AD-A124 070 STANDARDIZED MEASURES OF MERIT (MOM) DICTIONARY(U) AIR FORCE ELECTRONIC WARFARE CENTER KELLY AFB TX 20 MAR 79 1/2

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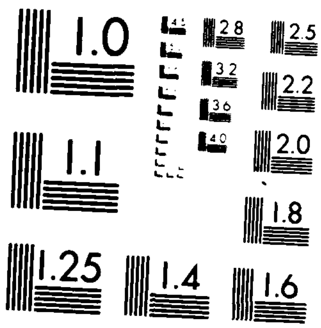

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The development of the Measures of Merit (MOM) dictionary was predicated on the theory that there are seven major areas of evaluation that must be addressed, either separately or in combination, dependent on the complexity of the Electronic Warfare (EW) system being tested. These areas are the effects on a target systems probability of target detection, probability of target tracking, the accuracy of the tracking, the data reporting/handling capability, the ability (Continued)

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20. Abstract (Continued)

to commit resources, the probability of engagement and the accuracy of the engagement. Each of the seven evaluation areas have a major set of measurement criteria that are used to provide accurate system performance data. Once collected and evaluated, the results form the basis for the assessment of the EW system's worth by the ultimate decision maker. The attached MOM dictionary identifies each of the evaluation areas and the major set of MOM that apply to each.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE ELECTRONIC WARFARE CENTER (USAFSS)
SAN ANTONIO, TEXAS 78243

REPLY TO ATTN OF: EW

20 March 1979

SUBJECT: Standardized Measures of Merit (MOM)

TO: SEE DISTRIBUTION LIST

1. In August 1978, the AFEWC requested inputs from various test and evaluation agencies on the EW MOM they have used. The AFEWC then prepared a consolidated list of EW MOM from the data received. We wish to thank those agencies/organizations that took the time to provide their MOM data. In one respect the response was unanimous in that each agency/organization agreed that the development of a consolidated and standardized manual of measurement criteria is direly needed.

2. The AFEWC has prepared a proposed dictionary from the data submitted and data available. Attachment two is a copy of this dictionary along with a foreword which explains the rationale for the manner in which the document is assembled.

3. Request each addressee review the attached MOM dictionary and forward comments to the AFEWC/EWT, San Antonio TX 78243. Request inputs to AFEWC by 30 May 1979.

FOR THE COMMANDER

Robertson M. Howe

ROBERTSON M. HOWE, GS-14
Dep Dir, EW Operations & Readiness

2 Atch
1. Distribution List
2. MOM Dictionary

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MEASURE OF MERIT (MOM)

DICTIONARY

Attachment 2

FORWARD

1. The AFEWC in August 1978 requested inputs from various test and evaluation agencies on the EW MOM they have used. The AFEWC proposed to then prepare a consolidated list of EW MOM from the date received.

2. Many of the MOM received in response to our August letter were duplicative in nature; the major difference being the title given i.e., Track Deviation, Position Error, Tracking Error and Angular Pointing Error. In each of these cases the measurement criteria was virtually the same. Another area in which differences of opinion arose was in the title of the measurement criteria itself. Measures of Effectiveness (MOE), Measure of Operational Suitability (MOS), Measures of Mission Success (MOMS) and, Measures of Merit (MOM) were all referenced and arguments presented for each as the proper title for the measurement criteria. The prime purpose of testing and evaluating electronic warfare can be traced back to providing answers to the ultimate decision maker on, "What is the military worth of the EW being tested?" For this reason we determined that the most accurate description of the measurement criteria used to provide this military worth information is, "Measures of Merit" (MOM).

3. There are two levels at which EW must be tested and evaluated, engineering and operational. The engineering effect is a measure of the EW systems ability to satisfy design specification criteria, and is normally measured on a one-on-one basis. The operational effect is a measure of the EW systems capability to intergrate with other systems in the accomplishment of operational objectives. Because these two levels of measurement often intermingle and interpretation of the results is sometimes difficult, the developed MOM dictionary is presently structured to address those MOM associated with operational testing and evaluation. The AFEWC will attempt to develop a engineering MOM dictionary in the future.

4. The development of the attached MOM dictionary is predicated on the theory that there are seven major areas of evaluation that must be addressed, either separately or in combination, dependent on the complexity of the EW system being tested. These areas are the effects on a target systems probability of target detection, probability of target tracking, the accuracy of the tracking, the data reporting/handling capability, the ability to commit resources, the probability of engagement and the accuracy of the engagement.

5. Each of the seven evaluation areas have a major set of measurement criteria (MOM) that are used to provide accurate system performance data. Once collected and evaluated the results form the basis for the assessment of the EW system's worth by the ultimate decision maker. The attached MOM dictionary identifies each of the evaluation areas and the major set of MOMs that apply to each. It will be noted that many of the MOMs within the major set apply to more than one of the evaluation areas; hence, their being identified as the major set. Additionally, each of the MOM definitions and related dictionary data are written to encompass all aspects of EW. They can be applied to

defensive or offensive ESM, ECM or ECCM and are applicable to EW systems, radars or communications.

6. The AFEWC has not yet attempted to develop the sub-sets to this major set of MOMs because much of the data required for their dictionary development was not provided in the initial response to the AFEWC request for data. The data that was received on these sub-sets is contained in section two of the attached dictionary. Upon receipt and development of the data required to complete these sub-set MOMs, the AFEWC will correlate these sub-set MOMs with their appropriate major MOM and coordinate this section of the dictionary with the appropriate agencies/organizations.

7. This dictionary is divided into two parts. Part I contains the major MOM. Part II contains the sub-set MOM broken into three sections; sub-sets with complete data, sub-sets with partial data and sub-sets identified by title only.

a. Part I identifies the MOM which fall into each of the seven major areas of evaluation. These MOM then follow in alphabetical order.

b. Each section of Part II is also included in alphabetical order.

8. The AFEWC realizes that a few of the MOM in the two parts of this dictionary have the same or similar titles. To the maximum extent possible we have attempted to leave the MOM data as we received it from the various organizations. Before we prepare the final dictionary we will resolve conflicts in title or other data.

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   d. Blip Scan Ratio (BSR)

   e. Electronic Counter Counter Measures (ECCM)

   f. Identification

   g. Operator Workload/Proficiency

   h. Communications Capability

   i. Equipment Status

   j. Power Resource Management

   k. ECM Zone of Effectiveness

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   b. Jamming/Signal Ratio

   c. Burnthrough Range

   d. Blip Scan Ratio (BSR)

   e. Electronic Counter Counter Measures (ECCM)

   f. Identification

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a. Electronic Counter Counter Measures (ECCM)

b. Operator Workload/Proficiency

c. Equipment Status

d. Position Error

e. Miss Distance

f. Probability of Kill (PK) Matrix

BLIP SCAN RATIO (BSR)

I. DEFINITION. The ratio of processed radar pulse detections (BLIPs) to the total number of antenna rotations over a specified period of time. Generally applied to early warning/acquisition radars which use circular rotating antenna systems.

II. REQUIREMENTS/CRITERIA.

1. Requires specification of time period reflecting well established initiation and termination points.

2. Accept/reject criteria must be established for each track point (BLIP) giving due consideration to inherent tracking errors caused by system calibrations, operator parallax when recording a BLIP and tracking accuracy requirements for radar type and scenario under investigation, e.g. a 10 NM error during initial early warning/acquisition detection may be acceptable whereas, that same error just prior to terminal threat hand off may be unacceptable. This criteria must be determined prior to flight test missions and based on specific mission requirements associated with the particular aircraft and defense system of interest.

3. Distinguish between raw and corrected BSR. Must be cognizant of and record time segments during a test mission when operators tracked non-mission aircraft, radar malfunctioned or similar circumstances contributed to misleading data segments. These data segments should be extracted from the data base accordingly.

III. BASELINE.

1. Requires a minimum of three runs in a benign environment over flight routes similar to those used for the actual flight tests and against the same radars (same operators, if possible).

2. BSR = Root mean square (RMS) of the corrected BSR for all runs.

3. Time duration for baseline data collection should be comparable to the anticipated time duration of an actual flight test mission.

4. Aircraft and external loading configuration should be identical to actual flight test mission aircraft and loading to present similar radar cross sections.

IV. INSTRUMENTATION.

1. Reference target tracking system is necessary (a radar tracking a beacon on the target is preferable to IFF tracking, for better accuracy).

2. Requires a sensing device affixed to the radar PPI scope to record each detection (BLIP) of the target.

3. Coordinate transformations and rotation routines are required to compare the differences between the reference track and target track which may have been collected at two widely separated locations.

V. LIMITATIONS.

1. BSR is influenced greatly by uncontrollable factors such as:

a. Radar operator compliance to tracking instructions i.e. continuing to record the BLIP on each scan even when the target is completely out of the segment screened by jamming.

b. "Help" which must be given to radar operators when non-mission aircraft are in the general area occupied by mission aircraft (i.e., tracking a non-mission aircraft neither proves nor disproves the effectiveness of ECM and renders the data collected worthless).

c. Radar operating parameters changing daily thereby altering inherent detection capabilities of the radar.

All of these factors can and do place serious restrictions on the interpretation and value of BSR as a MOM.

2. BSR does not accurately represent results in large scale tests due to the existence of multiple targets which present the radar operator with several track choices and present the data analyst with an entangled mound of unusable data.

BURNTHROUGH RANGE

I. DEFINITION

The range at which the target can be detected on the scope of the radar system. For an ECM condition, it is the range at which the target burns through the ECM.

II. REQUIREMENTS/CRITERIA

1. Requires a printout of true target position as a function of time.

2. Requires the time into the run and the target position at which the target was detected by the radar operator.

3. A predetermined number of runs are obtained to have good statistical data.

III. BASELINE

1. A predetermined number of runs are obtained without ECM for comparison.

2. Aircraft configuration and flight paths used for baseline runs are identical to those used for ECM runs.

IV. INSTRUMENTATION

A readout of the time the operator observes the target and the apparent location of the target by the operator.

. LIMITATIONS

1. Limitations include the day to day differences in the radar and ECM calibration.

2. Variations in detection ranges can occur on a run to run basis depending on gain setting and on the ability of the radar operator.

COMMUNICATION CAPABILITY

I. DEFINITION. The ability to pass required data between locations in a timely manner.

II. REQUIREMENTS/CRITERIA.

1. For each type of data that is to be passed essential elements of information (EEIs) must be established as well as maxium receipt times.

2. Transmission and receipt times must be recorded.

3. Data transmitted and received must be recorded (based upon the EEIs established).

4. The status of communication links and alternate communication means, operator workload and ECCM must be know and monitored.

5. It must be determined if the transmission and reception facilities are capable of handeling the amount of data required to be passed within the time frame established.

III. BASELINE.

1. The minimum data recipt time for each type of data to be passed must be determined.

2. All parameters used in the baseline case must be the same as those that wi be used in the testing phase.

IV. INSTRUMENTATION.

1. Time annotated recordings of received data and transmitted data are required.

2. Electronic Clip Boards (ECBs) can be used to record data for subsequent data processing into time annotated and coorelatable listings.

V. LIMITATIONS.

1. Playback of recorded data and subsequent logging can be time consuming and does not lend itself to rapid analysis and feedback of the results.

2. Considerable manual logging may be required to obtain the data necessary for analysis.

3. Minimum data receipt and maximum receipt times may have to be determined after the fact.

ECM ZONE OF EFFECTIVENESS

I. DEFINITION

The ECM zone of effectiveness of an airborne ECM system is that region surrounding the aircraft for which the ECM provides protection for that aircraft (and for any other aircraft that are within the zone). The zone of effectiveness is defined relative to a given threat radar and different zones of effectiveness will, in general, be associated with different threat radars.

II. REQUIREMENTS/CRITERIA

1. Hostile radar to serve as a measurement source.

2. Airborne ECM system with a formation of aircraft.

3. The formation of aircraft, with the jammer, will fly in the vicinity of the radar and the zone boundary points will be established as the aircraft burnthrough on the radar scope.

III. BASELINE

1. The jammer aircraft should escort one other aircraft into a single radar zone and the other aircraft should see how far away in different directions around the jammer they can get without being detected by the radar. This will give the approximate zone of protection about the jamming aircraft.

2. Jammer aircraft should fly straight toward the radar one at a time to determine when burnthrough occurs and when jam becomes effective again after passing over radar. This gives burnthrough ranges fore and aft.

IV. INSTRUMENTATION

Means to measure distance between the aircraft in formation with time, TV monitor on each radar scope with timing correlation information supplied.

V. LIMITATIONS

Making measurements in formation and coordinating with ground radar will require a great deal of concentration and effort on both ends of the test (ground and air). Also, as the jammer gets closer to the radar, the formation will have to become tighter for the jammer to protect his charges. This will also require concentration to slowly close formation to get a maximum of readings on protection zone size vs. range. The best that can be expected is an approximate size, but of course this will give an idea of the number of jammers needed per squadron.

ELECTRONIC COUNTER COUNTER MEASURES (ECCM)

I. DEFINITION. The procedures selected by an operator of a system to enable him to lessen or delete the effects of ECM. It includes both internal fixes and techniques/tactics used to enhance or permit operations.

II. REQUIREMENTS/CRITERIA.

1. For Communications

a. Time entries reflecting initiation and termination of each technique/tactic used.

b. Operator entries coorelatable to the technique/tactic used, reflecting the results (communications) obtained from the use of each technique/tactic.

c. A printout, time annotated, of all communications attempted.

2. For Radars

a. Time entries reflecting initiation and termination of each fix/technique/tactic used.

b. Operator entries coorelatable to the fix/technique/tactic used, reflecting the results (tracking) obtained from the use of each fix/technique/tactic used.

c. A printout of the true target position as a function of time.

d. A printout of the reported target position as a function of time.

III. BASELINE.

1. For Communications

A predetermination number of transmissions are obtained without ECM for comparision. Transmissions (message content) must be identical to that which will be used during the periods of ECM.

2. For Radars

a. A predetermined number of runs are obtained without ECM for comparison. Configuration of the target and flight paths used for the baseline runs are identical to those used for the ECM runs.

IV. INSTRUMENTATION.

1. For Communications

a. Recordings of all transmissions attempted and received.

b. A time annotated list of all transmissions attempted and received.

2. For Radars

a. A target tracking system with a time annotated track as an output.

b. Radar tracking of the target (positional data) as entered by the radar operator that is both time and radar fix/technique/tactic annotated.

c. Video tape/0-15 scope photography of radar scopes that are time annotated.

V <u>LIMITATIONS.</u>

1. For Communications

a. The operators workload/proficiency and hearability.

b. Capabilities can vary from day to day based upon natural RF and communication equipment and ECM calibration.

2. For Radars

a. The day to day differences in the radar, ECM and ECCM calibration.

b. Variations can occur in tracking capability on a run to run basis depending upon ECCM used and the ability of the radar operator.

EQUIPMENT STATUS

I. DEFINITION. The state of all equipment before, during and after the measurement period.

II. REQUIREMENTS/CRITERIA.

1. All equipment must be calibrated to insure that it is operating as required.

2. Equipment performance/output must be monitored before, during and after a mission period to isolate those anomolies that might be attributable to the equipment.

3. Critical equipment parameters that are crucial to mission accomplishment must be identified and monitored.

III. BASELINE.

1. Equipment parameters must be established and minimum performance allowable defined.

2. All equipment must be calibrated to specifications.

3. All equipment must be operated in accordance with real world operations.

IV. INSTRUMENTATION.

1. Instrumentation required can vary from simple spectrum analizer monitoring of a system before, during and after an event to an automatic data feedback system that will monitor specific functions of a system throughout an event.

V. LITATIONS.

1. Cost of the instrument monitoring system can be expensive and not all equipments are adaptable to these type monitoring system.

2. Measurement is not always available at all of the various test ranges.

3. Computer listings, time annotated, of the automatic monitoring system are required for coorelation with other collected data.

4. Accurate time measurement is required to insure that data collected can be coorelated with other collected data.

EXPOSURE TIME

I. DEFINITION.

1. For Communications: The time period during which transmissions are detectable.

2. For Radars and ESM systems: The time period during which targers/ emissions are in the composite area of radar/system coverage.

II. REQUIREMENTS/CRITERIA.

1. For Communications

a. Start and stop times of each transmission must be known.

b. A capability to detect the transmissions must be established.

2. For Radars and ESM systems

a. A capability to track ctiteria must be established, i.e. some maximum allowable error between reference track and detected target/emission and/ or a minimum number of valid detections during a specified time period.

b. Start point/time and end point/time must be specifically defined and may be scenario dependent, e.g. time may start when the first target/ emission crosses the outer extremity of the composite radar/system coverage or it may begin after jammers are turned on. The choice may be driven by scenario, test range constraints etc.

c. End point/time must be defined similarily, i.e. either when the target/emission exits a certain area/ceases or coincident with jammer shut-off or some other unique point.

d. Exposure time should not be accumulated for each target but, rather a strike force should be considered a single entity and a single time used for exposure time rather than an accumulated tiem for all targets.

e. Although Terminal threat radars have an acquistion capability which extends beyond missile/weapon range, exposure time should only be calculated during the period that targets are in the lethal envelope of the terminal threat weapons.

f. Rules for terminal threat operations must be stated explicitly in the test plan and should reflect current intelligence related to operational procedures. For example, terminal threat autonomous operations should be discuraged and data considered contaminated if excessive autonomous operation exists.

g. Start and stop criteria for terminal threats should be constrained primarily to the entrances and exit of the lethal envelope of the missile/ projectile.

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III. BASELINE.

1. For Communications

a. Maximum detection range must be established for each type of transmission and transmission system that will be used in the actual test.

b. Minmum transmission time for each type transmission and transmission system that will permit detection must be established.

2. For Radars and ESM systems

a. Once all radars/systems are in place, flight routes including radials and concentric circles at altitudes of interest should be developed and flown by targets similar to those anticipated in the actual flight test missions to determine empirically the actual composite area of radar/system coverage. Separate composites should be diveloped for all radar and ESM systems that will be used in the actual flight test.

b. Baselin exposure time is the time difference between initial target entry and final exit of the composite coverage chart less all time periods where tracking/detection would be extected to be lost due to ground clutter, radar dead spots, etc.

IV. INSTRUMENTATION.

1. For Communications

a. A Spectrum analysis system to monitor the spectrum and record the signal strength and time of all transmissions.

b. Time annotated listings of all detected transmissions.

2. For Radars and ESM systems

a. A target tracking system with a time annotated track as an output.

b. A system to record and output a time annotated listing of all detections of targets/emissions by the radars/ESM systems.

V. LIMITATIONS.

Exposure time does not include the effects that multiple targets have on an intergrated air defense system. Exposure time is also subject to probability of detection which would vary based on the number of radars/ESM systems providing coverage at any specific segement of the flight route. Resolving this point requires detailed knowledge of the composite radar/system coverage and the probability of detection for each radar/system given certain target, tactics and ECM suites. This becomes extremely scenario dependent and is beyond the scope of this definition.

IDENTIFICATION

I. DEFINITION. The ability of an individual or system to determine in a timely manner the identity of an unknown emission or target.

II. REQUIREMENTS/CRITERIA.

1. Intelligence data is required to determine items such as, mission profiles, emission characteristics, radar cross-section, type of transmission, echelon of transmission, message content, etc.

2. Timeliness constraints need to be identified and established for all of the types of data that may be available to the individual or system for identification determination.

3. Requires a printout of the true target position as a function of time.

4. When the ECM generates false targets, the number and duration (persistency) must be known.

5. For imitative communications deception (ICD) the anticipated effect must be identified.

6. Identification time required must be compared with that which is actually accomplished.

III. BASELINE.

1. A predetermined number of runs are obtained without ECM for comparision.

2. Configurations and flight paths used for the baseline runs must be identical to those used for the ECM runs.

3. Identification times for each type of communication must be determined by actual measurement of the time required in a non-ECM environment. This data must then be extrapolated into a table containing a high, low and average time for identification.

IV. INSTRUMENTATION.

1. A target tracking system with a time annotated track as an output.

2. A time annotated listing of all transmissions received.

3. Video tape and 0-15 photography of radar scopes for after the fact analysis.

4. Recordings of messages received with annotated time may be required.

V. LIMITATIONS.

1. The human factor will have considerable impact on the resolution of this measurement criteria and its interpretation must be accomplished with considerable care.

2. Limitations in the day to day calibration of communications, ESM and radar equipments as well as natural RF variances must be considered.

JAMMING TO SIGNAL POWER RATIO (J/S)

I. <u>DEFINITION</u>. J/S is a convenient and effective means of estimating the degree of disruption/degradation of a receiver caused by an interfering signal. The J/S level is particularly useful in estimating the ranges at which a radar or communications receiver is not able to accurately process the desired signal (S) because of the interfering signal (J). Conversely, these ranges determine a degree of effectiveness for intentional interference (jamming). In this respect, the J/S MOM is used to support the more general MOM of ECM protected exposure distance or area versus total exposure distance or area.

II. <u>REQUIREMENTS/CRITERIA</u>. Calculation of J/S requires the following factors: transmitter and jammer transmit power; transmitter, receiver, and jammer bandwidths and antenna patterns; wavelength; and ranges. (Calculations for a radar also require the target radar cross section.) The criteria is whether or not the calculated J/S exceeds the baseline J/S.

III. <u>BASELINE</u>. Establishing the baseline J/S is the most difficult aspect in using this MOM. It is necessary to know the J/S value for a specific level of receiver disruption/degradation. This can be determined by test. J/S can be measured in the receiver and correlated to measured/calculated system results which vary by range. When the chosen degree of degradation is observed, the baseline J/S is established. Unfortunately, most test plans do not require measurement of J/S with the result that it is usually necessary to estimate baseline J/S based on the few measured cases available.

IV. <u>INSTRUMENTATION</u>. A significant advantage of J/S as an MOM is ease of calculation. The various J/S formulae are readily programmed for calculations and computers. A considerable effort is usually required for data preparation and formatting to run a computer based J/S analysis. All aspect antenna patterns and radar cross section must be obtained and oriented to the chosen computer format. This often involves conversion from the coordinate system used for measurement to the coordinate system used in the computer program. Curve fitting techniques can be used to replace unwieldy numerical matrices with more compact point estimating formulae.

V. <u>LIMITATIONS</u>. The most significant limitation in using J/S is establishing the baseline as discussed in III above. Lack of antenna pattern and radar cross section data may also present a problem. In using J/S, it must be recognized that this MOM is strictly a calculation of power relationships and does not in itself reveal the effectiveness of the actual technique being used. For example, a radar jammer may have a very high effective radiated power but use a modulation rate that does not perturb the radar tracking circuits. This should be taken care of in the baseline J/S but is not always done. Interpretation of results requires understanding of both the radar/communications system and the jammer.

MISS DISTANCE

I. DEFINITION. The proportion of simulated missiles/projectiles launched at a target which pass within a predetermined radius (lethality envelope) of the target.

II. REQUIREMENTS/CRITERIA.

1. Requires specification of time period reflecting well established initiation and termination points.

2. Accept/reject criteria must be established considering known or suspected system malfunctions, adverse atmospheric conditions, improper system configuration (tracking mode, guidance mode, etc.), TSPI data drops, grossly excessive miss distances, missiles launched when aircraft is outside lethal envelope. These criteria should be established prior to test missions and be based on specific mission scenarios and weapon system employment doctrine.

3. Weapon system operating modes must be closely monitored and aircraft flight profiles closely controlled for each event.

4. Threat system must be operated IAW current intelligence information on employment operations/doctrine.

III. BASELINE.

1. Requires a minimum of two "dry" (non-ECM) runs for each test mission (one at the beginning, one at the end of mission activity).

2. Baseline run conditions must parallel wet conditions with the same REQUIREMENTS/CRITERIA factors applied.

3. If possible, baseline data should be taken on the same sortie as wet data for each condition.

IV. INSTRUMENTATION/DATA REQUIREMENTS.

1. Accurate Time-Space-Position-Information (TSPI) on target aircraft.

2. Time-correlated radar operating modes, missile launch data, and operating parameters.

3. Threat system operator logs (system malfunctions, operating modes, observations, etc).

4. Computer simulation of appropriate missile.

5. Threat system tracking errors and missile miss distance as a function of the targets range from the threat radar.

6. Documentation of environmental conditions (terrain, weather, electro-magnetic emissions, etc).

V. LIMITATIONS.

1. MMD only provides a relative indication of the effectiveness of ECM. Caution must be exercised to prevent the interpretation of MMD data as threat system probability-of-kill. For example, the ability to prevent 80% of SAMs from passing within 400 feet of the target aircraft does not mean the SAMs probability-of-kill is .20. Many other factors are involved in deriving probability-of-kill, not the least of which is the determination of a lethal missile radius (is 400 feet too big or too small).

2. The threat systems operator's proficiency is an important factor in MMD results, particularly in manual modes of operation. Are the operators at the test site more proficient than those deployed operationally? Is he smarter? These questions must be addressed.

3. Typically, detection, identification, acquisition, and track of the target aircraft by the threat system is assumed. It must be understood that these preconditions negate a large part of an Air Defense System's operational problems, i.e., if an Air Defense System is not capable of performing these functions, MMD is a useless evaluation tool since the target aircraft would not be engaged.

OPERATOR WORKLOAD/PROFICIENCY

I. DEFINITION. The tasks an operator has to accomplish within a given time frame and his skill at accomplishment.

II. REQUIREMENTS/CRITERIA.

1. Measurement of data handling and processing time by operators is required.

2. The stress factor must be considered and measured by comparing operator performance under varying circumstances.

3. All tasks to be completed and the time required for each must be compared to actual accomplishment.

4. Mode of operation, either manual or automatic, must be monitored and time annotated.

5. Dependent upon testing, monitoring of the body functions must be recorded.

III. BASELINE.

1. A comprehensive prioritized list of all tasks an operator is required to accomplish must be developed.

2. Completion times for each task must be determined by actual measurement of several operators operations. This is extrapolated into a table containing a high, low and average time for task accomplishemnt.

3. It must be also determined how many tasks (individually and by type) it is possible for an operator to accomplish within a given time frame.

4. Dependent upon testing, body function normal rates may have to be established.

IV. INSTRUMENTATION.

1. Listings of data required to be processed within a specific time frame and listing of data actually processed within this time frame, each time annotated, are required.

2. Dependent on testing, G factors, heart rates and other human engineering data may be required.

V. LIMITATIONS.

1. Many of the measurement criteria of this MOM are subjective in nature and are subject to missinterpretation.

2. In the area of human engineering considerable care must be taken in interpreting the data obtained as to how they effect the results.

3. The best manner to obtain much of the data required for this MOM is by personal observation which will require a considerable number of highly qualified personnel.

POSITION ERROR

I. DEFINITION. The range and angular differences between the actual location of the target and the location as reported by an automatic tracking system or by tracking operators.

II. REQUIREMENTS/CRITERIA.

1. Reported target position must be measured as a function of time and compared with true values to obtain differences which can be used to establish the azimuth, elevation and composite angle tracking errors and the range tracking error.

2. Requires a printout of true target position as a function of time.

III. BASELINE.

1. A predetermined number of runs are obtained without ECM to establish the tracking quality. The number of dry runs required is dependent on the type of tracking system (automatic, semi-automatic or manual).

2. Target configuration and flight profiles used for baseline runs are identical to those used for the ECM runs.

3. Under the no ECM condition runs the tracking must be of a quality consistent with that postulated for the tracking system.

IV. INSTRUMENTATION.

1. A target tracking system with a time annotated track as an output.

2. A system to record all reported track data and output a time annotated track of the data.

V. LIMITATIONS.

1. The day to day differences in the radar and ECM calibration and the abilities of the tracking system/operators.

2. When surface to air missile systems use three point guidance, the range tracking error may not be significant. Also, it should be noted that the tracking error is more significant in the terminal phase of an encounter.

POWER RESOURCE MANAGEMENT

I. DEFINITION

Ability of jammer to handle new and more hostile threats in a constant changing environment.

II. REQUIREMENTS/CRITERIA

1. Requires a variety of hostile radars or their simulators operating at one time and which can be controlled from a central operations center.

2. A definite flight path must be established to take the aircraft in and out of a maximum number of hostile radar scanning areas.

3. Start and end point times must be specifically defined according to location of aircraft, or jammer ON/OFF times.

4. Aircraft must fly at controlled speed and altitude during testing. Location of aircraft vs time must be measured using various checkpoints along flight path or by other means.

5. The time the jammer responded to a particular radar signal and the time span that the signal was effectively jammed.

III. BASELINE

1. Routes should be established and flown without jammer or with aircraft similar to the one with the jammer.

2. Radar ranges and times on/off should be established at this time.

3. Time of flight and times various radars acquired the target along the route should be established. Location of target vs time baseline can be established with respect to radar acquisition.

IV. INSTRUMENTATION

Aircraft tracking system with time annotated track output. jammer monitoring system which determines when jammer pick up a new signal and how it responds.

Jk

V. LIMITATIONS

If the hardware and software are not completely compatible it will definitely show up in this test. This is basically a software test to determine how effectively the system can handle hostile radars in its area as it becomes overloaded with incoming signals. Flight paths have to be closely monitored as time and location are key elements in evaluating response.

PROBABILITY OF KILL (P_K) MATRIX

I. DEFINITION

The probability of kill (P_K) of a specific weapon (SAM, AAM, AAA) against a specific target aircraft defined as a function of downtrack and offtrack position of the aircraft from the site at time of weapon launch.

II. REQUIREMENTS/CRITERIA

1. Target characteristics - vulnerable components, susceptability to blast/fragment damage, radar cross section

2. Missile characteristics - warhead size, fragment size, missile velocity, fragment initial velocity, fuze characteristics

3. End game geometry - trajectory and orientation of missile relative to target at time of closest approach ($\pm$1000 feet nominally) recorded in 1/20 second intervals (nominal).

4. Adequate sample points to populate matrix fully

   a. Multiple samples required from statistical sources (flight test, simulators, Monte Carlo models)

   b. Single samples only from deterministic (repeatable) models

   c. Several offtrack/downtrack nodes

5. Lethal index (P_K volume) and/or average P_K over bounded non-zero P_K surface required for comparisons of dry, ECM_1, ..., ECM_N conditions.

III. BASELINE

1. Aircraft without ECM (dry situation) are required to establish basic vulnerability to threat system.

   a. Single aircraft
   b. Formation of aircraft
   c. Straight and level and/or maneuvers

2. Identical flight paths and formations repeated for ECM conditions.

IV. INSTRUMENTATION

1. Missile trajectory data recorded in vicinity of target aircraft, on magnetic tape or equivalent medium, if from flight test or hardware missile simulation

2. Suitable computer program which calculates P_K per encounter for either magnetic tape inputs or internally generated generic flight paths.

V. LIMITATIONS

1. Vulnerable areas or components of aircraft need to be standardized so that inter-aircraft vulnerability comparisons can be valid.

2. Radar cross section data is normally availble only for far field measurements and not for near-field.

SIGNAL PROCESSOR THROUGHPUT

I. <u>DEFINITIONS</u>. The amount of time required for an EW/ESM Computer/Processor to execute required functions.

1. Weighted Mean Instruction Execution Time $\equiv \overline{T}$

$$\overline{T} = \sum_{i=1}^{N} w_i \, t_i$$

w_i = weight of i^{th} instruction
t_i = execution time of i^{th} instruction

NOTE: See Para II-3 below.

2. Alternate Weighted Instruction Exception Time $\equiv \overline{T}a$

$$\overline{T}a = 2.22 - 1.094M + 2.298R - 1.624S$$

M = memory activity index
R = processor activity index
S = program size index

NOTE: See Para II-4 and III below.

II. <u>REQUIREMENTS/CRITERIA</u>.

1. (EW/ESM) Computer/Processors are the throughput choke-point of EW/ESM systems. With very little variance, the memory access cycle time defines the real time throughput of any computer processor.

2. To a first order of magnitude, the memory access time of a computer/processor defines the throughput speed of that processor and may be used as a preliminary criterion of evaluation, selection, and elimination.

3. A more refined (and accurate) (EW/ESM) computer/processor criteria of evaluation, selection, measure of merit, are the ten most used microinstructions in EW/ESM programming. These ten microinstructions represent 79% of the total EW/ESM processing, including time. Listed below together with their frequency-time weights are these instructions:

Microinstruction	Weight
LOAD INTERNAL REGISTER	0.271
STORE INTERNAL REGISTER	0.195
QUICK BRANCH	0.132
BRANCH	0.086
BRANCH TO SUBROUTINE	0.069
REGISTER ADD/SUBSTRACT	0.067
BRANCH ON CONDITION	0.051
I/O CONTROL	0.048
REGISTER LOGICAL OPERATION	0.045
MODIFY INTERNAL REGISTER	0.036

The above microinstruction weights when applied to the respective microinstruction execution times and summed according to:

$$\overline{T} = \sum_{i=1}^{N} w_i t_i$$

where:

$\overline{T}$ = weighted mean instruction execution time

w_i = weight of ith instruction

t_i = execution time of i^{th} instruction

will provide an accurate assessment of (EW/ESM) computer/processor performance.

4. A less accurate assessment based upon a Computer Family Architecture/ Military Computer Family (CFA/MCF) study of computer software architecture performance was derived by cross-correlation with the above results. This "measure-of-merit" makes use of the CFA/MCF derived elements of computer performance: S, M, R that can be evaluated by simple bench-mark programs:

$$\overline{T_a} = 2.22 - 1.094M + 2.298R - 1.624S$$

where:

$\overline{T_a}$ = weighted instruction execution time

S = program size index

M = memory activity index

R = processor activity index

These indicies have been assessed for most military machines but are also available through benchmark programs.

The above criteria will all provide quantitative methods of evaluating computer/processors for EW/ESM (and military systems). The availability of the characteristics depends upon the cooperation of the processor vendor or an independent evaluation team.

5. Software and Hardware cost comparisons are equally well established, and simply and accurately evaluated. Software costs are highly correlated to the total investment in a computer architecutre:

$$C_{si} = 42.34 \, B_2^{-0.149}$$

where: C_{si} = \$ cost-per-instruction of the i^{th} architecture

B_2 = total Cost (\$M) of architectural inventory

Hardware costs are a function of the total number of circuits in the processor (including memory):

$$C_{Hi} = 594.74 \, N_c^{0.795}$$

where: C_{Hi} = Hardware cost (\$) of i architecture

N_c = total number of circuits

(ca 1977)
Hardware costs reduce an order of magnitude every ten years for a constant level of throughput.

III. BASELINE:

1. Memory access cycle time computer characteristic.

2. Microinstruction execution time for:

LOAD INTERNAL REGISTER
STORE INTERNAL REGISTER
QUICK BRANCH
BRANCH
BRANCH TO SUBROUTINE
REGISTER ADD/SUBTRACT
BRANCH ON CONDITION
I/O CONTROL
REGISTER LOGICAL OPERATION
MODIFY INTERNAL REGISTER

3. BENCHMARK PROGRAM MOM:

S - index: the number of memory bytes required by the BENCHMARK PROGRAM.

M - index: the number of bytes read or written to main memory during the execution of the BENCHMARK PROGRAM.

R - index: the sum of the CPU cycles required to execute the BENCHMARK PROGRAM.

4. COST MOM:

Software B_2 - the total inventory value ($M) invested in the computer architecture.

Hardware: N_c - number of circuits (switches) in the architecture.

The above parameters are time (yearly) variant; therefore, no baseline value exists except for a baseline year.

IV. INSTRUMENTATION:

The best means of evaluating (EW/ESM) computer/processors would be through another computer; such as an emulator, simulator that can operate on the characteristics of a particular architecture and evaluate its performance in a system. A noteable example is CFA/MCF's Instruction Set Processor, ISP, that can be used to evaluate processors by architectural simulation of test programs on a computer.

V. LIMITATIONS:

The above criteria are statistically derived based upon representative EW/ESM programming. Highly specialized applications can alter the results somewhat but not in the nominal case. The basic criterion of evaluation, MOM, is real-time throughput. In as much as redundancy can be eliminated, real-time throughput can be alleviated. However, such criteria would be applicable to all processor MOM; so, real-time throughput remains as the absolute Measure-of-Merit.

SYSTEM DELAY

I. DEFINITION. The amount of time required beyond that which has previously been established for the transfer of data and/or decision making process.

II. REQUIREMENTS/CRITERIA.

1. All data transfer and dcision making tasks to be completed must be identified and a normal transfer and processing time established for each.

2. Times determine in 1 above must compare to those obtainable through intelligence sources.

3. Much of the data required for this measurement criteria will be obtainable from the results of other major MOMs.

4. Measurement of data handling and processing times by operators or automatic systems in required.

5. All functions to be completed and the time required for each must be compared to actual accomplishment.

III. BASELINE.

1. A comprehensive prioritized list of all tasks an operator or system is required to accomplish must be developed.

2. Completion times for each task must be determined by actual measurement of several operators or several iterations through the system. This is then extrapolated into a table containing a high, low and average (normal) time for task accomplishment.

IV. INSTRUMENTATION.

1. Listings of tasks required to be accomplished within a specific time frame and listings of tasks actually accomplished within this time frame, each time annotated, are required.

2. Output listings of the results of many of the other major MOMs (those that reflect the time required for the action to be completed) will be required.

V. LIMITATIONS.

1. Many of the measurement criteria of this MOM are subjective in nature and are subject to misinterpretation.

2. The best manner to obtain much of the data required for this MOM is by personal observation which will require a considerable number of highly qualified personnel.

WEAPONS STATUS

I. DEFINITION. The state of all weapons/weapon system before and during the measurement period.

II. REQUIREMENTS/CRITERIA.

1. Critical weapon/system parameters that are crucial to mission accomplishment must be identified and monitored.

2. Weapons/systems must be operated IAW current intelligence information on employment operations/doctrine.

3. Weapons commitment data (time and number) must be recorded.

4. Weapons/systems status (down, standby, passive, active, etc) must be recorded.

III. BASELINE. All weapons/systems must be operated in accordance with real world operations.

IV. INSTRUMENTATION. Requires a data collection system that will output:

1. A listing of all weapons available prior to the measurement period and their status (time annotated) throughout the period.

2. A time annotated listing of all weapon commitments throughout the measurement period.

V. LIMITATIONS. Other uncontrollable factors such as weather can impact on this measurement criteria and require consideration.

PART II - MOM SUB-SETS

A. Sub-Set MOM on which complete dictionary data was recieved.

B. Sub-Set MOM on which partial dictionary data was received.

C. Sub-Set MOM on which nothing more than suggested titles were received.

PART II A

AUTOMATIC/MANUAL FREQUENCY SET-ON ACCURACY

I. DEFINITION:

1. The ability of a receiver system to automatically process RF signals and tune all ECM transmitter(s) to the received RF signal center frequency.

2. The ability of the "man-in-the-loop" to accurately tune an ECM transmitter to the received RF signal center frequency as displayed on the receivers associated display unit.

II. REQUIREMENTS/CRITERIA:

1. A maximum allowable frequency centering error must be established.

2. A minimum sample size (centering attempts) should be established based on actual planned flight time. This requirement is dependent on overall test objectives (i.e., one sample size per run may surfice if missile miss distance data is the primary test objective).

III. BASELINE: Requires a minimum of two runs in a benign environment over flight routes similar to those planned for actual flight tests and against the same radars.

IV. INSTRUMENTATION:

1. A precision target tracking reference radar is necessary (a radar tracking a beacon on the test aircraft is preferable).

2. A frequency, or ground monitor facility, with antennas slaved to the reference tracking radar is required. This facility should be capable of receiving, displaying, accurately measuring, and recording all RF emanations from the testaircraft and the ground (victim) radar.

V. LIMITATIONS: None

CROSS-CORRELATION INDEX

I. DEFINITION. The cross-correlation index (CCI) gives a measure of the similarity of the receiver audio outputs to the threat RF signal generator's baseband audio input. Auto-and cross-correlation measurements are made using a correlator, pseudorandom noise (PN) source, and audio filters. The results of these measurements are then used to derive the CCI, a fast, accurate, and repeatable measure of jamming effectiveness against voice communication.

II. REQUIREMENTS/CRITERIA.

1. The required jamming modulation, e.g., Gaussian noise or square wave must be specified.

2. The required jamming-to-signal (J/S) ratio must be specified.

3. The required receiver to be tested must be specified.

III. BASELINE.

1. The maximum auto-correlation of the receiver audio output channel must be made equal to the maximum auto-correlation of the voice-simulation channel to eliminate signal amplitude as a variable.

2. The cross-correlation of the receiver audio output channel is taken with respect to the voice-simulation channel. In addition, the auto-correlation of the voice-simulation channel is determined.

3. The CCI is determined using a ratio of the peak amplitude of the cross-correlation curve to the peak amplitude of the auto-correlation curve.

4. Experimentation has indicated that this CCI is a satisfactory jamming effectiveness measure consistent with listener - panel type tests.

IV. INSTRUMENTATION.

Instrumentation requirements: Two RF generators and their modulating sources, filters, attenuators, a hybrid coupler, the receiver under test, and a correlator.

V. LIMITATIONS.

1. The voice simulation signal is derived from a PN source filtered by a weighting network. Studies are in progress to determine more accurate voice-simulation signals.

2. Because of the requirement for determining the cross-correlation between the receiver audio output channel and voice-simulation channel the CCI measurement can only be made under laboratory conditions. Studies are under way to extend this capability to field conditions.

DEGRADATION ERROR

I. DEFINITION

The error is the percentage of time that the radar tracking errors are greater than a predetermined value. For surface-to-air missile systems and airborne interceptor systems this error is measured only when a missile is in the air; for AAA systems, this error is measured only when the guns are firing. Both range and angle degradation errors are measured.

II. REQUIREMENTS/CRITERIA

1. Requires a continuous comparison of the tracked range and angle of the target with the true range and angle.

2. Tracked range, elevation angle and azimuth angle must be measured as a function of time and compared with true values to obtain differences which can be used to establish the azimuth elevation and composite angle tracking errors and the range tracking error.

3. Under dry conditions (no ECM), the tracking must be of a quality consistent with that postulated for the threat radar, as identified in the Intelligence Data Input Package (IDIP) furnished by FTD.

4. The predetermined values used as breakpoints will be defined prior to the test as they are an input that can be varied from test to test.

III. BASELINE

1. A predetermined number of runs are obtained without ECM to establish the tracking quality. The number of dry runs required is dependent on the type of tracking system (automatic, semiautomatic or manual). Ten-run samples are usually adequate for automatic and semiautomatic operation while fifteen-run samples are required for manual tracking.

2. Aircraft configuration and flight profiles used for baseline runs are identical to those used for ECM runs.

IV. INSTRUMENTATION

1. Range, azimuth and elevation tracking errors must be recorded as a function of time.

2. The percentage of time that the tracking errors exceeded the predetermined breakpoints must be printed out at the conclusion of the run.

V. LIMITATIONS

1. Limitations include the day to day differences in the radar and ECM calibration and the abilities of the tracking operators.

2. The degradation errors should not stand alone. They should be studied in conjunction with the tracking errors in order to get a complete picture of the situation as the timing of the errors is critical to the success or failure of an engagement.

DEMAND SATISFACTION

I. DEFINITION. A measure of how well a logistic support system satisfies the demands placed upon it for mean and materials. It is evaluated based on the supply status of user units. Specific considerations include the quantity of materials ordered, received, due in and the time required to receive the due material. Designed to quantitatively measure the effects of communications jamming and/or physical disruption of the throughput of a logistics network.

II. REQUIREMENTS/CRITERIA.

1. Supply related communications are aggregated and considered delayed for various time periods for scenarios using computer simualtions.

2. Results are scenario dependent; two critical areas analyzed are requests for user units to the supply based and transportation network status messages.

III. BASELINE. Baseline values can be obtained from analyzing normal operations during periods of no communications jamming, over a specified time.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS. The MOM is best suited for computer simulations.

FALSE ALARM RATE (FAR)

I. DEFINITION: The proportion of missile launch detections per hour of system operation when no missile is present. Pertains to airborne air-to-air missile detection systems.

II. REQUIREMENTS/CRITERIA:

1. Requires specific time period reflecting well defined initiation and termination points. Such systems generally have well defined operating envelopes. Since FARs are rated as a function of operating time, the beginning and termination of this time is critical to the results.

2. Accept/reject criteria must be established giving consideration to the following factors:

a. The type of detection system, i.e., infrared or pulse doppler.

b. Known or suspected system malfunctions.

c. The presence of air vehicles in the area of the detection system which could, because of their operating characteristics (closure rate, IR signature, etc), present a valid target to the detection system.

d. For radar detection systems, the presence of interfering RF energy which could cause false alarms.

III. BASELINE: Due to the nature of this MOM, baseline runs are not required.

IV. INSTRUMENTATION/DATA REQUIREMENTS:

1. The detection system must be instrumented to provide all pertinent processing information such as system threshold settings, target range, azimuth and elevation, time of detection, velocity of target, etc.

2. Operator logs must include as much detection data (time, target range, azimuth and elevation, etc) as available, weather conditions (clear, cloudy, precipitation, etc), system malfunctions, the presence of other aircraft in the area at the time of detections, and start and stop times for data collection. NOTE: Weather conditions, to include the visibility and relative position of the sun to the aircraft, are particularly important for IR detection systems.

V. LIMITATIONS:

1. Determining the cause of false alarms is often difficult, particularly during system operations off range where the environment (other aircraft) is not controlled.

2. Missile detection systems are usually sensitive to both terrain and weather environments. Test limitations (time, money, flight hours, etc) may preclude system operation under all possible conditions.

INTERCEPT MISSILE LAUNCH PROBABILITY

I. DEFINITION. The probability that an interceptor will launch an air to air missile at a penetrator. Originally developed to evaluate VHF voice communications between GCI sites and airborne interceptors using the manned, real time REDCAP simulator.

II. REQUIREMENTS/CRITERIA.

1. Pre-specified ground tracks for the penetrator are needed.

2 Time duration for each runs should be consistent.

3. Opertors should be given "hands-on" training to familiarize themselves with the simulator.

4. GCI radio communication is doen with a single transmitter and one frequency is used.

5. Air to air relay of messages is allowed.

III. BASELINE.

1. A predetermined number of runs are made in which the penetrator uses no jamming.

2. The same number of runs are made in which the penetrator uses surveillance radar jamming; these are then compared to runs in which radar and communications jamming are both used, this will given an indication of communication jamming effectiveness.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS.

1. The penetrator may not make reactive maneuvers.

2. The simulator does not make allowances for intelligence gaps concerning doctrine.

3. All functions are not simulated.

MISS DISTANCE

I. DEFINITION. The distance by which a seeker misses an intended point target.

II. REQUIREMENTS/CRITERIA

1. Miss distances are intended to reflect the performance of ECM techniques against antiship cruise missiles, and are determined by closed loop laboratory simulations.

2. In order to properly simulate the event, target cross section, seeker performance, and ECM technique must be adequately defined in a combination of both hardware and software.

3. Runs have been typically started at 10 nmi or the outer limits of seeker range, whichever is less, and end when the seeker impacts or flys past the target. The simulation runs in real time.

4. Although miss distance is the quantifiable MOM, an assessment is often made in terms of hits or misses. Generally, because of the large target sizes, a hit is counted when the miss distance is less than 500 feet.

III. BASELINE.

1. There is little baseline data required. Several runs with no ECM are required to insure that the simulation runs correctly and the jammer and signal rf levels must be set to properly reflect the target cross section and jammer ERP.

IV. INSTRUMENTATION.

1. An anechoic chamber is used for the propogation of rf signals that represent the ECM and target return. A two axis pedestal within the chambers holds the seeker.

2. A computer is required to run the simulation. A PDP 11/45 is used and is augmented by an Applied Dynamics/Delta Four analog processor which provides missile flight dynamics.

3. A strip chart records key seeker outputs such as azimuth and elevation tracking errors, range, AGC level, and antenna position. An A scope permits an operator to view the received video.

4. During a run, a Tektronix 4014-1 and a 4010-1 terminal displays a history azimuth and elevation angle tracking errors as well as azimuth and elevation errors. A hard copy is available after the run to provide a permanent record. A copy of a 3D representation of the seeker trajectory is also available in hard copy.

V. LIMITATIONS.

1. The data obtained represents one on one performance in a laboratory environment. As such it does not include the effects of multiple simultaneous engagements, multipath, a distributed target, variation of target cross section, and actual ECM system performance.

2. Simulation of a threat is limited by the extent of available information. This fact must always be kept in mind when ECM techniques against ASCM threats are evaluated.

NUMBER OF KILLS ON STRIKE AIRCRAFT

I. DEFINITION. The number of intercept missile firings which result in kills. It is a sequential interation of "TOTAL NUMBER OF ATTACKS ON PENETRATORS".

II. REQUIREMENTS/CRITERIA. (Since the KECCA model is used for this MOM, the following restrictions normally apply).

1. Autonomous GCI or missile sites are not allowed.

2. Pilot/GCI controller feedback is not provided for. Success of jamming is a go/no-go based on J/S criteria.

3. The penetrator cannot take evasive action.

III. BASELINE.

1. For each test case, a predetermined number of runs with no jamming are made.

2. Using the same penetrator flight profiles, the same number of runs are made using only ECM against target acquisition radars. Runs are then made using communications jamming as well as radar ECM; this will give the total effect of jamming plus an indication of communications jamming effectiveness.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS. Results obtained are only indications of the immediate impact of an integrated jamming effort against the network, since many operations have been simplified for input into the model.

PENETRATOR/INTERCEPTOR MINIMUM SEPARATION DISTANCE

I. DEFINITION. The closest point of approach between a penetrator and defending interceptor. Developed to conduct a rigorous analysis of communications jamming effects against an air defense network using the manned, real time REDCAP simulator.

II. REQUIREMENTS/CRITERIA.

1. Pre-specified ground tracks for the penetrator are needed.

2. Time duration for each rune should be consistant.

3. Operators should be given "hands-on" training to familiarize themselves with the simulator.

4. GCI radio communication is done with a single transmitter and one frequency is used.

5. Air to air relay of messages is allowed.

III. BASELINE.

1. A predetermined number of runs are made in which the penetrator uses no jamming.

2. The same number of runs are made in which the penetrator uses surveillance radar jamming; these are then compared to runs in which radar and communications jamming are both used, this will give an indication of communication jamming effectiveness.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS.

1. The penetrator may not make reactive maneuvers.

2. The simulator does not make allowances for intelligence gaps concerning doctrine.

3. All functions are not simulated.

PROBABLE HIT OR MISS

I. DEFINITION. Whether or not a seeker will probably hit or probably miss a target.

II. REQUIREMENTS/CRITERIA

1. Probable hit or miss is an assessment made in "at sea" evaluations of shipboard EW systems.

2. Runs against a ship are made with multiple instrumented rf seekers carried on a special manned aircraft. Because these runs cannot be closed loop but are most often straight and level, there is no currently known method to obtain a quantifiable miss distance. Instead, a highly skilled analyst makes a determination of which would be more probable, a hit or miss. His decision is based on a detailed knowledge of EW system, seeker, and results of closed loop laboratory simulations. Most often, the decision is obvious.

III. BASELINE.

1. There is little baseline data required. Several runs with no ECM are required to insure that the seekers are operational.

IV. INSTRUMENTATION.

1. A reference radar on the instrumented aircraft tracks a beacon on the ship and provides reference az and el angle tracking data.

2. Strip chart recordings are made of key seeker parameters such as az and el tracking errors, range gate position, AGC level, and antenna position.

3. A scope presentations of all seeker video is available for operator viewing.

V. LIMITATIONS.

1. A primary limitation is due to the fact that the manned seeker carrying aircraft does not duplicate the actual seeker trajectory. Not only is the speed different, but the aircraft flys straight and level while the seeker flys to hit the target.

2. Simulation of a threat is always limited by the extent of available information. The evaluation of EW systems should reflect that fact.

SPREAD SPECTRUM ANTI-JAM ESTIMATE

I. DEFINITION. A gross estimate of how much spread spectrum anti-jam benefit can be obtained through suitable engineering pseudo noise encoding or frequency hopping can be obtained by the following:

$$\text{Spread Benefit (anti-jam margin)} = 10 \text{ Log } \frac{\text{Spread bandwidth or chip rate}}{\text{10 X information rate}}$$

II. REQUIREMENTS/CRITERIA.

1. A 10 db output of signal to noise is necessary to maintain a satisfactory bit error rate (BER).

2. A one to one relationship exists between bandwidth and chip rate.

III. BASELINE. No data provided.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS. Values are not operationally precise and provide only a "first estimate" assessment of spread spectrum communications from both an ECM and ECCM standpoint.

THREAT TRANSMISSION DUTY FACTOR

I. DEFINITION. Transmission duty factor is expressed as a percentage of utilized transmission time versus available transmission time. Developed to provide a quantitative measure of effectiveness of a communications system in the presence of jamming during GCI communications jamming effectiveness study conducted on the REDCAP simulator.

II. REQUIREMENTS/CRITERIA.

1. Pre-specified ground tracks for the penetrator are needed.

2. Time duration for each rune should be consistant.

3. Operators should be given "hands-on" training to familiarize themselves with the simulator.

4. GCI radio communication is done with a single transmitter and one freuquency is used.

5. Air to air relay of messages is allowed.

III. BASELINE.

1. A predetermined number of runs are made in which the penetrator uses no jamming.

2. The same number of runs are made in which the penetrator uses surveillance radar jamming; these are then compared to runs in which radar and communications jamming are both used, this will give an indication of communication jamming effectivensss.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS.

1. The penetrator may not make reactive maneuvers.

2. The simulator does not make allowances for intelligence gaps concerning doctrine.

3. All functions are not simulated.

TOTAL NUMBER OF ATTACKS ON PENETRATORS

I. DEFINITION. The firing of missiles by an interceptor at an attacking penetrator. Results are determined for various test cases of ECM packages, penetrator flight paths, communication jammers and drone flight paths.

II. REQUIREMENTS/CRITERIA. (Since the MECCA model is used for this MOM, the following restrictions normally apply).

1. Autonomous GCI or missile sites are not allowed.

2. Pilot/GCI controller feedback is not provided for. Success of jamming is a go/no-go based on J/S criteria.

3. The penetrator cannot take evasive action.

III. BASELINE.

1. For each test case, a predetermined number of runs with no jamming are made.

2. Using the same penetrator flight profiles, the same number of runs are made using only ECM against target acquisition radars. Runs are then made using communications jamming as well as radar ECM; this will give the total effect of jamming plus an indication of communications jamming effectiveness.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS. Results obtained are only indications of the immediate impact of an integrated jamming effort against the network, since many operations have been simplified for input into the model.

VISUAL DETECTION BY THE INTERCEPTOR

I. DEFINITION. A change in the probability that an interceptor will reach a point from which visual detection of a strategic penetrator is possible.

II. REQUIREMENTS/CRITERIA.

1. Pre-specified ground tracks for the penetrator are needed.

2. Time duration for each rune should be consistant.

3. Operators should be given "hands-on" training to familiarize themselves with the simulator.

4. GCI radio communication is doen with a single transmitter and one frequency is used.

5. Air to air relay of messages is allowed.

III. BASELINE.

1. A predetermined number of runs are made in which the penetrator uses no jamming.

2. The same number of runs are made in which the penetrator uses surveillance radar jamming; these are then compared to runs in which radar and communications jamming are both used, this will give an indication of communication jamming effectiveness.

IV. INSTRUMENTATION. No data provided.

V. LIMITATIONS.

1. The penetrator may not make reactive maneuvers.

2. The simulator does not make allowances for intelligence gaps concerning doctrine.

3. All functions are not simulated.

PART II B

CHANGE IN DAMAGE RATE

1. DEFINITION. The incremental change in damage rate (ΔD) inflicted by an attacking force is dependent upon the ratio of the damage inflicted without defensive ECM (Dwo) and the damage inflicted with defensive ECM (Dw) expressed as follows:

$$\Delta D = 1 - \frac{Dwo}{Dw}$$

No further data provided.

CHANGE IN LOSS RATE

1. <u>DEFINITION</u>. The change in loss rate (ΔL) of an attacking force is a function of the ratio of attack force losses without defense force ECM (Lwo) and attack force losses with defense force ECM (Lw) expressed as:

$$\Delta L = 1 - \frac{Lwo}{Lw}$$

No further data provided.

COMMUNICATIONS JAMMING MISSION EFFECTIVENESS (1) and (2) and (3)

1. DEFINITION. (1) The mission effectiveness (ME) is calculated for each communications jamming system using the following:

Mission effectiveness (%) =

$$\frac{\text{Time duration unable to communicate}}{\text{Time duration attempted to or did communicate}} \times 100$$

The resulting percentages are arbitrarily categorized as either successful, partially successful, or unsuccessful (or unknown) based upon the following percentage ranges:

$ME \geq 80\%$ Successful

$0 < M < 80\%$ Partially Successful

$ME = 0$ Unsuccessful or Unknown

(2) The results of each communications jamming mission are categorized as indicated:

Successful - Victim stations unable to communicate during the jamming period.

Partially Successful - Some degree of communications difficulty experienced by the victims.

Unsuccessful - Victims readily worked through jamming or the jamming opportunities were limited because of lack of activity.

A communications jamming mission effectiveness measure is then calculated as follows:

$$\text{Effectiveness Measure} = \frac{\text{Number of missions in category}}{\text{Total number of missions}} \times 100$$

(3) Expressed as a ratio of the total number of successful missions and the total number of missions; where, a mission is considered successful if it negates communications, delays communications, causes general confusion, misdirects stations, and/or deceives stations on the links. This can be mathematically expressed as a percentage:

Communications jamming mission effectiveness =

$$\frac{\text{Total number of successful missions}}{\text{Total number of missions}} \times 100$$

No further data provided on any of the above.

COMMUNICATION SYSTEM RANGE CAPABILITY

1. DEFINITION. The maximum effective range of a communications system under various levels of jamming activity. Factors varied include the number and proximity of the jammers.

No further data provided.

COVER AND DECEPTION EFFECTIVENESS

II. REQUIREMENTS/CRITERIA. Requires chronology of each transmitted signal, detected signal, each track, system status and engagement status.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, signal simulators, scope cameras, strip chart recorders, video recorders, audio recorders and data logs.

No further data provided.

DIRECTION FINDING BEARING ACCURACY

II. REQUIREMENTS/CRITERIA. Requires the chronology of each signal transmitted, each signal detected, system status and each track.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, threat signal simulators, video recorders, audio recorders and data logs.

No further data provided.

ECM/SUPER RBOC PK

III. REQUIREMENTS/CRITERIA. Requires the history of each track, the status of each engagement, hit/miss distance, system status and the chronology of each transmitted signal.

IV. INSTRUMENTATION. Signal simulators, receivers, spectrum analyzers, cameras, strip chart recorders, video and audio recorders and data logs.

No further data provided.

ESM DETECTION RANGE

III. REQUIREMENTS/CRITERIA. Requires the chronology of each signal transmission, signal detected, system status and, each track.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, threat simulators, video recorders, audio recorders data logs and, strip chart recorders.

No further data provided.

ESM IDENTIFICATION ACCURACY

II. REQUIREMENTS/CRITERIA. Requires the chronology of each transmitted signals range, bearing and altitude. Requires a record of each detected signals parameters and display symbology, and the system status.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, threat signal simulators, strip chart recorders, video recorders, audio recorders and data logs.

No further data provided.

ESM TRACKING CONTINUITY

II. REQUIREMENTS/CRITERIA. Requires the chronology of each signal transmission, each signal detected and the system status.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, threat signal simulators, strip chart recordings, video recordings, audio recordings and data logs.

No further data provided.

ERROR RATE (COMMUNICATIONS INTELLIGIBILITY)

1. DEFINITION. Expressed in terms of the number of ideas received incorrectly as a function of jammer to signal ratios for several different modulations. For data modes of communication, error rates are expressed in terms of the number of bits received incorrectly.

No further data provided.

FALSE ALARM RATE

II. <u>REQUIREMENTS/CRITERIA</u>. Requires the chronology of each transmitted signal, track, system status and command response.

IV. <u>INSTRUMENTATION</u>. Receivers and spectrum analyzers, threat signal simulators, strip chart recorders, video recorders, audio recorders and data logs.

No further data provided.

FORCE DEFENSE ROLE EFFECTIVENESS

II. REQUIREMENTS/CRITERIA. Requires a chronology of each transmitted signal, detected signal, system status, engagement status, track history and hit/miss data.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, cameras, video and audio recorders, strip chart recorders, signal simulators and data logs.

No further data provided.

FREQUENCY OF JAMMING RECEPTION

1. DEFINITION. Expressed as the number of times jamming is initiated versus the number of times jamming is received.

No further data provided.

GOAL ATTAINMENT PROFICIENCY

1. DEFINITION. Consists of four measures of how effectively and efficiently a maneuver/C^2I system is able to pursue assigned tactical objectives. These standard indicators of combat activity are:

(1) Ait = Advance of unit (i) toward its objective in time period (t).

(2) CSrit = Casualitities of resources of type (r) sustained by unit (i) in time period (t).

(3) CIrit = Casualties of resources by type (r) inflicted (on opposing units) by unit (i) in time period (t).

(4) FRrit = Ratio of force resource type (r) in contact in unit (i) area of operations in time period (t).

Used to evaluate the effects of communications jamming on standard indicators of combat activity.

No further data provided.

INTEREFERENCE TO/FROM SYSTEMS

II. REQUIREMENTS/CRITERIA. Requires a chronology of each transmitted signal, the EMCON status, track histories and system status.

IV. INSTRUMENTATION. Signal simulators, receivers, spectrum analyzers, audio and video recorders and data logs.

No further data provided.

JAMMER EFFECTIVENESS

1. DEFINITION. Jammer effectiveness (E) is defined as the jammer utilization divided by the average transmitter utilization.

Where: Jammer utilization (U) = the fraction of time the jammer spends actually jamming victims (as opposed to searching for victims).

Average transmitter utilization = the product of the number of frequencies being used by the jamming victim (K) times the probability that the frequency is being used.

$$\frac{\lambda}{2 + M}$$

Where: λ = transition rate from frequency idle state to frequency utilized state.

M = transition from frequency utilized state to frequency idle state.

$$\therefore \; E = \frac{M}{K\left(\frac{\lambda}{2+M}\right)} = \frac{M(2+M)}{K2}$$

No further data provided.

JAMMER EFFECTIVENESS CONTOUR

1. DEFINITION. The contour is plotted by overlaying the jamming to signal ratio for communications system minimum intelligibility threshold on a plot of victim range from control transmitter versus victim range from the jammer.

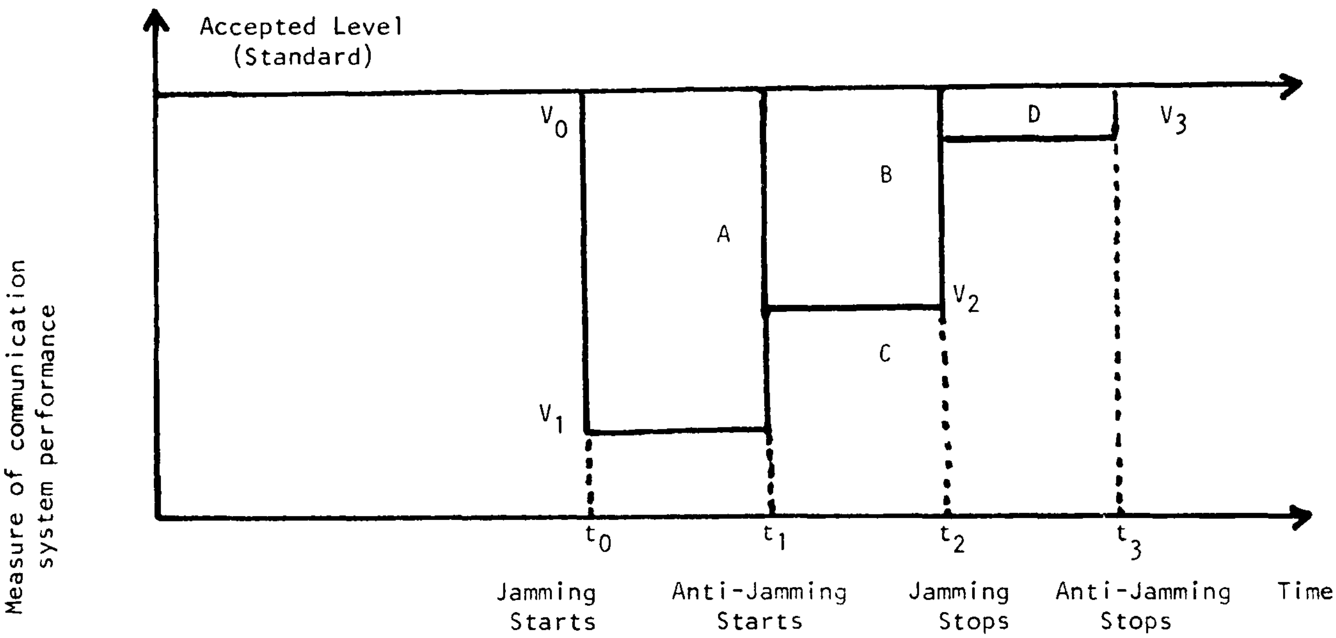
No further data provided.

JAMMING EFFICIENCY

1. <u>DEFINITION</u>. The efficiency (Mj) of jamming may be defined as the actual impact of a jammer measured against the potential impact of jamming. This may be expressed as:

$$Mj = \frac{A + B + D}{A + B + C}$$

Where A, B, C, and D are "areas" as defined in the following illustration



V_0 = Standard level of measure of system performance.

V_0-V_1 = Degradation due to jamming.

V_2-V_1 = Improvement due to anti-jamming protection.

V_0-V_3 = System degradation due to anti-jamming protection.

t_1-t_0 = Time required to recognize a jamming condition.

t_2-t_0 = Duration of the jamming condition.

t_3-t_2 = Time required to detect the absence of a jamming condition.

No further data provided.

MAXIMUM NUMBER OF SIMULTANEOUS ECM ENGAGEMENTS

III. REQUIREMENTS/CRITERIA. Requires chronology of each transmitted signal, detected signal, ECM measure applied and engagement system status.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, signal simulators, video recorders, audio recorders and data logs.

No further data provided.

MISSILE FIRING EVENTS VERSUS AIRCRAFT EXPOSURES

1. <u>DEFINITION</u>. Defined as missile firing events per 1,000 exposures:

a. Where a missile firing event is defined as an engagement by a surface to air missile (SAM) defenses (one aircraft fired upon by a salvo of three missiles is one missile firing event as is an aircraft fired upon using a signle missile).

b. An "exposure" occurs when an attack sortie comes within the lethal envelope of a SAM system.

No further data provided.

MULTI-JAMMER EFFECTIVENESS

1. DEFINITION. Jammer effectiveness (E) may be determined as a ratio of expected number of jammed transmissions and the expected number of transmissions. This may be expressed as:

$$(E) = \frac{\sum_{L=1}^{J} i \binom{K}{i} \left(\frac{A}{1-A}\right)^{i} + \sum_{i=J+1}^{K} J \binom{K}{i} \left(\frac{A}{1-A}\right)^{i}}{NA \sum_{i=1}^{K} \binom{K}{i} \left(\frac{A}{1-A}\right)^{i}}$$

Where: A = The duty factor of each frequency.
NA = The expected number of transmissions.
K = Number of frequencies utilized.
J = Number of frequencies jammed.

No further data provided.

NETWORK THROUGHPUT CONNECTIVITY

1. DEFINITION. The number of pairs of nodes that can exchange information within a network. For a total of n nodes in a network, the maximum throughput is n(n - 1). Actual throughput is calculated as a function of jammer to receiver distance.

No further data provided.

NUMBER OF RETRANSMISSION REQUESTS

1. DEFINITION. The number of requests by an operator on a jammed link for retransmission of voice radio messages.

No further data provided.

PERCENT OF THREAT EMITTERS DETECTED

II. REQUIREMENTS/CRITERIA. Requires the chronology of each transmitted signal, each detected signal and the system status.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, strip chart recorders, threat signal simulators, video recorders, audio recorders and data logs.

No further data provided.

PERCENT OF THREAT EMITTERS ENGAGED

II. <u>REQUIREMENTS/CRITERIA</u>. Requires a chronology of each transmitted signal, each signal detected, the ECM measures utilized and the systems engagement status.

IV. <u>INSTRUMENTATION</u>. Receivers and spectrum analyzers, radar scope cameras, threat signal simulators, strip chart recorders, video recorders, audio recorders and data logs.

No further data provided.

PERCENTAGE OF MISSIONS COMPLETED

1. DEFINITION. Percent of attempted airborne intercepts which resulted in detection and radar lock-on by the interceptor aircraft.

No further data provided.

PERCENT OF MULTIPLE TRACKS GENERATED

II. REQUIREMENTS/CRITERIA. Requires a chronology of signal transmissions, track histories and system status.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, threat signal simulators, strip chart recorders, video recorders, audio recorders and data logs.

No further data provided.

PROBABILITY OF MESSAGE RECEPTION

1. DEFINITION. The probability that at least one message will be received from a reconnaissance-communications unit.

$$= \left\{ 1 - \left[1 - Prt\ (1 - Pjc)\ Dj \right] \emptyset rt \right\}$$ Where:

Prt = Probability that a reconnaissance communications unit can transmit a message with correct information concerning target location.

Pjc = Probability that a jamming unit can prevent the message from reaching its destination.

Dj = Number of jamming units.

Ørt = Number of reconnaissance - communication units.

No further data provided.

PROBABILITY OF SUCCESSFUL DATA LINK RECEPTION

1. DEFINITION. The probability that a 12-symbol digital message will be successfully received. This probability is determined as follows:

(1) A plot is made of the probability that there will be an error in tone detection versus the ratio of signal energy to rms jammer noise density (E/No).

(2) The above plot is used to generate a plot of E/No versus the probability of successful 12 character digital message reception.

(3) Given a signal to noise ratio, E/No may be calculated by the expression:

$$(E/No) = S/N + 26 \text{ db}$$

(4) Probability of successful 12 character message reception is obtained from entering plot of step 2 with calculated E/No.

No further data provided.

PROBABILITY FO TARGET KILL

I. <u>DEFINITION</u>.

$$\overline{Pk} = \frac{\left(\sum_{t=1}^{n} \bullet \; uPt\right)}{n}$$

Where:

$\overline{Pk}$ = Probability of Kill.

uPt = Unconditional probability of kill against each target in a given target class.

n = The number of examined targets in each class.

The impact of communications jamming is measured in terms of jamming induced changes in rate of kill against various targets, target classes evaluated include command posts, artillery and morter batteries, signal centers, radar sites, and air defense weapons.

No further data provided.

REACTION TIME TO COUNTER THREAT

II. REQUIREMENTS/CRITERIA. Requires the chronology of each signal transmission, each detected signal and the recording of each track.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, threat signal simulators, strip chart recorders, video recorders, audio recorders and data logs.

No further data provided.

REPEATER JAMMER EFFECTIVENESS AREA

I. <u>DEFINITION</u>. The maximum theoretical area within which a repeater jammer could impact on a frequency hopping transmitter at a given frequency hopping rate can be derived from the following relationship:

$$d^{t}\ on = \left(\frac{d_1}{V}\right) + \quad + \left(\frac{d_2}{V}\right) - \left(\frac{2c}{v}\right)$$

Where: d = A constant to represent the assumed coincidence of jammer pulse on transmitter pulse ($0 \leq d \leq 1$).

t = On-time of frequency hopping transmitter.

on = Transmitter duty factor x pulse repetition time.

d_1 = Distance between jammer and transmitter.

d_2 = Distance between jammer and receiver.

2c = Distance between transmitter and receiver.

= Jammer processing delay.

= Wave propagation velocity (3×10^8 M/Sec).

Repeater jammer geometry is then represented as an ellipse with the transmitter to receiver distance (2c) equal to the focal length. The major axis of the ellipse is defined as 2a and the minor axis as 2b ($2b = d_1 = d_2$).

Hence: $$b = \left\{ \left[\frac{d^{t}\ on\ v}{2} - \frac{\Delta v}{2} + c \right]^2 - c^2 \right\}^{\frac{1}{2}}$$

and $$a = \sqrt{b^2 + c^2}$$

No further data provided.

AD-A124 070 STANDARDIZED MEASURES OF MERIT (MOM) DICTIONARY(U) AIR FORCE ELECTRONIC WARFARE CENTER KELLY AFB TX 20 MAR 79 2/2

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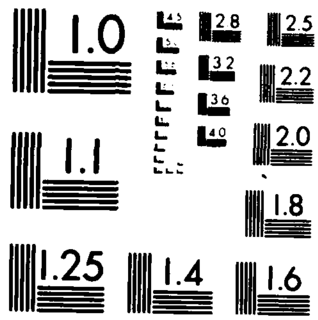
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SATCOM UPLINK CHANNEL CAPACITY

1. <u>DEFINITION</u>. The impact of jamming to the data rate capacity of a communications satellite uplink channel can be derived from the following:

$$R = \frac{WS}{\left(\frac{Eb}{No}\right) \gamma (J+I+S) \left\{ 1 = \frac{KTW}{\frac{EG}{L}} \right\}}$$

Where: R = Transmitted data rate capacity.

W = Spread spectrum bandwidth.

S = Uplink signal EIRP.

(Eb/No) = Required post correlation signal to noise.

γ = Signal suppression in the transponder.

J = Jammer EIRP.

I = Sum of other uplink signals (EIRP).

E = Satellite full output downlink EIRP.

L = Downlink path loss.

K = Boltzmann's constant.

G/T = Receiver earth terminal figure of merit.

No further data provided.

SELF DEFENSE EFFECTIVENESS

II. <u>REQUIREMENTS/CRITERIA</u>. Requires a chronology of the signal transmissions, system status, signals, engagement status, track history and hit/miss data.

IV. <u>INSTRUMENTATION</u>. Receivers and spectrum analyzers, signal simulators, cameras, strip chart recorders, video and audio recorders and data logs.

No further data provided.

SITUATION AND DEMAND PERCEPTIONS

1. DEFINITION. Reflects the specific effect of counter-C^3 actions which delay information transfer among maneuver/command elements. Specifically:

(1) Peit = (Peit, Teit) = Perception of situation element (e) by unit (i) in time period (t) where:

Peit = Perceived "value" of situation element (e).

Teit = Time associated with perceived "value". The value of (e) ranges over elements of unit situation perception (i.e., force ratio in a sector, advance rate in a sector, etc).

(2) Dijct = Demand of unit (i) as perceived by unit (j) for commodity (c) over time period (t) where: (ij) range over all units such that unit (i) is a direct subordinate of unit (j) and (c) ranges over "commodities" that (i) can request from (j) (e.g., information, replacement, fire support, supplies, special weapons release, etc).

No further data provided.

SPREAD SPECTRUM ANTI-JAM PERFORMANCE CRITERIA

1. DEFINITION. For multi-tone jamming of frequency hopping (FH) spread spectrum communications, the minimum effective jammer power in that power required to cause an error rate that is higher than the maximum allowed after error control encoding/decoding.

$$Pe \cong 0.5e^{-Es/2jo}$$

Pe = Final error rate after error control encoding/decoding.

Es = Energy per information symbol = received signal power x symbol length.

jo = Total jammer power ÷ RF bandspread bandwidth.

No further data provided.

STAND ALONE ECM PK

II. REQUIREMENTS/CRITERIA. Requires track history, engagement status, hit/miss data, system status and signal transmissions.

IV. INSTRUMENTATION. Receivers and spectrum analyzers, cameras, signal simulators, strip chart recorders, video and audio recorders and data logs.

No further data provided.

TARGET KILL RATE

1. DEFINITION. The rate of kill (Rk) is a ratio of the expected number of targets killed and time. An expected rate of kill is determined for several classes of targets (e.g., command posts, radars, artillery pieces, etc). Rate of kill is a function of the time sequence in which individual targets are acquired, the accuracy with which they are acquired, the decision on allocation of firepower to targets, the time delay involved between target acquisition and firing data unit, the time a target remains in one location, and the individual kill probabilities for the weapon employed against each target class.

No further data provided.

TRANSPORATION WORKLOADS

1. DEFINITION. Measures that indicate the level of resources which must be utilized to satisfy the demands of combat. The measures are derived from the average lead experienced, peak load experienced, transportation network throughput, and queue buildups experienced.

No further data provided.

VOICE INTELLIGIBILITY THRESHOLD

1. DEFINITION. Intelligibility threshold is the maximum jamming intensity that a communications system can experience and still achieve transfer of usable information.

No further data provided.

PART II C

Ability to establish and carry tracks.

AI radar transmission duration.

Correlation of data.

Continuous tracking time.

Conversion accuracy.

Conversion geometry.

Conversion probability.

Cross sector data correlation.

Dead reckoning accuracy.

Delay from assignment to intercept conversion.

Delay from first report to established track.

False target reports.

Intercept completion ratio.

Maximum number of interceptors in final phase.

Number of locations reports where actually located outside CEP.

Number of messages intercepted.

Number of messages sent.

Number of transmission gisted.

Number of transmissions that should have been gisted.

Observations on the accuracy of gists.

Observed problems in providing gists of recorded transmissions.

Observed problems in providing transcripts of recorded transmissions.

Penetration depth.

Penetrator/interceptor life plots.

Probability of an intercept.

Sensor/visual acquisition discrimination range.

Simultaneous interceptors under GCI control.

Strobe reporting accuracy.

Time from availability of all coordination for a report until report is available.

Time from initiation or intercept of the target transmission until gist is available for release from system.

Time from initiation or intercept of a transmission until a report is available for release from system.

Total jamming located within ten seconds of tasking.

Total nets operational by frequency.

Total number of essential report elements by type report.

Total number of essential report elements reported by type report.

Total number of essential report elements reported correctly by type report.

Total number of locations reported.

Total number of reports issued.

Total number of reports that should have been issued.

Total number of transmissions.

Total number of tube and rocket artillery transmissions.

Total number of tube and rocket artillery transmissions located and identified within two minutes of intercept.

Total number of transmissions located and within one minute of initiation.

Total simulated threat emitters.

Total targets assigned as a function of tasking.

Total targets correctly identified.

Total targets detected.

Total target engaged as a function of detection.

Total targets located.

Track accuracy versus number of tracks.

Vectoring error.

Vectoring error on missed intercepts.

Vectoring mode.

Vectoring time.

Weapon allocation delay.

FILM

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