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**RTO AGARDograph 300**
**Flight Test Technique Series – Volume 28**

**AG-300-V28**

# Electronic Warfare Test and Evaluation

(Essai et évaluation en matière
de guerre électronique)

This AGARDograph has been sponsored by the

Systems Concepts and Integration Panel.

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by

Mr. Martin Welch

Mr. Mike Pywell

# The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

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- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

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# AGARDograph Series 160 & 300

Soon after its founding in 1952, the Advisory Group for Aerospace Research and Development (AGARD) recognized the need for a comprehensive publication on Flight Test Techniques and the associated instrumentation. Under the direction of the Flight Test Panel (later the Flight Vehicle Integration Panel, or FVP) a Flight Test Manual was published in the years 1954 to 1956. This original manual was prepared as four volumes: 1. Performance, 2. Stability and Control, 3. Instrumentation Catalog, and 4. Instrumentation Systems.

As a result of the advances in the field of flight test instrumentation, the Flight Test Instrumentation Group was formed in 1968 to update Volumes 3 and 4 of the Flight Test Manual by publication of the Flight Test Instrumentation Series, AGARDograph 160. In its published volumes AGARDograph 160 has covered recent developments in flight test instrumentation.

In 1978, it was decided that further specialist monographs should be published covering aspects of Volumes 1 and 2 of the original Flight Test Manual, including the flight testing of aircraft systems. In March 1981, the Flight Test Techniques Group (FTTG) was established to carry out this task and to continue the task of producing volumes in the Flight Test Instrumentation Series. The monographs of this new series (with the exception of AG237 which was separately numbered) are being published as individually numbered volumes in AGARDograph 300. In 1993, the Flight Test Techniques Group was transformed into the Flight Test Editorial Committee (FTEC), thereby better reflecting its actual status within AGARD. Fortunately, the work on volumes could continue without being affected by this change.

An Annex at the end of each volume in both the AGARDograph 160 and AGARDograph 300 series lists the volumes that have been published in the Flight Test Instrumentation Series (AG 160) and the Flight Test Techniques Series (AG 300) plus the volumes that were in preparation at that time.

# Electronic Warfare Test and Evaluation

## (RTO-AG-300-V28)

# Executive Summary

Control and exploitation of the electromagnetic spectrum has become as much a part of modern warfare as air superiority or dominance of the sea lanes. Electronic Warfare (EW) is the mission area responsible for establishing and maintaining a favourable position in the electromagnetic domain. Test and evaluation (T&E) of those devices used on modern military aircraft to prosecute this critical mission area requires the use of a wide range of test techniques and analytical methods to assure users of the readiness of EW systems to meet the challenges of the combat environment. Actual in-flight testing comprises a relatively small portion of the EW T&E process. As a result, the reader will find that the concentration in this handbook is far broader than 'flight test' – ranging from laboratory efforts to establish the system performance baseline through complex ground-based simulations and finally the limited verification accomplished in the open air range environment.

This handbook is intended as an introductory text dedicated to EW systems T&E. While other volumes in the Flight Test Techniques Series have provided limited coverage of EW system testing, they have been generally aimed at a broad view of T&E and have not resulted in a singular focused handbook on EW test techniques.

While the primary goal of this handbook is to introduce the novice to a disciplined approach to EW testing, it will also serve more experienced testers and programme managers as a concise reference for the EW test process and test resources. It begins with an overview of the test process in the context of the roles and missions expected of EW systems. Subsequent chapters provide examples of test requirements for major categories of EW systems. The final chapters focus on descriptions of specific types of test resources and how they can be linked to simulate predicted operational conditions. A catalogue of some useful EW Test Facilities is included in an annex to this handbook.

The original version of the handbook has been updated to include additional details with previous treatments while introducing new material and greatly expanding the use of figures as an aid to understanding. New material includes discussions about the T&E of infrared countermeasures systems, radio frequency towed decoy systems, low observable systems, and directed energy weapons (High-Power Microwave [HPM] and High-Energy Lasers [HEL]). The chapters addressing T&E resources, modelling and simulation, and lessons learned have been updated to account for advances in the last decade. The annex providing a sample of the member Nations' EW T&E facilities has also been updated.

# Essai et évaluation en matière de guerre électronique

## (RTO-AG-300-V28)

# Synthèse

Le contrôle et l'exploitation du spectre électromagnétique sont devenus une composante à part entière de la guerre moderne, au même titre que la supériorité aérienne ou la maîtrise des couloirs maritimes. La guerre électronique (GE) constitue le champ de mission responsable de l'établissement et du maintien d'une position favorable dans le domaine de l'électromagnétique. L'essai et l'évaluation (E&E) des appareils utilisés à bord des avions militaires modernes pour mettre en œuvre ce champ de mission critique nécessitent une large batterie de techniques d'essai et de méthodes d'analyse, ce afin de garantir aux utilisateurs un niveau de préparation des systèmes de GE qui répondent aux défis de l'environnement de combat. Les essais en vol réel ne représentent qu'une part relativement faible du procédé d'E&E de GE. En conséquence, comme pourra le constater le lecteur, les sujets de ce manuel s'étendent au-delà de « l'essai en vol », allant des activités en laboratoire visant à établir la référence de performance du système jusqu'à la vérification limitée obtenue dans un environnement aérien ouvert en passant par des simulations au sol complexes.

Ce manuel fait office d'introduction aux E&E des systèmes de GE. Tandis que d'autres volumes de la série des Techniques d'essais en vol ont apporté des informations limitées sur les essais des systèmes de GE, ils étaient généralement destinés à fournir un large aperçu des E&E et n'ont pas abouti à l'élaboration d'un manuel unique axé sur les techniques d'essai de GE.

Bien que ce manuel ait pour principal objectif de présenter au novice une approche disciplinée des essais de GE, il est également utile aux contrôleurs des essais et directeurs de programme en tant qu'objet concis de référence pour le procédé d'essai de GE et les ressources d'essai. Il s'ouvre sur une présentation d'ensemble du procédé d'essai dans le contexte des rôles et missions escomptés des systèmes de GE. Les chapitres qui suivent offrent des exemples d'impératifs d'essais pour les grandes catégories de systèmes de GE. Les derniers chapitres portent essentiellement sur des descriptions de types spécifiques de ressources d'essai et sur la manière dont on peut les associer pour simuler des conditions opérationnelles prédites. Un catalogue non exhaustif de Centres d'essai de GE utiles est inclus en annexe de ce manuel.

La version d'origine de ce manuel a été mise à jour pour apporter des détails supplémentaires à des traitements antérieurs, tout en présentant de nouveaux supports et en exploitant plus largement les données chiffrées afin de faciliter la compréhension. Les nouveaux supports incluent des discussions relatives aux E&E des systèmes de contre-mesures infrarouges, systèmes de leurre à radiofréquences remorqué, systèmes furtifs et armes à énergie dirigée (hyperfréquences à grande puissance [HPM] et laser à énergie élevée [HEL]). Les chapitres traitant des ressources d'E&E, de la modélisation et de la simulation, ainsi que de l'expérience acquise, ont été mis à jour pour tenir compte des avancées des dix dernières années. L'annexe proposant un échantillon des centres d'E&E de GE des Etats membres a également été mise à jour.

# Acknowledgements

The authors of this update acknowledge the stalwart efforts of the editors, H. Banks and R. McQuillan, and the many contributors to the original version of this Handbook. That version has already stood the test of time, having been a useful and widely available reference work for more than a decade for those active in the field of EW T&E – engineers, managers, researchers, academics and those new to EW. The original version has formed an excellent and solid basis for this update, with some sections requiring only minor amendments – indeed a testament to the knowledge and wisdom of the original authors.

Acknowledgement is given to contributors to this update, especially the agencies and companies who have kindly provided the photographs that the co-authors hope will make this update more informative than its predecessor. The authors are grateful for the guidance and assistance of Mr. Carter Wilkinson, FT3 Champion for SCI-203, and for the FT3 Group's comments on the drafts of the update, especially those of Mr. Bertil Gustavsson (Swedish FMV: Test & Evaluation's Chief Flight Test Engineer). Thanks also go to the following, whose assistance has helped the co-authors during this three-year SCI-203 tasking: Mr. Mitch Midgley-Davies (EW Test Facility), Mrs. Alison Heminsley (Head of M&S), Mr. Tony Shields (Systems Test Department) and Mr. Ian MacDiarmid (Head of Electromagnetics), all of BAE SYSTEMS – Military Air and Information. Thanks for input also go to Mr. Gordon Slater (Slater Aerosystems Ltd.).

The authors would also like to thank Mr. Steve Ruthven, Ms. Theresa Pham, Mr. Mario Dorado, and Mr. David Krohman of the 412th EW Group for their thorough review of the document and helpful suggestions. Mr. Lyndell Brown's (Tybrin Corporation) expertise and contribution to the High-Power Microwave and High Energy Lasers section was invaluable and is greatly appreciated. The technical editing support provided by Ms. Terressa Schmitz (JT3 Corporation) and Ms. Carolyn Rogers (JT3 Corporation) of the 412th Test Wing was also extremely helpful and is greatly appreciated.

The authors also acknowledge permission to use some material from prior publications by M. Pywell: the Institution of Engineering and Technology, Wiley & Sons (Encyclopedia of Aerospace Engineering) and the Royal Aeronautical Society.

Finally, the co-authors would like to thank their agencies, the U.S. Air Force Flight Test Center and BAE Systems (Military Air and Information), for support during the SCI-203 task to update this Handbook.

# Foreword

While other volumes in the Flight Test Techniques Series have provided limited coverage of Electronic Warfare (EW) system testing, they have been generally aimed at a broad view of test and evaluation (T&E) and have not resulted in a singular, focused handbook on EW test techniques. This volume has as its sole focus the processes, techniques, facilities, and goals of T&E of modern EW systems. Much of the world of EW remains shrouded in secrecy, and detailed descriptions of some test resources, test results, and EW techniques cannot be presented herein. However, this volume can fulfil its desired goal of serving as a comprehensive introduction to the practice of EW test.

The first chapter provides a historical perspective of EW system development, an overview of EW systems, and basic motivations for T&E. The reader will quickly realise that the development and eventual qualification of EW systems is heavily reliant on the use of ground-based T&E resources. Since EW system performance is substantially scenario-dependent, much of the testing must be accomplished in a combat-representative electromagnetic environment. These high density and wildly dynamic conditions can only be offered to the tester through the application of complex models, simulations, and analytical processes.

Chapters 2, 3, and 4 of this handbook examine the motivation for testing each of the three primary classes of EW systems: EW Support Systems, Electronic Attack Systems, and Electronic Protect Systems. The characteristics of each type of system are discussed and examples of test objectives, measures of performance (MOPs) (a more detailed discussion of MOPs has been included as Annex B), and test resource utilisation are discussed. Chapter 5 introduces architectural considerations for EW Systems and discusses how various architectures may affect the test approach.

The EW Test Process, defined in Chapter 1, is based on an organised application of test resources including measurement facilities, models, simulations, hardware-in-the-loop facilities, installed system test facilities, and open air ranges. Chapter 6 describes the EW T&E resource types in detail, while Chapter 7 covers the important topic of modelling and simulation and threat simulation. EW T&E mission execution is complex and expensive and Chapter 8 describes the essential elements of EW flight test planning, execution and operations. Finally, some lessons learned in the T&E of EW systems have been collected in Chapter 9. While the specific issues depicted by these anecdotes may not be present in some future test programme, the general nature of the lessons may be useful in avoiding costly, time-consuming and often preventable problems.

This handbook also includes five Annexes. Annex A is a catalogue of some NATO EW Test Facilities. Annex B provides an enhanced discussion of MOPs and related test considerations. Annex C shows the derivation of the jam-to-signal ratio for two important cases. Annex D provides a Glossary and Annex E lists previous 160 and 300 series AGARDograph publications.

Overall, this handbook will help the novice EW tester become familiar with the major elements of EW T&E. More experienced testers will find the handbook to be a helpful reference source with a concise description of both test processes and test resources throughout the U.S. and Europe. For those individuals with broader responsibilities in the acquisition, operations, or sustainment of EW systems, this volume will be a useful introduction to the potential for gaining in-depth understanding of EW system functionality and performance through the disciplined application of the EW test process.

# Preface

Mr. Martin Welch is a technical expert for 412th Electronic Warfare Group at the U.S. Air Force Flight Test Center, at Edwards AFB, California. He has been involved in the T&E of avionics, EW systems, and aircraft survivability technologies for 27 years. Since 2001, he has also served as the Director of the 412th EW Group's EW T&E University where he has played an instrumental role in educating the next generation of EW T&E professionals. He has been involved with the T&E of numerous radio frequency and infrared countermeasures systems as well as low observable and aircraft survivability technologies on a variety of platforms including the MC-130H Combat Talon II, AC-130U gunship, F-16, B-2A, and the F-117A.

Mr. Welch received Bachelor of Science degrees in Aerospace and Mechanical Engineering from Tri-State University in Angola, Indiana and a Master of Science degree in Electrical Engineering from the U.S. Naval Postgraduate School in Monterey, CA. Mr. Welch is also a graduate (by correspondence) of the USAF Air Command and Staff College and the Air War College.

Mr. Mike Pywell is an EW Technologist in the Electromagnetic Engineering Department at BAE Systems – Military Air and Information Division, U.K. He has been involved in T&E of avionics, EW systems, and survivability technologies for 37 years, and is an internationally recognised expert on RF threat simulators. For seven years he was also the Unit's RF and Laser Safety Officer, and for 11 years was also the division's EW Technology Programme Manager. He has been involved with T&E of Defensive Aids and RF communications systems on a number of platform types, and has an extensive background in electromagnetic interference and compatibility. He was a key player in the design of the company's aircraft-sized EW Test Facility and, more recently, led the multi-£M project to update its instrumentation.

For over 13 years he has represented the U.K. and his company on various NATO activities, including NATO Research and Technology Organisation (RTO) Studies SAS-011 (*Requirements and Options for Future NATO EW Capabilities*) and SAS-064 (*Update of Requirements and Options for Future NATO Airborne EW Capabilities*), and NATO Industrial Advisory Group (NIAG) Study Groups SG-66 (*Future Electronic Support System – Digital Solutions*), SG-79 (*Emitter Location and Data Links to facilitate Suppression of Enemy Air Defence*), and SG-105 (*Self-Protection interoperability (Flare/Chaff) for Aircraft and UAVs*). He has written several peer-reviewed journal and conference papers on Survivability and EW topics, and in 2007 won a Written Paper Prize (Silver Award) from the U.K.'s Royal Aeronautical Society. In 2010, he had two invited chapters published in the Encyclopedia of Aerospace Engineering: '*Electronic Warfare and Defensive Aids Systems Design and Development*' and '*Design Aspects of Aircraft Vulnerability*'.

Mr. Pywell received a Bachelor of Science degree in Electrical and Electronic Engineering from Coventry University and a Master of Philosophy degree from the University of Central Lancashire, where he has been a Senior Visiting Research Fellow since 2004. He is a Chartered Engineer and a Fellow of the Institution of Engineering and Technology.

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# List of Acronyms and Symbols

| | |
|---|---|
| 1-v-1 | 1-versus-1 |
| | |
| a.k.a. | also known as |
| AAA | Anti-Aircraft Artillery |
| AAP | Allied Administrative Publication |
| AATF | Aircraft Anechoic Test Facility |
| ABL | Airborne Laser |
| ABSTIRRS | Airborne Staring Infrared Radiometric System |
| ACETEF | Air Combat Environment Test & Evaluation Facility |
| ACMI | Air Combat Maneuvering Instrumentation |
| ADC | Analogue-to-Digital Converter |
| Ae | Effective Aperture |
| AFB | Air Force Base |
| AGARD | Advisory Group for Aerospace Research and Development |
| AGL | Above Ground Level |
| AI | Airborne Interceptor / Avionic Integration |
| AIDEWS | Advanced Integrated Defensive Electronics System |
| AM | Amplitude Modulation |
| AMES | Advanced Multiple Emitter Simulator |
| AMIRS | Advanced Millimeter Wave Imaging System |
| Amp | Amplitude, Amplifier |
| AoA, AOA | Angle-of-Arrival, Analysis of Alternatives |
| ARM | Anti-Radiation Missiles |
| ASC | Anechoic Shielded Chamber |
| ASE | Aircraft Survivability Equipment |
| ASIL | Advanced System Integration Laboratory |
| ASIMS | Airborne Spectral Infrared Measurement System |
| ASTE | Advanced Strategic and Tactical Expendables |
| ATIMS III | Airborne Turret IR Measurement System III |
| ATIRCM | Advanced Threat Infrared Countermeasures System |
| AVGPO | Anti-Velocity Gate Pull Off |
| AWSEM | Airborne Weapon System Engagement Model |
| | |
| BAF | Benefield Anechoic Facility |
| BC | Bus Controller |
| BE | Boundary Element |
| BEM | Boundary Element Method |
| BIT | Built-In Test |
| | |
| © | Copyrighted |
| C&D | Controls and Displays |
| C3I | Command, Control, Communication, and Intelligence |
| CAD | Computer-Aided Design |
| CCM | Center for Countermeasures |
| CCTV | Closed Circuit Television |
| CCU | Cockpit Control Unit |
| CE | Conducted Emissions |
| CEESIM | Combat Electromagnetic Environment Simulator |
| CEM | Computational EM Modelling |

| | |
|---|---|
| CHAMP | Composite Hard-body And Missile Plume |
| CIGARS | Calibrated Infrared Ground/Airborne Radiometric System |
| Cm | Centimeter |
| CM | Countermeasures |
| CMDS | Countermeasures Systems |
| CNI | Communication, Navigation, Identification |
| COI | Critical Operational Issues |
| COMINT | Communications Intelligence |
| COMSEC | Communications Security |
| CONOPS | Concepts Of Operation |
| CONSCAN | Conical Scan |
| CROSSBOW | Construction of a Radar to Operationally Simulate Signals Believed to Originate Worldwide |
| CRT | Cathode Ray Tube |
| CS | Conducted Susceptibility |
| CTP | Critical Technical Parameter |
| CW | Continuous Wave |
| | |
| D&D | Design and Development |
| DAP | Data Analysis Plan |
| DAS | Defensive Aids Suite/System |
| dB | decibel |
| dBm | decibel (referenced to a milliWatt) |
| dBW | decibel (referenced to a Watt) |
| DE | Directed Energy |
| Deg | Degrees |
| DEWSIM | Directed Energy Weapons Simulator |
| DF | Direction Finding |
| DIADS | Digital Integrated Air Defence System |
| DIRCM | Directed Infrared Countermeasures |
| DOA | Direction Of Arrival |
| DoD | Department of Defense |
| DRFM | Digital RF Memory |
| DRG | Defence Research Group |
| DSM | Digital Signal Model |
| DSTL | Defence Science and Technology Laboratory |
| DT&E | Developmental Test and Evaluation |
| | |
| E3 | Electromagnetic Environmental Effects |
| EA | Electronic Attack |
| EC | Electronic Combat |
| ECCM | Electronic Counter Countermeasures |
| ECM | Electronic Countermeasures |
| ECR | Electronic Combat Range |
| ECSEL | EC Systems Evaluation Laboratory |
| ELINT | Electronic Intelligence |
| ELS | Emitter Locating System |
| EM | Electromagnetic |
| EMC | Electromagnetic Compatibility |
| EMCON | Emission Control |
| EMH | Electromagnetic Hazards |
| EMI | Electromagnetic Interference |
| EMMLS | Eglin Mobile Missile Launcher System |

| | |
|---|---|
| EMP | Electromagnetic Pulse |
| EO | Electro-Optical |
| EP | Electronic Protection |
| ERP | Effective Radiated Power |
| ES | EW Support |
| ESD | Electro-Static Discharge |
| ESM | Electronic Support Measures |
| EW | Electronic Warfare |
| EWC | Electronic Warfare Chamber |
| EWCC | Electronic Warfare Coordination Cell |
| EWS | EW Support |
| EWsT | EW Simulation Technology |
| EWTF | EW Test Facility |
| EXCM | Expendable Countermeasures |
| | |
| F | Fahrenheit |
| FCR | Fire Control Radar |
| FDTD | Finite Difference Time Domain |
| FEM | Finite Elements Model |
| FLIR | Forward Looking Infrared |
| FMM | Fast Multi-Pole Method |
| FOTD | Fibre Optic Towed Decoys |
| ft | Feet |
| FTEC | Flight Test Editorial Committee |
| FTTG | Flight Test Techniques Group |
| FVP | Flight Vehicle integration Panel |
| | |
| G | Gain |
| GCI | Ground Controlled Intercept |
| GHz | Gigahertz |
| $G_J$ | Antenna Gain (Jammer) |
| GO | Geometrical Optical |
| GPS | Global Positioning System |
| $G_R$ | Antenna Gain (Radar) |
| $G_{R\text{-}SL}$ | Antenna Gain (Radar Sidelobe) |
| GSE | Ground Support Equipment |
| GTD/UTD | General and Uniform Theory of Diffraction |
| GWEF | Guided Weapons Evaluation Facility |
| | |
| HARM | High-Speed Anti-Radiation Missile |
| HEL | High Energy Laser |
| HEMP | High-Altitude Electromagnetic Pulse |
| HF | Hostile Fire |
| HIRF, HiRF | High Intensity Radiated Field |
| HITL | Hardware-In-The-Loop |
| HLA | High Level Architecture |
| HPM | High-Powered Microwave |
| HPRF | High Pulse Repetition Frequency |
| HUD | Head Up Display |
| | |
| IADS | Integrated Air Defence System |
| IC | Integrated Circuit |
| IEEE | [US] Institute of Electrical and Electronics Engineers |

| | |
|---|---|
| IF | Intermediate Frequency |
| IFAST | Integration Facility for Avionic Systems Testing |
| IFM | Instantaneous Frequency Measurement |
| IR | Infrared |
| IRCM | Infrared Countermeasures |
| ISAR | Inverse Synthetic Aperture Radar |
| ISTAR | Intelligence Surveillance Targeting And Reconnaissance |
| ISTF | Installed System Test Facilities |
| | |
| J/S | Jamming-to-Signal ratio |
| JEWCS | [NATO] Joint EW Core Staff |
| JMITS | Joint Mobile Infrared Countermeasures Test System |
| J-PRIMES | Joint-Prefight Integration of Munitions and Electronic Systems |
| JSF | Joint Strike Fighter |
| JTE | Joint Threat Emitter |
| | |
| kHz | Kilohertz |
| kW | Kilowatt |
| | |
| L | Loss |
| LAIRCM | Large Aircraft IR Countermeasures |
| LEPO | Large Element Physical Optics |
| LLSC | Low Level Swept Characterisation |
| LO | Low Observable |
| LPF | Low Pass Filter |
| LPRF | Low Pulse Repetition Frequency |
| LRU | Line Replaceable Unit |
| LWIR | Long Wavelength IR |
| LWS | Laser Warning System |
| | |
| m | Meter |
| M&S | Modelling and Simulation |
| MALD | Miniature Air-Launched Decoy |
| MANPADS | Man-Portable Air Defence Systems |
| MAW | Missile Approach Warners |
| MC | NATO Military Committee |
| MC | Mission Computer |
| MDF | Mission Data Files |
| MDS | Minimum Discernable Signal |
| MERAJS | Millimeter Wave Emitters, Radars, and Jamming System |
| MF | Measurement Facilities |
| MFD | Multi-Function Display |
| MFS | Manned Flight Simulation |
| MG | Missile Guidance |
| MHz | Megahertz |
| MIJA | Mobile Intercept Jamming Assets |
| MLAW | Missile Launch and Approach Warners |
| MLFMM | Multi-Level Fast Multiple Method |
| MMI | Man-Machine Interfaces |
| MMW | Millimeter Wave |
| MNF | Multi-National Force |
| MoD | Ministry of Defence |
| MOE | Measures Of Effectiveness |

| | |
|---|---|
| MoM | Method of Moments |
| MOP | Measures Of Performance |
| MOS | Measures Of Suitability |
| MPRF | Medium Pulse Repetition Frequency |
| MROCS | Millimeter Wave Obscurant Characterization System |
| MRV | Mini-Radar Van |
| MS&SE | Modelling, Simulation and Synthetic Environments |
| MWIR | Mid-Wavelength IR |
| MWS | Missile Warning System |
| | |
| NATO | North Atlantic Treaty Organization |
| NEDB | NATO Emitter Database |
| NEWVAN | NATO EW Van |
| NIAG | NATO Industrial Advisory Group |
| NMSG | NATO Modelling and Simulation Group |
| NRL | Navy Research Laboratory |
| NSRL | NATO Simulation Resource Library |
| | |
| OAR | Open Air Range |
| OCC | Operations Control Center |
| OE | Operational Effectiveness |
| OFP | Operational Flight Program |
| OPSEC | Operational Security |
| OS | Operational Suitability |
| OT | Operational Test |
| OT&E | Operational Test and Evaluation |
| | |
| PC | Personal Computer |
| PDW | Pulse Descriptor Word |
| $P_e$ | Probability of Effect |
| PID | Program Introduction Document |
| $P_J$ | Jammer Transmitter Power |
| $P_k$ | Probability of kill |
| PO | Physical Optical |
| PPI | Plan Position Indicator |
| $P_R$ | Radar Transmitter Power |
| PRF | Pulse Repetition Frequency |
| PRI | Pulse Repetition Intervals |
| PSI | Platform Systems Integrator |
| PSSSEF | Portable Seeker/Sensor/Signature Evaluation Facility |
| PTC | Planned Test Condition |
| PTD | Physical Theory of Diffraction |
| PW | Pulse Width |
| | |
| R | Range |
| R&D | Research and Development |
| RAM | Radar Absorbent Material |
| RCIED | Radio-Controlled Improvised Explosive Device |
| RCS | Radar Cross Section |
| RE | Radiated Emissions |
| RF | Radio/Radar Frequency |
| RFCM | RF Countermeasures System |
| RiL | Reduction in Lethality |

| | |
|---|---|
| RiS | Reduction in Shot Opportunities |
| RISS | Real-time IR Scene Simulator |
| RMS | Root Mean Squared |
| ROE | Rules Of Engagement |
| RS | Radiated Susceptibility |
| RTA | Research and Technology Agency |
| RTB | Research and Technology Board |
| RTCHAMP | Real Time Composite Hard-body And Missile Plume |
| RTO | Research and Technology Organisation |
| RWR | Radar Warning Receiver |
| | |
| SAD | Short-Range Air Defence Site Simulator |
| SAM | Surface-to-Air Missile |
| SAR | Synthetic Aperture Radar |
| SBR | Shooting Bouncing Ray |
| SCR | Shielded Control Room |
| SE | Survivability Equipment |
| Sec | Seconds |
| SI | System Integration |
| SIGINT | Signals Intelligence |
| SIL | Systems Integration Laboratory |
| SMA | Sub-Miniature A |
| SMS | Signal Measurement System |
| SOC | Statement of Capability |
| SOJ | Stand-Off Jamming, Jammer |
| SPIRTS | Spectral and In-band Radiometric Imaging of Targets and Scenes |
| SPJ | Self-Protection Jamming, Jammer |
| SS | Sub-System |
| SSA | Solid State Amplifier |
| SSL | Solid-State Lasers |
| STANAG | [NATO] STANdardisation AGreement |
| STEF | Seeker Test & Evaluation Facility |
| STIRRS | Staring Infrared Radiometric System |
| STV | Seeker Test Van |
| SUT | System Under Test |
| | |
| T&E | Test and Evaluation |
| TC | Test Conductor |
| TD | Test Director |
| TEL | Transporter-Erector-Launcher |
| TGP | Targeting Pod |
| TIGER | Threat IR Generic Emulation Radiometer |
| TLM | Transmission Line Method |
| TM | Telemetry |
| TRACSVAN (TV) | Transportable Radar and Communications Jamming and Simulation Vans TV |
| TSPI | Time-Space-Positioning Information |
| TT | Target Tracking [radar] |
| TTI | Time To Impact |
| TWS | Track While Scan |
| TWTA | Travelling Wave Tube Amplifier |
| | |
| U.K. | United Kingdom |
| U.S. | United States |

| | |
|---|---|
| UAS | Unmanned Aerospace/Autonomous System |
| UAV | Unmanned Aerospace Vehicle |
| UCAS, UCAV | Unmanned Combat Air/Autonomous System/Vehicle |
| USA | United States of America |
| USAF | United States Air Force |
| UTD | Uniform Theory of Diffraction |
| UV | Ultraviolet |
| | |
| V&V | Verification and Validation |
| VGPO | Velocity Gate Pull-Off |
| VV&A | Verification, Validation and Accreditation |
| | |
| WPNS | Weapons |
| WRA | Weapon Replacement Assembly |
| | |
| σ | Radar cross-section |

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Threat simulation

**14. Abstract**

Electronic Warfare (EW) Test and Evaluation (T&E) is a complex and expensive undertaking. Practitioners must understand the subject matter to efficiently apply available test resources and cost effectively meet their test objectives. This revised EW T&E handbook provides an overview of various types of EW systems and basic test methodologies. It also describes various test resources and discusses their associated strengths and limitations. Some typical problems are identified and discussed in a Learning from Experience section. A brief overview of some test resources and facilities across NATO and Partnership for Peace countries are provided along with points of contact to aid potential customers.

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