
<td>C</td>
</tr>
<tr>
<td>47</td>
<td>C</td>
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#### Sign Bit

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
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<tbody>
<tr>
<td>48</td>
<td>I1 = (FLD(10.9 + 9.1JFILE(I,Q)) / 2**27) + TOP ANTENNA GAIN</td>
</tr>
<tr>
<td>49</td>
<td>I2 = (FLD(10.9 + 9.1JFILE(I,Q)) / 2**27) + BOTTOM ANTENNA GAIN</td>
</tr>
<tr>
<td>50</td>
<td>I3 = (FLD(10.9 + 9.1JFILE(I,Q)) / 2**27) + TOP ANTENNA GAIN</td>
</tr>
<tr>
<td>51</td>
<td>II = I1 / 2**27</td>
</tr>
<tr>
<td>52</td>
<td>I2 = I2 / 2**27</td>
</tr>
<tr>
<td>53</td>
<td>I3 = I3 / 2**27</td>
</tr>
<tr>
<td>54</td>
<td>GS = I1 / 10.0 + 4.7 - 1.9</td>
</tr>
<tr>
<td>55</td>
<td>IF ((I3 / 10.0 + 4.7 - 1.9).GT GS) GS = I3 / 10.0 + 4.7 - 1.9</td>
</tr>
<tr>
<td>56</td>
<td>GV = I2 / 10.0</td>
</tr>
<tr>
<td>57</td>
<td>GSUM = GS + GV</td>
</tr>
<tr>
<td>58</td>
<td>IF = FL(17.10 + ICASFI(I,Q-1))</td>
</tr>
<tr>
<td>59</td>
<td>IPW = FL(17.10 + ICASFI(I,Q-1))</td>
</tr>
<tr>
<td>60</td>
<td>PW = IPW</td>
</tr>
<tr>
<td>61</td>
<td>PW = PW + GSUM</td>
</tr>
<tr>
<td>62</td>
<td>TCAS II M REPLY POWER</td>
</tr>
<tr>
<td>63</td>
<td>IF (IJFILE(I,Q-4).EQ.3) PW = PW - 2.2</td>
</tr>
<tr>
<td>64</td>
<td>PW = PW + GSUM</td>
</tr>
<tr>
<td>65</td>
<td>TCAS II M REPLY POWER</td>
</tr>
</tbody>
</table>

---

**B-28**
*** FRUITA ***

2   106. IF (ITY .NE. 0) PLUI = 0
2   107. C COMPUTE AND STORE FRUIT RATE:
2   108.     FRIRAT = PREP(IQ)*IADJIM(IQ) + PREP(IQ)*PLUI
2   109.     FRUIT(I1) = FRUIT(I1) + FRIRAT
2   110.     END IF
1   111. 4000 CONTINUE
1   112. RETURN
1   113. END

END FTN 351 IBANK 1073 DBANK 33381 COMMON
FUNCTION HIATPW(NWSL)

1. THIS FUNCTION DETERMINE THE HIGHEST ATCR&S M-S LEVEL SENT WHEN A TOTAL OF NWSL ARE TRANSMITTED.

2. FIND THE HIGHEST POWER LEVEL (IN DBM) SENT

3. IMIPRI = NWSL + 1

4. IF( IMIPRI LE. 63) THEN

5. POWLEV = 69 - (IMIPRI + 2)/4

6. ELSE IF( IMIPRI .LE. 80) THEN

7. POWLEV = 36

8. ELSE

9. POWLEV = 36 - 2*(IMIPRI - 80)

10. END IF

11. HIATPW = 10.**((POWLEV+6-30)/10.)

12. RETURN

END IF

22. END

END FTN 64 IBANK 21 DBANK

** ** FILES ** **
**INIT**

*DFM/S INIT INIT*

1. **SUBROUTINE INIT**
2. C
3. C THIS SUBROUTINE SETS UP INITIAL VALUES FOR ALL THE COMMON
4. C VARIABLES TO BE USED IN THE MODEL. DETAILED DESCRIPTIONS OF ALL
5. C THE VARIABLES ARE CONTAINED IN THE DATA DICTIONARY OF THE TCAS
6. C SIGNAL ENVIRONMENT MODEL BY C. GILCHRIST AND G. PATRICK.
7. C
8. C INCLUDE RESTART LIST
9. C
10. PARAMETER (NUAIR = 320)
11. C
12. THE LOGICAL VARIABLE PRINT WHEN FALSE WILL SUPPRESS ALL WRITE
13. C STATEMENTS IN THE MODEL.
14. C
15. LOGICAL PRINT
16. C DIMENSION TFILE(NUAIR, 8), IJFILE(NUAIR, 8), ICASFILE(83, NUAIR, 8)
17. C COMMON /TCDATA/ 1111083)*DENS(83)
18. C IATIN(NUAIR), IATSU(NUAIR), IDABS(NUAIR)
19. C EQUIVALENCE (TFILE, IJFILE)
20. C COMMON /CASS/ ICASFILE, TFILE, MAC, II, PRINT
21. C COMMON /ADJSEN/ SESSITY(83)
22. C COMMON /ANTENN/ A2PAT(36), D2PAT(36)
23. C COMMON /ANF/ PASTOP(19), PASTBOT(19)
24. C COMMON /AF/ AF(19), AFBOT(19)
25. C COMMON /ATE/ DRATE(83)
26. C COMMON /GBEAR/ FLAT, TLOW, RLOW, DIST, BEARTX
27. C COMMON /DPLTMT/ IATCH, IDAB, ICTA
28. C COMMON /FRUIT/ FRUIT(83)
29. C COMMON /SLMS/ KCAIR(83), AHSK(83), IRESET(83)
30. C COMMON /LEVEL/ ISETA, JMAX, KMAX, TPW, PMAX
31. C COMMON /LEVEL2/ ICHK
32. C COMMON /MISAD/ MIS(NUAIR)
33. C COMMON /MNT/ DINTRC(NUAIR), IUPRATE(NUAIR), AHMEAN(200), ASDE(200)
34. C COMMON /RATE/ IA0JU(NUAIR), IA0JSU(NUAIR)
35. C COMMON /RACG/ ITIR1(46), ITIR2(46), ITIR3(46), ITIR4(46), ITIR5(46)
36. C COMMON /SROT/ SROT(10)
37. C COMMON /ROLCO/ ROLSUM, ACQSUM, DORSUM, RROL, MAQ, NDOOR, MSQ
38. C COMMON /SSENS/ JSENS(NUAIR)
39. C COMMON /SETA/ ADDR(NUAIR)
40. C COMMON /SINT/ LPLUS, K, ITOB(100)
41. C COMMON /SHOOT/ NOV(83), TIS(83), TPS(83)
42. C COMMON /SURV/ ITRACK(83, 500)
43. C COMMON /TCA/ NUMTCA
44. C COMMON /TCAT/ ATCRAT(NUAIR)
45. C COMMON /TF/ TF(100)
46. C COMMON /TREPL/ TREP(NUAIR)
47. C COMMON /TRANS/ TTRANS(NUAIR)
48. C COMMON /WSCP/ ILWS(83)
49. C COMMON /WSHUT/ IPRF(24), IPRS(40), IPRA(15), IPRBOT(4)
50. C COMMON /IPW(24), IPWS(4), IPWB(15), IPWBO(4)
51. C COMMON /IPW(15), IPWB(15), IPWBO(4)
52. C DO 200 I = 1, 83
53. C SESFT(I) = 0.
54. C DRAK(I) = 0.
55. C FRUIT(I) = 0.
*** INIT ***

1 47. KCARR(I) = 83
1 48. AMSP(I) = 0.
1 49. IRESET(I) = 0
1 50. NOW(I) = 0
1 51. TIS(I) = 0.
1 52. TOPS(I) = 0.
1 53. IT11(I) = 0
1 54. TCST(I) = 0.
1 55. ILWS(I) = 0
1 56. DENS(I) = 0.
1 57. IF (I .LT. 42) IPOWS(I) = 0
1 58. C DD 100 J = 1, NUAIR
1 59. TCAST(M, J, I) = 0
2 60. 300 CONTINUE
2 61. 375 J = 1, 500
2 62. ITRACK(I, J) = 0
2 63. CONTINUE
2 64. 200 CONTINUE
2 65. 200 CONTINUE
1 66. C DD 400 I = 1, NUAIR
1 67. MIS(I) = 0
1 68. DINTM(I) = 0.
1 69. UPRATE(I) = 0.
1 70. IAOJIN(I) = 0
1 71. IAOJUSU(I) = 0
1 72. JSEMS(I) = 0.
1 73. ADRESS(I) = 0.
1 74. IATIN(I) = 0
1 75. IATSU(I) = 0
1 76. IOANH(I) = 0
1 77. IOANS(I) = 0
1 78. ATCRAT(I) = 0.
1 79. PREC(I) = 0.
1 80. JTRANS(I) = 0.
1 81. DO 500 J = 1, 8
2 82. 500 CONTINUE
2 83. TJFILE(I, J) = 0.
2 84. 400 CONTINUE
2 85. 400 CONTINUE
1 86. C DO 600 I = 1, 200
1 87. ASOEC(I) = 0.
1 88. IF (I .LE. 100) IT0B(I) = 0
1 89. 600 CONTINUE
1 90. C DD 700 I = 1, 24
1 91. IPOWS(I) = 0.
1 92. IF (I .LE. 15) IPOWS(I) = 0
1 93. 700 CONTINUE
1 94. C TLAT = 0.0
1 95. TLON = 0.0
1 96. RLAT = 0.0
1 97. RLON = 0.0
1 98. DIST = 0.0
1 99. BEARTX = 0.0
2 100. SM = 0
2 101. TAC = 0
2 102. ITAC = 0
2 103. BAC = 0
2 104. BAP = 0
2 105. BACR = 0

B-32
106. IDAB = 0
107. ITCA = 0
108. ISETA = 0
109. JMAX = 0
110. KNAX = 0
111. TPOW = 0.0
112. PMAX = 0.0
113. ICHER = 0
114. ROLSUM = 0.0
115. ACONUM = 0.0
116. DORSUM = 0.0
117. MROL = 0
118. MAQ = 0
119. MSG = 0
120. NULL = 0
121. LPLUS = 0
122. I TIME = 0
123. X = 0
124. NUMTCA = 0
125. ITIME = 0

126. DATA (ANTTOP(1),1=1,19)/-31.3,-16.3,-8.5,-4.0,-4.0,-3.0,-2.0,0.0
127. 0.0,-5.0,-8.0,-12.0,-16.0,-17.0,-18.0,-21.0,-25.0,-31.0,-32.0/
128. DATA (ANTBOT(1),1=1,19)/-32.0,-31.0,-25.0,-21.0,-18.0,-17.0,-16.0,
129. -12.0,-8.0,-5.0,0.0,0.0,0.0,-2.0,-3.0,-4.0,-6.0,-8.5,-16.3,-31.3/
130. DATA (ITRIL1(1),1=1,6)/5,3,3,0,0,0/
131. DATA (ITRIL2(1),1=1,6)/2,2,2,0,0,0/
132. DATA (ITRIL3(1),1=1,6)/1,1,1,0,0,0/
133. DATA (ITRIL4(1),1=1,6)/1,0,0,0,0,0/
134. DATA (ITRIL5(1),1=1,6)/2,2,2,2,2,2/
135. DATA (AZPAT(1),1=1,6)/0,0,1,2,4,6,9,15,27,45,63,96,159
136. 21,33,51,81,125,211,339,511,793,1281,2063,3391
137. 5041,8431,13831,2221,3551,5581,8901,13831,2221,3551
138. 5041,8431,13831,2221,3551,5581,8901,13831,2221,3551
139. DATA (PHOT(1),1=1,9)/-31.3,-16.3,-8.5,-4.0,-4.0,-3.0,-2.0,0.0
140. 0.0,-5.0,-8.0,-12.0,-16.0,-17.0,-18.0,-21.0,-25.0,-31.0,-32.0/
141. DATA (PASLOT(1),1=1,19)/-32.0,-31.0,-25.0,-21.0,-18.0,-17.0,-16.0,
142. -12.0,-8.0,-5.0,0.0,0.0,0.0,-2.0,-3.0,-4.0,-6.0,-8.5,-16.3,-31.3/
143. 2,5,1.0,-0.5,-3.0,-7.0,-11.0,-14.5,-17.0,-18.0,-31.0,-32.0/
144. DATA (PASBOT(1),1=1,19)/-32.0,-31.0,-18.0,-17.0,-14.5,-11.0,-7.0,
145. -3.0,-0.5,1.0,2.5,2.5,2.0,1.5,-0.3,-2.8,-8.5,-16.3,-31.3/
146. DATA (IPRF(1),1=1,24)/15,9,15,17,21,25,29,33,37,41,45,49,53
147. 57,61,66,70,73,76,78,79/
148. DATA (IRFSC(1),1=1,40)/2,3,4,5,6,7,10,11,14,15,18,19,22,23,26,27,
149. 30,31,34,35,38,39,42,43,46,47,50,51,54,55,58,59,62,63,66,68
150. 68,69,71,72,74,75/
151. DATA (IPRFR(1),1=1,15)/4,8,12,16,20,24,28,32,36,40,44,48,52,56,60/
152. DATA (IPRFRB(1),1=1,15)/1,4,8,12,16,20,24,28,32,36,40,44,48,52,56,60/
153. DATA (IPRFRD(1),1=1,15)/1,4,8,12,16,20,24,28,32,36,40,44,48,52,56,60/
154. RETURN.
155. END
**APPENDIX B**

*INPUT*

**SUBROUTINE INPUT**

The function of this subroutine is to load characteristics from L. A. basin model and rates generated from DABS/ATCRBS/AIMS/PPN for each transponder.

1. Inputs / Outputs

<table>
<thead>
<tr>
<th>COMMON BLOCKS / VARIABLES</th>
<th>INPUTS</th>
<th>OUTPUTS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS / IJF</td>
<td>TYPE OF EACH AIRCRAFT</td>
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<tr>
<td>MAC / IJF</td>
<td>NUMBER OF AIRCRAFT</td>
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<tr>
<td>TPJ</td>
<td>AIRCRAFT CHARACTERISTICS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDABC / IJF</td>
<td>NUMBER OF ATCRBS/A/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDABC / IJF</td>
<td>NUMBER OF MODE S A/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RATE / IJF</td>
<td>INTERROGATION RATES FOR EACH A/C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAJJSU / IJF</td>
<td>SUPPRESSION RATES FOR EACH A/C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21. Include restart list

22. Parameter (NUAIR = 328)

23. The logical variable PRINT, when false, will suppress all write statements in the model.

24. Logical print

25. Dimension IJF, IJF

26. COMMON /CAS/ IJF, IJF, MAC, IT, PRINT

27. Dimension IATINR(NUAIR), ISUPRT(NUAIR)

28. COMMON /RATE/, IAJSU(NUAIR), IDABC(NUAIR)

29. EQUIVALENCE TYPE, ITYPE, NAC, NAC

30. DATA 0.8481368E-6, SECONDS TO RADIANS

31. DATA 1, SECONDS TO RADIANS

32. MAC = 0

33. RATIO = 0.420

34. DO 100 L = 1, NUAIR

35. READ(8,1)IATINR(L), ISUPRT(L), IDABC(L), IDAUS(L), LAT(L), LONB(L), ALT(L), TYPE(L)

36. IF(RAN.GE.RATIO) GO TO 2

37. READ(8,1)IATINR(L), ISUPRT(L), IDABC(L), IDAUS(L), LAT(L), LONB(L), ALT(L), TYPE(L)

38. CALL RANCRAN()  

39. Randomly eliminate aircraft

40. IF(RAN.GE.RATIO) GO TO 2

41. Read the transponder characteristics from the L. A. basin model

42. FORMAT(3,50,END=140), LAMBDA, LAT, LON, ALT, TYPE

43. DX = 0.4

44. CALL RANCRAN()  

45. Randomly eliminate aircraft

46. IF(RAN.GE.RATIO) GO TO 2

*END*
## LOWER DENSITY DEPLOYMENTS

<table>
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<td>80. C</td>
</tr>
</tbody>
</table>

*NON-STO USAGE 3128 *TYPE* EQUIVALENCED TO A NONCHARACTER ITEM

END FTM 1 NON-STD USAGES 183 IBANK 796 DBANK 31988 COMMON
THE PURPOSE OF THIS SUBROUTINE IS TO CHECK THE AMOUNT OF TCAS II INTERFERENCE SPENT (WITH MOD F S AND ATCAS) AND TO DETERMINE IF ANY OF THE THREE INTERFERENCE LIMITING INEQUALITIES ARE VIOLATED. IF VIOLATED, POWER AND SENSITIVITY ADJUSTMENTS ARE POSSIBLE ACCORDING TO INTERFERENCE LIMITING PROTOCOL. THIS SUBROUTINE WAS MODELED ACCORDING TO THE MINIMUM OPERATIONAL PERFORMANCE STANDARDS (MOPS).

*** INPUTS / OUTPUTS ********************

<table>
<thead>
<tr>
<th>COMMON BLOCKS</th>
<th>VARIABLES</th>
</tr>
</thead>
<tbody>
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<td>INPUTS</td>
<td>OUTPUTS</td>
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<td>CAS</td>
<td>II</td>
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<td>AMSP</td>
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<td>IRESET</td>
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<td>JSENS</td>
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<td>NOW</td>
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<td>TEMP</td>
<td>ITIME</td>
</tr>
<tr>
<td>TRAX</td>
<td>JTRANS</td>
</tr>
</tbody>
</table>

PARAMETER ( PMATCH = 10.**((3.0-4.1)/10.) ) : FACTOR-FOR MODE S POWER
PARAMETER ( PMSFAC = 10.**((-4.4)/10.) ) : DEFINE S POWER AT ANTENNA
PARAMETER ( ONEDB = 10.**((4.1)/10.) ) : DEFINE 1 DB

INCLUDE RESTART#LIST
PARAMETER ( NUAIR = 743 )

THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.

LOGICAL POISH0IPINTLI.PTCMT.PATMOD.POISIN.PFILES.PFRUIT.PSTATS
COMMON /PRTOL: POISH0IPINTLI.PTCMT.PATMOD.POISIN.PFILES.PFRUIT/PSTATS

DIMENSION TFILE(NUAIR), IFILE(NUAIR), IACSPF(NUAIR)
COMMON /TCDATA ITIIT(NP3), DENS(83),
IATINNUAIR), IATINNUAIR), IATIINNUAIR)
COMMON /CAS IACSPF.TFILE.NAC II, PRINT
INCLUDE TERP#LIST
COMMON /TERP# ITIME
INCLUDE IMR#LIST
COMMON /FILSF WSL(83), AMSP(83), IRESET(83), ATSUMP(83),
COMMON /HEADER TPOW
INCLUDE SMOOTH#LIST
COMMON /SMOOTH NOW(83), AVMSPM(83), TIS(S3)
INCLUDE AJSEN#LIST
COMMON /AJSEN SARITI(S3)
INCLUDE ATE-LIST
COMMON /ATL/ IRATL(13)

INCLUDE TRAX-LIST
COMMON /TPAR/ JTRANS(NPAIR)

INCLUDE SENS-LIST

COMMON /SENS/ JSENS(NPAIR)

44. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)

40. INCLUDE TRAX-LIST

1. COMMON /TRA/ JTRANS(NPAIR)

41. INCLUDE SENS-LIST

42. INCLUDE ATFE-LIST

1. COMMON /Att/ DRATL(33)
IF IPW = ITATPW + TMSPW

IF(IPW < 45600 OR LSEQ2 + 60,GT,1000) THEN
    B SEE FIGURE 3-5
ELSE

    IF (IPW < 8000) THEN
        RETURN
    IF

    END IF

ENDIF IF

END IF

IF (IPW < 1000) THEN
    RETURN
ELSE

    END IF

ENDIF IF

106.

IPOW = ITATPOW + TMSPOW

107.

IF (POW < 45600 OR LSEQ2 + 60, GT, 1000) THEN
    B SEE FIGURE 3-5
ELSE

    GO TO 20
    B GO TO POINT 3
ENDIF IF

END IF

ENDIF IF

END IF

110.

POWMS = JERANS(II)/1000.

111.

IF (AMSP(II) < POWMS) THEN
    B INST POW < MAX POW
    GO TO POINT 3
ELSE

    END IF

ENDIF IF

IF (AMSP(II) > 10000) THEN
    B 1 DB INCREASE IN POWER
    GO TO POINT 3
ELSE

    END IF

ENDIF IF

IF (AMSP(II) < 10000) THEN
    B 1 DB DECREASE IN MTL
    GO TO POINT 3
ELSE

    END IF

ENDIF IF

END IF

110.

AMSP = AMSP(II) - ONEDB

111.

IF (AMSP < 0) THEN
    B AMSP < 0
    GO TO POINT 3
ELSE

    END IF

ENDIF IF

IF (AMSP(II) = AMSP(II) + ONEDB) THEN
    RETURN
ELSE

    RETURN
END IF

RETURN

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110.
**LOAD**

*FTM S LOAD LOAD

FTM 1IR1 02/27/85-16:35(15,)

1. SUBROUTINE LOAD

**THE FUNCTIONS OF THIS SUBROUTINE ARE:**

- 1. TO UPDATE AIRCRAFT POSITIONS
- 2. TO COMPUTE THE HEADING OF EACH TCAS
- 3. TO UPDATE NODE S TRACK ARRAY (I TRACK)
- 4. TO LOAD ARRAY BETWEEN TCAS AND VICTIM AIRCRAFT (ICASFI)
- 5. TO COMPUTE THE AIR TRAFFIC DENSITIES ABOUT EACH TCAS.

**INPUTS / OUTPUTS**********************

**COMMON BLOCKS / VARIABLES**

**INPUTS OUTPUTS DESCRIPTION**

1. CAS / ICA$PI TCAS II ENVIRONMENTAL FILE
2. MAC / NMAC NUMBER OF AIRCRAFT
3. SURF / ITRACK ITRACK A/C CHARACTERISTICS FILE
4. TCA$ / NUMTC AIRCRAFT NUMBER OF TCAS II M AIRCRAFT
5. TC$DATA / IDENS A/C DENSITY ABOUT EACH TCAS II M
6. ITRACK TCAS II M POINTER FILE
7. TEMP / ITIME ELAPSED TIME IN SIMULATION

**LOGICAL ZERO**

1. COMMON/ABBEAR/TLAT,TLON,DIST,BEARM
2. INCLUDE RESTART LIST
3. PARAMETER (NUAIR = 328)

**LOGICAL PRINT**

1. DIMENSION TJFILE(NUAIR,8), ITRACK(NUAIR,8), ICA$PI(83,NUAIR,1)
2. COMMON /TC$DATA/ ITRACK(83), NUMTC(83,500)
3. COMMON/TEMPITIME
4. COMMON/TCA$/NUMTC
5. DIMENSION THETA(83)
6. DEFINE FL01(J,K) = 8*TS(K+1)*J
7. CF = 0.000209
8. B CONVERTS NAUTICAL MILES TO
9. RADIANS.
10. IF (TIME.NE.0) THEN
11. UPDATE A/C POSITIONS EVERY FORTY SECONDS.
12. DO 310 K = 1, NUMTC
13. OLAT = TJFILE(KR,1)
17. CONTINUE
18. END IF
### LOAD

1. LOAD/UPDATE ARRAYS.
2. DENSU = 0.
3. DENSU1 = 0.
4. DENSUS = 0.
5. DENSUS1 = 0.
6. DENS3 = 0.
7. DENS30 = 0.
8. DO 300 J = 1, NUMTCAS
9. LOOP OVER ALL TCAS II M AS/C

#### COMPUTE HEADING OF TCAS II M

1. IN = I111(I)
2. THETA(I) = ASIN(TJFILE(IN,5)/(TJFILE(IN,5)**2)**0.5))*57.2957
3. THE FACTOR OF 57.2957 IN THE ABOVE EQUATION CONVERTS THE ANGLE FROM RADIANS TO DEGREES.
4. YAW = 90. - THETA(I)
5. IF (TJFILE(IN,5).LT.0.) YAW = 270. + THETA(I)
6. MAXNAC = 0
7. RYAT = TJFILE(IN,1)
8. RYAT = TJFILE(IN,2)
9. RYAT = TJFILE(IN,3)/6076.0
10. LOOP OVER ALL AIRCRAFT
11. DO 500 J = 1, NAC
12. ICASFI(I,J,1) = 0
13. IF (JM.EQ.J) GO TO 500
14. NAC
15. RYAT = TJFILE(J,1)
16. RYAT = TJFILE(J,2)
17. RYAT = TJFILE(J,3)/6076.0
18. CALL BEAR
19. BEARTX = BEARTX + 40.
20. A = DIST
21. 8 = (ALT1 - ALT2)

B-40
2 100. C ZCSQRT(A*A+B*B))*10. & STRAIGHT LINE DISTANCE
2 101. C SLTRG = C + 1. & IN TENTHS OF NAUTICAL MILES
2 102. C IF (IJFILE(J,J4),EQ.O) GO TO 5006 & IF MODE S OR TCAS II M/A/C,
2 110. C UPDATE TRACK FILE
2 111. C 0=ABS(S+1.15*5280.) & LOAD NEW AIRCRAFT
2 112. C IF ((SLTRG .LE. 500) .AND. (B .LT. 1.48)) THEN
2 113. C ZERO = .FALSE. & SLANT RANGE.
2 114. C IF (IJFILE(J,J#4).EQ.O) GO TO 5004
2 115. C 1200 & LOAD NEW AIRCRAFT
2 116. C IF ((SLTRG .LE. 500) .AND. (B .LT. 1.48)) THEN
2 117. C 1201 & LOAD NEW AIRCRAFT
2 118. C J1 = IX END IF
2 119. C IF ((SLTRG .LE. 500) .AND. (B .LT. 1.48)) THEN
2 120. C 1201 & LOAD NEW AIRCRAFT
2 121. C ELSE & ELIMINATE FROM MODE S TRACK
2 122. C SLTRG110 & LOAD NEW AIRCRAFT
2 123. C THE SLANT RANGE
2 124. C IN NAUTICAL MILES
2 125. C IF (SLTRG .LT. 500) THEN
2 126. C 5001 & END IF
2 127. C IF (SLTRG .LT. 500) THEN
2 128. C 5001 & END IF
2 129. C IF (SLTRG .LT. 500) THEN
2 130. C 5004 & END IF
2 131. C 5004 & END IF
2 132. C UPDATE TCAS ENVIRONMENTAL ARRAY
2 133. C IN THE FOLLOWING PROPAGATION LOSS EQUATION;
2 134. C 37.80 = CONSTANT ADJUSTMENT FACTOR FOR THE UNITS
2 135. C 1030 = UPLINK FREQUENCY IN MEGAHertz
2 136. C SLTRG10 = THE SLANT RANGE IN MII
2 137. C 5.0 = CABLE LOSS
2 138. C 60.0 = CONVERSION FROM KILOWATTS TO MILLIWATTS
2 139. C AP = 37.80*20.*ALOG1OCIO3O.)*20.*ALOGIO0(SLTRtGIIO.)43.0-60. & PROPAGATION LOSS EQUATION:
2 140. C PR = (AP)*10. & COUPLINGS.
2 141. C IF (SLTRG .GE. 500) ICA$FICI*J*I) = 0
2 142. C IF (SLTRG .LE. 500) THEN
2 143. C IF (A.LE.10.) MAXNAC = MAXNAC + 1 & COUNT THE AIRCRAFT WITHIN
2 144. C 10 NAUTICAL MILES.
2 145. C IF (SLTRG .LE. 500) THEN
2 146. C IF (A.LE.10.) MAXNAC = MAXNAC + 1 & COUNT THE AIRCRAFT WITHIN
2 147. C 10 NAUTICAL MILES.
2 148. C IX = INT(SLTRG) & RELATIVE RANGE.
2 149. C IX = INT(SLTRG) & RELATIVE BEARING.
2 150. C IX = INT(SLTRG) & RELATIVE POWER.
2 151. C FLO(0,09*IICAS$ICI*J*I) = IX & LOAD RANGE.
2 152. C FLO(17910*IICAS$ICI*J*I) = IX & LOAD RANGE.
2 153. C FLO(10917*IICAS$ICI*J*I) = IX & LOAD RANGE.
2 154. C FLO(10917*IICAS$ICI*J*I) = IX & LOAD RANGE.
2 155. C FLO(10917*IICAS$ICI*J*I) = IX & LOAD RANGE.
2 156. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 157. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 158. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 159. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 160. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 161. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 162. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 163. C (XI/560.) - THETA(I) & LOAD BEARING OF VICTIM.
2 164. C 500 & END VICTIM ALE FILE.
LOAD

**

2 165. C COMPUTE LOCAL DENSITY ABOUT TCAS II M
2 166. C
1 167. C DENS(I) = MAXMAC/(3.14159*100.)
1 168. C AIR TRAFFIC DENSITY
1 169. C WITHIN 10 NAUTICAL MILES.
1 170. C
1 171. C 300 CONTINUE
1 172. C RETURN
1 173. C END

END FYN 517 IBANK 206 DBANK 72837 COMMON
**SUBROUTINE** PRESET

**THE PURPOSE OF THIS SUBROUTINE IS TO APPROXIMATE THE INTERFERENCE**

**LIMITING EFFECTS ON EACH TCAS AIRCRAFT.**

**THIS SUBROUTINE IS ONLY CALLED FOR TIME = 0.**

***************** INPUTS / OUTPUTS ***************

**COMMON BLOCKS / VARIABLES**

**INOUTS** DESCRIPTION

1. ADJSEN / SESIT TCAS II M SENSITIVITIES ADJUSTED TO CONFORM TO I-L EQUATIONS
2. GAS / TJF FILE AIRCRAFT CHARACTERISTICS FILE
3. DPLYMT / IDAB NUMBER OF MODE S AIRCRAFT
4. ILM / AMSP NUMBER OF TCAS II M AIRCRAFT
5. SENS / JSENS AIRCRAFT SENSITIVITY LEVELS
6. SURV / ITRACK MODE S TRACK FILE
7. TCAA / NUMTCA NUMBER OF TCAS AIRCRAFT
8. TCDA / I1I1 TCAS II M POINTER FILE
9. TRAX / JTRANS AIRCRAFT TRANSMISSION POWERS

**PARAMETER** (NUAIR = 328)

**LOGICAL PRINT WHEN FALSE WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.**

**LOGICAL**

1. DIMENSION TJFILE(NUAI R), IQFILE(NUAI R), ICASFI(NUAI R), I1I1(83)
2. COMMON /TDATA/ ITS11(B3), DENS(B3)
3. IATINC(NUAI R), IATSINC(NUAI R), IDAB(NUAI R), IDAB(S
4. EQUIVALENCE (TJFILE, IQFILE)
5. COMMON /CAS/ ICSFI, TJFILE, NAC, II, PRINT
6. COMMON/SURV/ITRACK(B3,500)
7. COMMON/TCAA/NUMTCA
8. COMMON/ILMS/IAB(R3), AMSP(B3), IRESET(B3)
9. COMMON/ADJSEN/SESIT(B3)
10. COMMON/TRAX/ITRACK(NUAIR)
11. COMMON/SENS/JSENS(NUAIR)
12. COMMON/DPLYMT/ITC,R1A,B, I1I1
13. DEFINE FLO(IP,J,K) = BITS(K,J+1,J)
14. NTRK = 500
15. DO 1 IT = 1, NUMTCA
16. SOUTARG = 0.
17. AQTARG = 0.
18. RCTARG = 0.
19. LT = I1I1(IT)
20. TCAL = TJFILE(LT,3)
21. DO 2 IF = 1, NTRK
22. K = FLO(IP,10,ITRACK(IT,IF))
23. IF (K,EQ,0) GO TO 2
24. IF (ITEMP.EQ,0) GO TO 2

**B-43**
247. \( SR = \frac{FLOP9(\text{ICASF}T(\text{ITK,1})))}{10}. \)

248. IF (\( SR > 35 \)) GO TO 2

249. \( SQTARG = SQTARG + 1 \)

250. \( AMSALT = T\text{FILE}(K,3) \)

251. \( DALT = \text{ABS}(\text{TCDALT} - \text{AMSALT}) \)

252. IF (\( SR > 30 \)) GO TO 2

253. IF (\( \text{DALT} \geq 9000 \)) GO TO 2

254. IF (\( SR > 7.16 \)) \( AQTARG = AQTARG + 1 \)

255. IF (\( SR \leq 7.16 \)) \( RCTARG = RCTARG + 1 \)

256. CONTINUE (END TRACK LOOP)

257. \( IMOS = IDAB + ITCA \)

258. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

259. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

260. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

261. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

262. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

263. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

264. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

265. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

266. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

267. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

268. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

269. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

270. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

271. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

272. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

273. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

274. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

275. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

276. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

277. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

278. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

279. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

280. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

281. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

282. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

283. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

284. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

285. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

286. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

287. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

288. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

289. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

290. \( \text{NTCS=SQTARG*(FLOAT(\text{ITCA}))/FLOAT(IMOS))} \)

END FTN 236 IBANK 88 QEBANK 73821 COMMON

B-44
SUBROUTINE RANN(RAN)

THIS SUBROUTINE IS A RANDOM NUMBER GENERATOR DEVELOPED BY C. W. EHLER.

LOGICAL GTIST

IF (.NOT.(GTIST)) THEN
   ISEED = 532413
   GTIST = .TRUE.
END IF

ISEED = ISEED*3125
RAN = ABS(FLOAT(ISEED))*2910383046299172500-10

RETURN
END
SUBROUTINE STATS

THE PURPOSE OF THIS SUBROUTINE IS TO COMPUTE STATISTICS FOR SEVERAL TCAS VARIABLES.

.............................. INPUTS / OUTPUTS ..................................

COMMON BLOCKS / VARIABLES

- INPUTS / OUTPUTS / DESCRIPTIONS

COMMON BLOCKS / VARIABLES

- INPUTS / OUTPUTS / DESCRIPTIONS

INCLUDE RESTART-LIST

PARAMETER (NUAIR = 320)

THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.

LOGICAL PRINT

DIMENSION TFILE(NUAIR,N), IJFILE(NUAIR,N), TCASFI(83,NUAIR,N)

COMMON /TCDA1/I111(83), OENS(83), IATIN(NUAIR), IATSU(NUAIR), IDABN(NUAIR), IOABS(NUAIR)

COMMON/EQUIVALENCE(TJFILE, IJFILE)

COMMON/TMAX/ITIME

COMMON/SMOOTH/NOW(83), T15C83), TPS(83)

COMMON/ATE/DRATE(83)

COMMON/DLNYT/IATCR, IDAB, ITCA

COMMON/TCRAT1/ATCRAT(NUAIR)

COMMON/TCAS1/TCAS1

COMMON/ITEMPl/ITIME

COMMON/IATEIDRATC3)

COMMON/OPLYMTIIATCRPIDABITC

COMMON/ITCRATIATCRAT(NUAIR)

COMPUTE AVERAGE NUMBER OF TCAS II M WITHIN EACH TCAS VOLUME, AND AVERAGE NUMBER OF INTERROGATIONS SENT BY TCAS II M.

SIGSUM = 0.0
PSUM = 0.0
OSUM = 0.0
OD 10 NS = 1, ITCA

SIGSUM = SIGSUM + ANOW*ANOW
PSUM = PSUM + ANOW*FLOAT(ITCA)
OSUM = OSUM + ORATE(NS)*FLOAT(ITCA)

SIGSUM = SIGSUM + ANOW*ANOW
PSUM = PSUM + ANOW*FLOAT(ITCA)
OSUM = OSUM + ORATE(NS)*FLOAT(ITCA)

ESDEV = SQRT((SIGSUM/FLOAT(ITCA)) - PSUM*PSUM)

CONTINUE
**** STATS ****

47. SUM = ITCA + IDAB
48. SUM1 = IA
49. ISUM2 = 0
50. ISUM3 = 0
51. ISUM4 = 0
52. ISUM5 = 0
53. ISUM6 = 0
54. ISUM7 = 0
55. ISUM8 = 0
56. ISUM9 = 0
57. ISUM10 = 0
58. DO 11 IK = 1, MAC
59. IF (IJKFILE(IK) .NE. 0) THEN
60. COMPUTE STATS ON TCAS I, TCAS II, AND MODE S INTERROGATIONS.
61. ISUM2 = ISUM2 + IDABM(IK) + ATCRAT(IK)
62. ISUM3 = ISUM3 + IDABM(IK) + ATCRAT(IK)
63. ISUM4 = ISUM4 + (IDABM(IK) + ATCRAT(IK))**2.
64. ISUM5 = ISUM5 + IDABM(IK)**2.
65. ELSE
66. COMPUTE NUMBER OF WHISPER-SHOUT INTERROGATIONS AND SUPPRESSIONS RECEIVED AT ATCRBS.
67. ISUM8 = ISUM8 + IATINM(IK) + ATCRATM(IK) AT ATCRBS DUE TO TCAS I & II MODES.
68. ISUM9 = ISUM9 + IATSUMM(IK) A WHISPER-SHOUT SUPPRESSION RECEIVED AT ATCRBS.
69. ISUM10 = ISUM10 + (IATINM(IK) + ATCRATM(IK))**2.
70. ISUM11 = ISUM11 + IATSUMM(IK)**2.
71. END IF
72. 11 CONTINUE
73. AI = ISUMM/SUM
74. AS = ISUMM/SUM
75. AISOV = SQRT(ISUMM/SUM - AI*AI)
76. ASSOV = SQRT(ISUMM/SUM - AS**2).
77. DI = ISUMS/SUM
78. DS = ISUMS/SUM
79. DISOV = SQRT(ISUMS/SUM - DI*DI)
80. DSSDV = SQRT(ISUMS/SUM - DS**2).
81. IF (PRINT) WRITE(12) ITIME, PSUM, ESOEVP, AI, AISOV, AS, ASSOV, DI, DISOV, DS, DSSDV
82. 12 FORMAT (*1X, PSUM, ESOEVP, AI, AISOV, AS, ASSOV, DI, DISOV, DS, DSSDV
83. 13 FORMAT (*1X, "STANDARD DEVIATION:")
84. 14 FORMAT (*1X, *12)
85. 15 FORMAT (*1X, "STANDARD DEVIATION:")
86. 16 FORMAT (*1X, "STANDARD DEVIATION:")
87. 17 FORMAT (*1X, "STANDARD DEVIATION:")
88. 18 FORMAT (*1X, "STANDARD DEVIATION:")
89. 19 FORMAT (*1X, "STANDARD DEVIATION:")
90. 20 FORMAT (*1X, "STANDARD DEVIATION:")
91. 21 FORMAT (*1X, "STANDARD DEVIATION:")
92. 22 FORMAT (*1X, "STANDARD DEVIATION:")
93. 23 FORMAT (*1X, "STANDARD DEVIATION:")
94. 24 FORMAT (*1X, "STANDARD DEVIATION:")
95. 25 FORMAT (*1X, "STANDARD DEVIATION:")
96. 26 FORMAT (*1X, "STANDARD DEVIATION:")
97. 27 FORMAT (*1X, "STANDARD DEVIATION:")
98. 28 FORMAT (*1X, "STANDARD DEVIATION:")
99. 29 FORMAT (*1X, "STANDARD DEVIATION:")
100. 30 FORMAT (*1X, "STANDARD DEVIATION:")
101. 31 FORMAT (*1X, "STANDARD DEVIATION:")
**Appendix B**

TCASI

**Function of this Subroutine**

The function of the subroutine is to determine the effects of deploying TCAS I aircraft in the environment. All Mode S aircraft are assumed to be TCAS II-equipped. This subroutine is called only when a TCAS I analysis is conducted.

---

**Inputs/Outputs**

- **Inputs**
  - ANTO / PASBOT: Receiving antenna patterns; bottom
  - PASTOP: Top
  - ANT / ANTBOT: Transmitting antenna patterns; bottom
  - ANTTOP: Top
  - CAS / IJFILE: Aircraft types
  - MAC: Number of aircraft
  - TJFILE: Aircraft characteristics
  - SENS / JSENS: Sensitivity levels for each aircraft
  - TCRAI / JSENS: Number of TCAS I interrogations at each aircraft

- **Outputs**
  - IATIN(NUAIR): IATSU(NUAIR): IDABS(NUAIR)

- **Variables**
  - IATIN(NUAIR): IATSU(NUAIR): IDABS(NUAIR)

---

**Variables**

- IATIN(NUAIR): IATSU(NUAIR): IDABS(NUAIR)

---

**Subroutine TCASI**

- **Inputs**
  - TJFILE: Aircraft types
  - ICASFI: Number of aircraft

- **Outputs**
  - TCRAI: Number of TCAS I interrogations at each aircraft

---

**COMMON Blocks**

- **COMMON Blocks**
  - COMMON ITCOATAI 1111(83), DENS(83)
  - COMMON IATIN(NUAIR): IATSU(NUAIR): IDABS(NUAIR)

---

**Logic**

- IF (CCIJFILE(N4).EQ.3).OR.(IJFILE(NN,4).EQ.0)) GO TO 10
- IF (NN.EQ.IA) GO TO 11
- IF ((JSFILE(NN,4),EQ.3).OR.(TJFILE(NN,4),EQ.0)) GO TO 10
**TCAS1**

2 47. \( \text{THET} = \left( \text{ATAN} \left( \text{ARGA} \right) \right) \times 57.296 \)  \( \quad \) DETERMINE ANGLE BETWEEN
2 48. \( \text{THETA1} = \text{ABS} \left( \left( \text{THET} + 90. \right) / 10. \right) \)  \( \quad \) TCAS 1 AND VICTIM A/C
2 49. \( \text{ITH1} = \text{THETA1} + 1 \)  \( \quad \)
2 50. \( \text{ITH2} = \text{THETA2} + 1 \)  \( \quad \)
2 51. \( \text{ITH3} = \text{THETA3} + 1 \)  \( \quad \)
2 52.  \( \quad \)
2 53. **C** DETERMINE GAIN OF ANTENNA.
2 54. **C**
2 55. **C**
2 56. \( \text{GN1} = \text{ANTTOP} \left( \text{ITH1} \right) + \left( \text{ITH1} - \text{FLOAT} \left( \text{ITH1} \right) \right) \)  \( \quad \)
2 57. \( \quad \)
2 58. \( \quad \)
2 59. \( \quad \)
2 60. \( \quad \)
2 61. \( \quad \)
2 62. \( \quad \)
2 63. \( \quad \)
2 64. **C**\( \quad \)
2 65. **C**
2 66. **C**
2 67. **C**
2 68. **C**
2 69. **C**
2 70. **C**
2 71. **C**
2 72. **C**
2 73. **C**
2 74.  \( \quad \)
2 75.  \( \quad \)
2 76.  \( \quad \)
2 77.  \( \quad \)

END FTN 274 IBANK 87 DBANK 32067 COMMON
**TCNOT**

**Subroutine TCNOT**

**The purpose this subroutine is to produce values for the Emission powers and Interrogations rates smoothed over a 16-second time period.**

**************** Inputs / Outputs ***************

**Common blocks / Variables**

**Inputs**

1. **ATE** / **DATE**
2. **CAS** / **II**
3. **ILMS** / **ANSP**
4. **SMOOTH** / **TIS**
5. **AVMSWP**
6. **TCDATA** / **ITIME**
7. **TEMP** / **ITIME**

**Outputs**

- Total Emissions recorded by each TCAS II M Transponder
- TCAS II M Identity
- Adjusted TCAS II M Transmission Power
- Smoothed Emission Power
- Smoothed Total Mode S Power
- TCAS II M PoWer file
- Elapsed time in simulation

**Include RFSTARTLIST**

1. **PARAMETER** (NUAIR = 743)
2. **THE LOGICAL VARIABLE PRINT WHEN FALSE WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.**
3. **LOGICAL POISNO=POINTL=PTCSMT=Pathod=POISIN=PFILe=FFRUIT=PSTAT**
4. **COMMON /PRINTL/POISNO=POINTL=PTCSMT=Pathod=POISIN=PFILe=FFRUIT=PSTAT**
5. **COMMON /TEMPI**
6. **COMMON /TEMPSW(83), TIS(83)**
7. **COMMON /ILMS/NSL(83), ANSP(83), IRESET(*3), ATSUMP(0:83)**
8. **COMMON /TRAX/ TRANS(NUAIR)**
9. **REAL INSTNT(0:15), STSUMP(83)**
10. **COMMON /TRAX/ TRANS(NUAIR)**

**Dimension**

1. **TJFILE(NUAIR,8), IJFILE(NUAIR,8), ICASPI(83,NUAIR)**
2. **ATM(NUAIR), IATSU(NUAIR), IDASN(NUAIR)**
3. **EQUIVALENCE (TJFILE, IJFILE)**
4. **COMMON /CAS/, IACSF, TJFILE, MAC, II, PRINT**
5. **COMMON /AETE/, DATE(83)**
6. **INCLUDE TEMP LIST**
7. **COMMON /TCHP/, ITIME**
8. **INCLUDE SMOOTH LIST**
9. **COMMON /SMOOTH/, NOW(83), AVMSWP(83), TIS(83)**
10. **INCLUDE ILMS LIST**
11. **COMMON /ILMS/, NSL(83), ANSP(83), IRESET(*3), ATSUMP(0:83)**
12. **COMMON /TRAX/, TRANS(NUAIR)**

**Real**

- **INSTNT(0:15), STSUMP(83)**
- **IFCTR**, **IETMP**, **TJFILE**, **I桢C**
- **TOTAL MODE S POWER IN CURRENT SECOND**
- **DON'T SMOOTH FOR 1ST 15 SECONDS**
- **INDEX = MOD(ITIME, 15)**
- **TOTAL MODE S POWER IN CURRENT SECOND**

**Variables**

1. **SMOOTH**
2. **AVMSWP(II)**
3. **TIS(II) = DATE(II)**

**Appendix B**

---

B-51
*** TLSHOT ***

1 34. ELSE
1 39. AVTIME = ITIME + 15 * AVERAGING TIME
1 40. RSUMP(I) = RSUMP(I) + TSPW - INSTNT(INDX, II)
1 41. AVMSPW(I) = RSUMP(I)/AVTIME
1 42. TIS(I) = TIS(I) + ( ORATE(I) - TIS(I) )/AVTIME
1 43. INSTNT(INDX, II) = TSPW
1 44. END IF
1 45. RETURN
1 46. END

END FTN 115 IBANK 1447 DBANK 72175 COMMON

SHGSP *** TRANSP ***
TRANSP

* SET POWER AND SENSITIVITY CHARACTERISTICS DERIVED FROM ATC-9 FOR EACH TYPE OF TRANSPONDER.

DECLARE COMMON BLOCKS / VARIABLES / INPUTS / OUTPUTS / DESCRIPTION

CASC / IJFILE : TYPE OF EACH AIRCRAFT
NAC : NUMBER OF AIRCRAFT
SENS / JSENS : SENSITIVITY LEVEL OF EACH A/C
TRAX / JTRANS : TRANSMISSION POWER OF EACH A/C

INCLUDE RESTART/LIST
PARAMETER (NUAIR = 328)

THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.

LOGICAL PRINT
DIMENSION TFILE(NUAI*8), IJFILE(NUAI*8), ICASP(NUAI*1)
COMMON /ICASC/ 1111(83), DENS(N3), IATSU(NUAI), IDABS(NUAI)
EQUIVALENCE (TFILE, IJFILE)
COMMON /CAS/ ICASP, TFILE, NAC, II, PRINT
COMMON/TRAX/JTRANS(NUAIR)
COMMON/SENS/JSENS(NUAIR)
DIMENSION XNORM(NUAIR)
DIMENSION TNOIM(NUAIR)
DIMENSION YSENS(NUAIR)
DIMENSION NSENS(NUAIR)
DIMENSION YSENS(NUAIR)

TRANSMISSION POWER:
XNORM(1) = 16 398 535
YNORM(1) = 16 398 535
CALL RANON(XNORM,NUAIR,27,0.5)
CALL RANON (YNORM, NUAIR, 29.2, 0.5)

DO 17 IO = 1, NAC
IF (IJFILE(IO) .EQ. 0) THEN
   CALL RANON(RAN)
   RAN = RAN + 100.
   IF (RAN .LE. 0.2) THEN DIFF = 11.
   ELSE IF (RAN .LE. 0.4) THEN DIFF = 10.
   ELSE IF (RAN .LE. 0.6) THEN DIFF = 9.
   ELSE IF (RAN .LE. 0.92) THEN DIFF = 8.
   ELSE IF (RAN .LE. 3.00) THEN

B-53
*** TRANSP ***

3 47. ELSE IF (RAN .LE. 5.20) THEN
3 48. DIFF = 7.
3 49. ELSE IF (RAN .LE. 9.30) THEN
3 50. DIFF = 6.
3 51. ELSE IF (RAN .LE. 15.40) THEN
3 52. DIFF = 5.
3 53. ELSE IF (RAN .LE. 25.60) THEN
3 54. DIFF = 4.
3 55. ELSE IF (RAN .LE. 36.80) THEN
3 56. DIFF = 3.
3 57. ELSE IF (RAN .LE. 49.00) THEN
3 58. DIFF = 2.
3 59. ELSE IF (RAN .LE. 60.50) THEN
3 60. DIFF = 1.
3 61. ELSE IF (RAN .LE. 69.00) THEN
3 62. DIFF = 0.
3 63. ELSE IF (RAN .LE. 74.40) THEN
3 64. DIFF = -1.
3 65. ELSE IF (RAN .LE. 81.80) THEN
3 66. DIFF = -2.
3 67. ELSE IF (RAN .LE. 90.70) THEN
3 68. DIFF = -3.
3 69. ELSE IF (RAN .LE. 95.70) THEN
3 70. DIFF = -4.
3 71. ELSE IF (RAN .LE. 99.38) THEN
3 72. DIFF = -5.
3 73. ELSE IF (RAN .LE. 99.78) THEN
3 74. DIFF = -6.
3 75. ELSE
3 76. DIFF = -7.
3 77. END IF
3 78. ELSE IF (TJFILE(IQ) .EQ. 0) THEN
3 79. JTRANS(IQ) = 500 000 * (0.543 ** DIFF)
3 80. END IF
3 81. ELSE IF (TJFILE(IQ) .EQ. 1) THEN
3 82. XCONVT = XNORM(IQ) / 10.
3 83. END IF
3 84. ELSE
3 85. XCONVT = XNORM(IQ) / 10.
3 86. END IF
3 87. END IF

17 CONTINUE

C SENSITIVITY CALCULATIONS

1 90. C
1 91. XSENS(1) = 16398540
1 92. YSENS(1) = 16398540
1 93. CALL RANDN(XSENS, YSENS, 77.60, 1.5)
1 94. CALL RANDN(YSENS, 77.50, 0.75)
1 95. CALL RANDN(XSENS, 77.50, 0.75)
1 96. CALL RANDN(YSENS, 77.60, 1.5)
1 97. CALL RANDN(XSENS, 77.60, 1.5)
1 98. CALL RANDN(YSENS, 77.50, 0.75)
1 99. CALL RANDN(XSENS, 77.50, 0.75)
1 100. CALL RANDN(YSENS, 77.60, 1.5)
1 101. CALL RANDN(XSENS, 77.60, 1.5)
1 102. CALL RANDN(YSENS, 77.50, 0.75)
1 103. CALL RANDN(XSENS, 77.50, 0.75)
1 104. CALL RANDN(YSENS, 77.60, 1.5)
1 105. CALL RANDN(XSENS, 77.60, 1.5)

B-54
<table>
<thead>
<tr>
<th></th>
<th>TRANSP</th>
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<tbody>
<tr>
<td>3</td>
<td>106.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 0.4) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 48.</td>
</tr>
<tr>
<td>3</td>
<td>107.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 0.6) THEN</td>
</tr>
<tr>
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<td>SENT = 51.</td>
</tr>
<tr>
<td>3</td>
<td>108.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 1.0) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 52.</td>
</tr>
<tr>
<td>3</td>
<td>109.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 1.43) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 54.</td>
</tr>
<tr>
<td>3</td>
<td>110.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 2.07) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 55.</td>
</tr>
<tr>
<td>3</td>
<td>111.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 2.28) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 56.</td>
</tr>
<tr>
<td>3</td>
<td>112.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 3.79) THEN</td>
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<tr>
<td>3</td>
<td>SENT = 57.</td>
</tr>
<tr>
<td>3</td>
<td>113.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 4.00) THEN</td>
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<td>3</td>
<td>SENT = 58.</td>
</tr>
<tr>
<td>3</td>
<td>114.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 4.43) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 59.</td>
</tr>
<tr>
<td>3</td>
<td>115.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 5.29) THEN</td>
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<tr>
<td>3</td>
<td>SENT = 60.</td>
</tr>
<tr>
<td>3</td>
<td>116.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 6.80) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 61.</td>
</tr>
<tr>
<td>3</td>
<td>117.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 8.52) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 62.</td>
</tr>
<tr>
<td>3</td>
<td>118.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 10.89) THEN</td>
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<tr>
<td>3</td>
<td>SENT = 63.</td>
</tr>
<tr>
<td>3</td>
<td>119.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 14.12) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 64.</td>
</tr>
<tr>
<td>3</td>
<td>120.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 17.14) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 65.</td>
</tr>
<tr>
<td>3</td>
<td>121.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 19.94) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 66.</td>
</tr>
<tr>
<td>3</td>
<td>122.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 25.33) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 67.</td>
</tr>
<tr>
<td>3</td>
<td>123.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 31.80) THEN</td>
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<tr>
<td>3</td>
<td>SENT = 68.</td>
</tr>
<tr>
<td>3</td>
<td>124.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 39.14) THEN</td>
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<tr>
<td>3</td>
<td>SENT = 69.</td>
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<tr>
<td>3</td>
<td>125.</td>
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<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 44.10) THEN</td>
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<td>3</td>
<td>SENT = 70.</td>
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<td>3</td>
<td>126.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 51.22) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 71.</td>
</tr>
<tr>
<td>3</td>
<td>127.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 57.26) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 72.</td>
</tr>
<tr>
<td>3</td>
<td>128.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 65.03) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 73.</td>
</tr>
<tr>
<td>3</td>
<td>129.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 69.78) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 74.</td>
</tr>
<tr>
<td>3</td>
<td>130.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 75.17) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 75.</td>
</tr>
<tr>
<td>3</td>
<td>131.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 81.00) THEN</td>
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<tr>
<td>3</td>
<td>SENT = 76.</td>
</tr>
<tr>
<td>3</td>
<td>132.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 86.61) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 77.</td>
</tr>
<tr>
<td>3</td>
<td>133.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 90.06) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 78.</td>
</tr>
<tr>
<td>3</td>
<td>134.</td>
</tr>
<tr>
<td>3</td>
<td>ELSE IF (RAN LE. 94.59) THEN</td>
</tr>
<tr>
<td>3</td>
<td>SENT = 79.</td>
</tr>
</tbody>
</table>

B-55
**TRANSP**

```plaintext
***
165. ELSE IF (RAN .LE. 95.50) THEN
166. SENT = 80.
167. ELSE IF (RAN .LE. 98.03) THEN
168. SENT = 81.
169. ELSE IF (RAN .LE. 98.46) THEN
170. SENT = 82.
171. ELSE IF (RAN .LE. 98.89) THEN
172. SENT = 83.
173. ELSE IF (RAN .LE. 99.32) THEN
174. ELSE
175. SENT = 87.
176. END IF
177. SENT = SENT + 3.
178. JSENS(II) = -SENT
179. ELSE IF (JFILE(II,4) .EQ. 1) THEN
180. ZSENS = -JSENS(II)
181. IF (ZSENS .LT. -80.) ZSENS = -80.
182. IF (ZSENS .GT. -74.) ZSENS = -74.
183. JSENS(II) = ZSENS
184. ELSE
185. ZSENS = -JSENS(II)
186. IF (ZSENS .LT. -79.) ZSENS = -79.
187. IF (ZSENS .GT. -75.) ZSENS = -75.
188. JSENS(II) = ZSENS
189. END IF
190. 12 CONTINUE
191. 12 CONTINUE
192. RETURN
193. END
END
```

**END FTM 547 IBANK 1508 DBANK 31985 COMMON**

B-56
SUBROUTINE TSQUIT( IPRGTS )

THE PURPOSE OF THIS SUBROUTINE IS TO COUNT THE NUMBER OF TCAS II-N DETECTED BY SQUITTERS AND SET THE SQUITTER START TIME.

****************************************************** INPUTS / OUTPUTS ******************************************************

COMMON BLOCKS / VARIABLES

ARG LIST / IPRGTS
CAS / II
SINT / K
SNOOT / I
TCA / NUMTC
TCDATA / I
TEMP / ITIME
TRAN / ILAST
TRAN / IACTOT

DESCRIPTION
INDICATES WHETHER THE REC POW > SENSIT
TCAS II M IDENTITY
VICTIM AIRCRAFT IDENTITY
NUMBER OF TCAS II M DETECTED
TCAS II M AIRCRAFT
TCAS II M POINTER FILE
ELAPSED TIME IN SIMULATION
PROBABILITY OF REPLY FOR EACH AIRCRAFT
TCAS II M SQUITTER START TIME
CONVERTS A/C ID TO TCAS ID (II)

INCLUDE RESTART-LIST
PARAMETER (NUAIR = 743)
THE LOGICAL VARIABLE PRINT, WHEN FALSE, WILL SUPPRESS ALL WRITE STATEMENTS IN THE MODEL.
LOGICAL POISMD,PINTL,PICSMT,PATMOD,POISS,PFILES,PFREU,PSTATS
COMMON /PRTFL/ POISMD,PINTL,PICSMT,PATMOD,POISS,PFILES,PFREU
PSTATS
DIMENSION TFILE(NUAIR,8), IJFILE(NUAIR*S), IJFILE(NUAIR, 1)
COMMON /TFILE/ TFILE, IJFILE, NAC, IT, PRINT
INCLUDE TCAA-LIST
COMMON /TCAA/ NUMTC
INCLUDE TEMP-LIST
COMMON /TEMP/ ITIME
INCLUDE TRAN-LIST
COMMON /TRAN/ ILAST(NUAIR,8), IACTOT(NUAIR)
INCLUDE SMOOTH-LIST
COMMON /SMOOTH/ NOW(83), ARMSP(83), TIS(83)
INCLUDE SINT-LIST
COMMON /SINT/ LPLUS, K, ITO(100)
INCLUDE TPREPL-LIST
COMMON /TPREPL/ PRL(NUAIR)
DEFINE FLO(. . ., JK)

COMPUTE NUMBER OF TCAS II M DETECTED BY SQUITTER
K IS THE ID OF THE N'TH TCAS A/C. IT IS NECESSARY TO FIND THE VALUE OF N, WHICH IS USED AS AN INDEX OF THE TCST AND IILAST ARRAYS.
IDTCAS = IACTOT(K)

B-57
### Appendix B

```plaintext
*** TQUIT ***

35. * IF( IDTCA < GT. NUMTCA) WRITE(6,16)(ITC,1111(IITC))
40. 2 IACTO(I111(IITC),I1C=1,NUMTCA)
41. 16 FORMAT(* TQUIT II 111 IACTO*,5(I6,*,-,13,*,-,13))
42. * ITLSQ = FLO(1,10,ITLAST(I11,1DTCAS))
43. * IF( ITLSQ .EQ. 0) ITLSQ = MINI( RANDOM() * 9. ) + 1
44. * IDELT = ITIME - ITLSQ
45. * INTRK = FLO(1,10,ITLAST(I11,1DTCAS))  A IS THE K* A/C IN SQUITTER FILE
46. * AT TIME = 1 SEC LOAD ALL TCAS A/C THAT CAN BE DETECTED BY THEIR SQUITTER
47. * AND HAVE A SUFFICIENTLY HIGH PROP OF DETECTING THE SQUITTER
48. * IF( ITIME .EQ. 1) THEN B AT TIME=1 LOAD SQUITTER FILE
49. * CALL RAXN(RAN)
50. * IF( IPRGS .EQ. 1 .AND. PREP(K) .GT. RAN) THEN B SQUITTER RECEIVED
51. * IF(INTRK .EQ. 0) NOW(I1) = NOW(I1) + 1 A NEW A/C IN SQUITTER FILE
52. * FLO(1,10,ITLAST(I11,1DTCAS)) = 1  A NEW A/C IN SQUITTER FILE
53. * END IF
54. / 55. * AT TIMES > 1 SEC CHECK TO SEE IF A TCAS A/C SHOULD BE ADDED OR DELETED FROM
56. * THE SQUITTER FILE
57. * ELSE IF( IDELT .GT. 20 .AND. INTRK .EQ. 1) THEN > 20 SEC SINCE LAST RX S
58. * NOW(I1) = NOW(I1) - 1 A 1 LESS A/C IN SQUITTER FILE
59. * FLO(1,10,ITLAST(I11,1DTCAS)) = 0  A 1 LESS A/C IN SQUITTER FILE
60. * END IF
61. * ELSE IF( MOD(IDELT,10) .EQ. 0) THEN K*TH TCAS TX TIME
62. * CALL RAXN(RAN)
63. * IF( IPRGS .EQ. 1 .AND. PREP(K) .GT. RAN) THEN B SQUITTER RECEIVED
64. * IF(INTRK .EQ. 0) NOW(I1) = NOW(I1) + 1  A NEW A/C IN SQUITTER FILE
65. * FLO(1,10,ITLAST(I11,1DTCAS)) = 1  A NEW A/C IN SQUITTER FILE
66. * FLO(1,10,ITLAST(I11,1DTCAS)) = ITIME  A LASTEST SQ RX TIME
67. * END IF
68. * END IF
69. * ELSE IF( IDELT .EQ. 0) THEN K*TH TCAS RX TIME
70. * END IF
71. * END IF
72. * WRITE(6,16)(IPRGS,I111,IDTCA,ITLSQ,IDELET,LSQUT,NOW(I1))
73. * RETURN
74. * END
```

END FTM 222 IBANK 98 DBANK 79450 COMMON

```
* *** TSTART ***
```

B-58
**TSTART**

SUBROUTINE TSTART

**INPUTS / OUTPUTS**

**COMMON BLOCKS / VARIABLES**

**DESCRIPTION**

**PARAMETER**

1. IJFILE(I#4) = IJFILE(I#4, ITC) = ITC

2. COMMON /TCOATAI /IJFILE(I#4), IJFILE(I#4, ITC) = ITC

3. **COMMON BLOCK**

4. COMMON /IATIN(I#4), IATIN(I#4)

5. COMMON /NAC, IJA, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

6. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

7. COMMON /IJFILE(I#4), IJFILE(I#4, ITC) = ITC

8. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

9. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

10. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

11. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

12. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

13. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

14. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

15. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

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27. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

28. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

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31. COMMON /IJA, IJA, NAC, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

END

**INPUTS / OUTPUTS**

**COMMON BLOCKS / VARIABLES**

**DESCRIPTION**

**PARAMETER**

1. IJFILE(I#4) = IJFILE(I#4, ITC) = ITC

2. COMMON /TCOATAI /IJFILE(I#4), IJFILE(I#4, ITC) = ITC

3. **COMMON BLOCK**

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5. COMMON /NAC, IJA, ICASFI, IJFILE(I#4), IJFILE(I#4, ITC) = ITC

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END
**WSPOWE**

**THE PURPOSE OF THIS SUBROUTINE IS TO LOAD INTO ARRAYS THE POWER ASSOCIATED FOR EACH LEVEL OF WHISPER SHOUT FOR THE TOP AND BOTTOM ANTENNA.**

---

**INPUTS / OUTPUTS**

---

**COMMON BLOCKS / VARIABLES**

---

**INPUT**

**OUTPUT**

**DESCRIPTION**

---

1. **WHOUT**

2. **IPW8O**

3. **N-S LEVELS FOR TOP ANTENNA**

4. **IPWBO**

5. **N-S LEVELS FOR BOTTOM ANTENNA**

6. **IPWS**

7. **W-S LEVELS FOR SIDE ANTENNAS**

---

**EACH WHISPER SHOUT STEP CHECKED FOR TOTAL RADIATED POWER OF TCAS IIX-ATCRBS EMISSIONS.**

---

**LOAD POWER FOR EACH WHISPER SHOUT LEVEL.**

---

1. **IDROP = 0**

2. **IPEAK = 40**

3. **DO 3002 K = 1, 24**

4. **IPW8O(K) = IPEAK - IDROP**

5. **IDROP = IDROP + 1**

6. **FACT = (IPW8O(K) - 30.)/10.**

7. **POW8O = POW8O + (10.**

8. **CONTINUE**

---

**LOAD POWER FOR EACH WHISPER SHOUT LEVEL.**

---

1. **IDROP = 0**

2. **IPEAK = 45**

3. **DO 3003 K = 1, 40, 2**

4. **IPW8O(K) = IPEAK - IDROP**

5. **IDROP = IDROP + 1**

6. **FACT = (IPW8O(K) - 30.)/10.**

7. **POW8O = POW8O + (10.**

8. **CONTINUE**

---

**LOAD POWER FOR EACH WHISPER SHOUT LEVEL.**

---

1. **IDROP = 0**

2. **IPEAK = 40**

3. **DO 3004 K = 1, 15**

4. **IPW8O(K) = IPEAK - IDROP**

5. **IDROP = IDROP + 1**

6. **FACT = (IPW8O(K) - 30.)/10.**

7. **POW8O = POW8O + (10.**

8. **CONTINUE**

---

**LOAD POWER FOR EACH WHISPER SHOUT LEVEL.**

---

1. **IDROP = 0**

2. **IPEAK = 36**

3. **DO 3005 K = 1, 4**

4. **IPWBO(K) = IPEAK - IDROP**

5. **IDROP = IDROP + 1**

6. **FACT = (IPWBO(K) - 30.)/10.**

7. **POWBO = POWBO + (10.**

8. **CONTINUE**

---

**DOT/PL/P/M-85/22**

Appendix B
*** WSPDUE ***
1 58. C CALCULATE TOTAL ATCRBS INTERROGATION CONTRIBUTION FOR TOP & BOTTOM ANTENNAS.
1 59. C
1 60. C
1 61. C
1 62. PTOT = POWFR + POWSD + POWBK + POWBOT
63. RETURN
64. END

ENO FTN 176 IBANK 45 DBANK 167 COMMON
APPENDIX C
SAMPLE EXECUTION

The control cards that execute the TCAS SEM follow. Each record begins in column 1 and is spaced as shown.

@RUN,/RTP (JRID),(CHARGE#),(USER),30,1000
@ASG,AX FAA*TCAS/U.
@ASG,A FAA*INRATE/U.
@USE 8.,FAA*INRATE/U.
@ASG,A FAA*OUTRTS/U.
@USE 10.,FAA*OUTRTS/U.
@ASG,A FAA*BASIN1/U.
@XQT FAA*TCAS/U.RUN.
@ADD FAA*BASIN1/U.
@FIN
@@

The files named in the above records are defined in TABLE C-1. The output file to be used in the DABS/ATCRBS/AIMS PPM contains the information shown in TABLE C-2.
### TABLE C-1
**FILES USED IN THE TCAS SEM**

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>INRATe</td>
<td>Input file of Interrogation and Suppression Rates at each aircraft due to ground ATC from DABS/ATCRBS/AIMS PPM</td>
</tr>
<tr>
<td>OUTRTS</td>
<td>TCAS Signal Rates to be used in the DABS/ATCRBS/AIMS PPM</td>
</tr>
<tr>
<td>BASINI</td>
<td>Deployment Information: latitude, longitude, altitude, type, and velocity of each aircraft</td>
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### TABLE C-2
**KEY TO COLUMNS OF TCAS SEM OUTPUT**

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<tr>
<td>Mode S Misaddresses</td>
<td>Number of Mode S misaddressed interrogations received above sensitivity</td>
</tr>
<tr>
<td>Mode S Suppressions</td>
<td>Number of ATCRBS suppressions received above sensitivity at Mode S transponder-equipped aircraft</td>
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<tr>
<td>Modes S Interrogations</td>
<td>Number of ATCRBS interrogations received above sensitivity at Mode S transponder-equipped aircraft</td>
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<td>Number of ATCRBS interrogations received above sensitivity at ATCRBS transponder-equipped aircraft</td>
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<td>ATCRBS Interrogations</td>
<td>Number of ATCRBS interrogations received above sensitivity at ATCRBS transponder-equipped aircraft</td>
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<tr>
<td>TCAS II M Deadtime</td>
<td>Mutual-suppression time (in µs) of each TCAS II M receiver</td>
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<td>TCAS I Interrogations</td>
<td>Number of TCAS I interrogations received above sensitivity at ATCRBS and Mode S-equipped aircraft</td>
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### Appendix C

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