

## Training Course Information:

# Introduction to Radar Electronic Warfare (ATEP 03)

24 Jan. - 28 Jan. 2016

### COURSE AIMS

This course aims to impart an appreciation of the capabilities, techniques and tactics of modern military radar electronic warfare equipment. It provides a basic level of analysis between the operational parameters of radar electronic warfare equipment and its effect on a victim radar and of the techniques which a radar may employ to preserve its operation in the presence of the efforts of electronic warfare equipment deployed against it.

### PRE-REQUISITES

Students should have successfully completed the "Introduction to Radar" short course, or its equivalent. This course assumes no prior knowledge of the subject matter, however, it is recommended that students have a background in maths, science or engineering. Students should be competent in high-school level mathematics

### COURSE DELIVERY

This course is delivered primarily as a series of lectures which are supported by presentations. Attendees will receive a hard copy of the presentation slides and an electronic copy (PDF) of the presentations. Ample time is also allowed for students to ask questions of the lecturer. The taught material is reinforced by a series of tutorials in which problems are set and discussed. The lecturer will present worked solutions to the problems. A live demonstration of noise jamming of a simple, short range surveillance radar is conducted within the classroom.

The course provides concentrated and wide-ranging coverage of radar electronic warfare; it moves quickly and is suited for those who need an overview of the subject. It is technically demanding and requires a high degree of student motivation.

### WHO SHOULD ATTEND

- Military technicians,
- Engineering officers new to the subject of radar electronic warfare,
- Defence personal involved in the procurement or specification of radar electronic warfare systems,
- Radar electronic warfare users and operators,
- Defence industry technicians and graduate engineers,
- Engineering management requiring an appreciation of radar electronic warfare,
- Graduate students in mathematics, science or engineering subjects.

## LEARNING OBJECTIVES

Upon successful completion of this course, the student will be able to:

- Define electronic warfare (EW) and describe the activities which comprise it,
- Describe EW protection scenarios,
- Appreciate the threat from different types of guided weapons and the various stages of an engagement during which EW action is possible,
- Explain methods of determining the direction of arrival of a jamming signal, their typical accuracies and the antenna configurations necessary to support each method,
- Describe techniques to minimise jamming via radar sidelobes,
- Describe and compare the performances and applications the structure of various receiver types which may be used for signal intercept,
- Describe techniques which a radar might employ to reduce the probability that its emissions may be intercepted whilst maintaining adequate radar detection performance,
- Describe and compare various forms of noise jamming and the effects they have on a victim radar,
- Analyse the ranges at which noise jamming is effective and, in particular, calculate the burn-through range,
- Describe techniques a radar may employ to defend itself against noise jamming via its side lobes,
- Describe repeater and transponder techniques to inject false targets into a victim radar and the techniques by which the range and velocity of false targets may be generated,
- Sketch a block diagram of a digital radio frequency memory (DRFM) based jammer and explain its operation,
- Describe how a DRFM may mimic target radar cross section, range and velocity,
- Explain DRFM design considerations,
- Describe the techniques of range gate pull-off and pull-in and how a victim radar may be alerted to these counter-measures,
- Describe the techniques of velocity gate pull-off and pull-in and how a victim radar may be alerted to these counter-measures,
- Describe the techniques for producing angle tracking errors in a victim radar and which radar types may be most susceptible to the various counter-measures and how a victim radar may defend itself against these counter-measures,
- Describe the structure of chaff and how it may be deployed for platform protection and the effects it has on a tracking radar,
- Describe the structure of corner-reflectors and how they may be deployed for platform protection and the effects they have on a tracking radar,
- Calculate the radar cross section required from passive decoys necessary for effective platform protection,
- Describe the deployment of active decoys and how they may be used for platform protection,
- Calculate the effective radiated power required from an active decoy necessary for effective platform protection,
- Appreciate the issues of coverage afforded by active and passive decoys and counter-measures aboard a platform in the defence of the platform,
- Appreciate the necessity for integration and coordination of EW systems and sensors on board a platform and, in particular, the difficulties of isolation which exist on airborne platforms.

## COURSE CONTENT

### Introduction to Radar Electronic Warfare (1 hr)

- The Electronic Warfare Family Tree
- Basic concepts of radar EW
- Definitions
- EW Protection Scenarios

### Evaluation of the Threat from Guided Weapons (2 hrs)

- The Electronic Warfare Family Tree
- Basic concepts of radar EW
- Direct / Indirect Threats
- Guidance Methods
- Short Range Air Defence, SAM Systems
- Long Range Air Defence, AWACS
- Air-to-Air
- Air-to-surface anti-tank
- Anti-ship missiles (ASM)

### Angle of Arrival Measurement (2 hrs)

- Spinning antenna
- Multi-port direction finding (DF)
- Monopulse DF
- Interferometric DF
- Receive Beamformers
- Adaptive Jammer/Sidelobe Cancellation and Null Steering

### Radar ESM Receivers (3 hrs)

- Classes of ESM Receivers: RWR, ESM, ELINT receivers
- Differences between Radar and ESM Receivers,
- Important Parameters (dynamic range, sensitivity, bandwidth).
- Superheterodyne Receiver,
- Scanned Superheterodyne Receiver,
- Channelised Superheterodyne Receiver,

- Instantaneous Frequency Measurement Receivers,
- Compressive Microscan Receivers,
- Acousto-Optical Bragg Cell Receivers

### Principles of Low Probability of Intercept (LPI) Radar (1 hr)

- Intercept & Radar Ranges,
- Processing gains of radar and intercept receiver,
- Low Probability of Intercept (LPI) waveforms,
- Power management techniques,
- Applications.

### Principles of RCS Reduction (Stealth) (2 hrs)

- EW benefits of RCS reduction,
- Detection range as a function of RCS,
- Factors influencing RCS and scintillation,
- RCS reduction using shaping,
- RCS reduction using radar absorbent materials
- RCS reduction using impedance loading,
- Relevance of surface detail, Doppler signature, cavities and screening,
- VHF band RCS & implications for radar detection.

### Noise Jamming (1 hr)

- Principles of noise jamming,
- Radar response to noise jamming, jamming spokes,
- Main beam, sidelobe jamming, inverse gain jamming,
- Barrage, spot and swept spot noise jammers,
- Range burn-through of jamming,

**There will be a live demonstration of noise jamming of a radar.**

### Sidelobe Cancellation and Guard Channels (defence against noise jammers) (1 hr)

- Sidelobe jamming, inverse sidelobe jamming
- Sidelobe blanking,
- Guard antennas
- Sidelobe cancellation, adaptive sidelobe cancellation

### Repeaters and Transponders (1 hr)

- False target generation
- Repeater jamming
- Transponders
- Falsifying range and velocity

### The Digital Radio Frequency Memory (DRFM) False Target Jammer (1 hr)

- DRFM architecture
- Sampling rate & bandwidth
- Digitisation sampling spurs
- Dynamic range and SNR
- Multiple signals
- RCS simulation
- Techniques generator
- Frequency offset methods
- Power amplification

### Electronic attack and Associated Electronic Defence of Tracking Radars (3 hrs)

- Range Gate Pull-Off and Pull-In
- Velocity Correlation and Guard Gates
- Monopulse Seekers and Issues of Angle Deception
- Crosseye for Angle Deception
- Ground Bounce
- Cooperative Measures Jamming

### Passive Decoys (1 hr)

- Chaff, narrowband, broadband
- Weight, bandwidth, RCS issues
- Illuminated chaff
- Retroreflectors
- Corner reflectors and their use in ship protection

### Active Decoys (1 hr)

- Active decoys, Power levels required for platform protection
- Deployment methods and coordination with other methods in ship protection
- Towed decoys for aircraft protection, power levels, tow line length.

### System Integration (1 hr)

- Coverage,
- Deployment of equipment on a strike aircraft,
- DAS controller,
- Interfaces and interoperability with other EM sensors,
- Sensor isolation, possible runaway problems,
- Future trends.

**Tutorials:** worked examples will be conducted and discussed in a series of tutorials.

**Demonstration:** a live demonstration of noise jamming against a short-range surveillance radar will be conducted.