

# update



## Terma Self-Protection for Royal Air Force Tornado GR4

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**TERMA<sup>®</sup>**

# Terma to Protect Royal Air Force Tornado GR4 Fighter Aircraft

**Terma has been awarded a contract by BAE Systems to provide Advanced Infrared Protection Systems for the Royal Air Force Tornado GR4 Fighter Aircraft.**

The Tornado GR4 is an advanced ground attack aircraft, capable of operating during all light and weather conditions and delivering a large array of conventional and precision guided munitions. It can also be equipped with an advanced reconnaissance system, contained in the RAPTOR pod.

For active self-defense the GR4 is equipped with two AIM-9L Sidewinder Missiles, and for self-protection it will now be equipped with Terma's advanced infrared protection system. This system is based on the Terma Modular Countermeasures Pod, MCP, that is operational on several other types of aircraft in the UK, the Netherlands

and Germany. The pod for the Tornado GR4 is a derivative of the MCP which accommodates missile warning sensors and flare dispensers for the high speeds and loadings connected with operating the Tornado GR4.

Since the flight time of an attacking infrared guided missile may be very short indeed, only a few seconds, it is essential that countermeasures action is taken automatically and without delay.

Terma's Electronic Warfare Management System, AN/ALQ-213(V), is well proven and ideally suited for this purpose. Not only does it ensure automatic and timely flare dispensing, it also ensures integration with other EW self-protection systems and with aircraft avionics, and it gives the pilot the necessary visual and audio warnings.

BAE Systems has been selected by the Royal Air Force to integrate the Terma

Infrared Protection System on the Tornado GR4. According to the contract, delivery will take place in the early spring of 2009.

The time between contract signature and delivery under this program is unusually short, the main reasons being:

- Implementation of the program is characterized by a very open and trustful atmosphere between the involved parties, the RAF, BAE Systems and Terma.

- Terma's experience of many years in designing EW self-protection solutions based on previously developed core EW components such as the AN/ALQ-213(V) EW Management System, the Tactical Data Unit, the Modular Countermeasures Pod, and the Advanced Countermeasures Dispensing System with magazines, sequencers and EMI filters.

# Terma Electronic Warfare Competence Support Center in the Netherlands

**Based on Terma Airborne Systems' more than 20 years of close relations and cooperation with the Royal Netherlands Air Force and the Dutch Aerospace Laboratory, NLR, Terma has decided to establish a European Electronic Warfare Competence Center in the Netherlands.**

Airborne electronic systems, such as electronic warfare equipment have a life span of many years, therefore requiring timely maintenance and upgrades to ensure reliable functionality and to meet evolving operational requirements.

Terma's support concept is therefore to be as close as possible to key customers

in order to reduce time and cost connected with maintenance and upgrades.

The first step in implementing this concept was taken in 2003, when Terma established a maintenance support center in Warner Robins, Georgia to support the large number

# Components for Tornado GR4 IR Protection



Electronic Warfare Management Unit, EWMU



Safety Switch/EMI Filter



Modular Countermeasures Pod (Sketch) for RAF Tornado GR4 with missile warning sensors and flare magazines. Modules can be rotated in 15 deg increments to obtain optimal firing direction.



Tactical Data Unit, TDU  
Data loading/unloading, recording



Digital Sequencer Switch for chaff  
& flare dispensing



Dispenser Assembly/Magazine

## EW COMPETENCE CENTER

of Terma EW systems in service with the US Air Force. This facility has since grown into a separate company, Terma North America Inc.

The Terma support facility in the Netherlands will be located at Logistics Center Woensdrecht in order to secure close coordination with the users and other maintenance facilities. The support center will be fully implemented in the spring of 2009. In the meantime, activities have been started up at the existing Terma BV

facility in Leiden and at the NLR facilities in Amsterdam.

In the longer term, the intention is that the Terma Woensdrecht Support Center will also serve the users of Terma systems in other European countries.

### Agreement with NLR

Terma considers it a great asset and a privilege to have entered into a cooperation agreement with NLR, signed in November of 2007. This agreement gives Terma access to NLR's wide range of competencies within

research, development, testing, validation, certification, and to NLR's facilities such as wind tunnels, simulators and research aircraft.

This cooperation with NLR and with Logistics Center Woensdrecht enables Terma to offer to international customers complete turnkey solutions, which can be in the form of direct sales or through cooperation with Terma North America, where sales can be channeled through the US Foreign Military Sales system.

# Terma Electronics Manufacturing Services in Leading International Programs

With participation in programs such as Galileo and Joint Strike Fighter, Terma has proved its ability to cope with challenges at the highest technological levels.

Terma has a tradition of many years of participating in international programs, notably the F-16, the Viggen, the AWACS and the SeaSparrow programs. With the added competencies from electronic warfare systems, power supplies, star trackers and x-band radar technology, Terma has a solid background for taking on even more challenging and sophisticated tasks within programs such as Galileo and Joint Strike Fighter.

## The Galileo Program

Galileo is the European Global Positioning System, intended to match and even surpass the US and Russian GPS systems. The aim is to have a European system under civilian



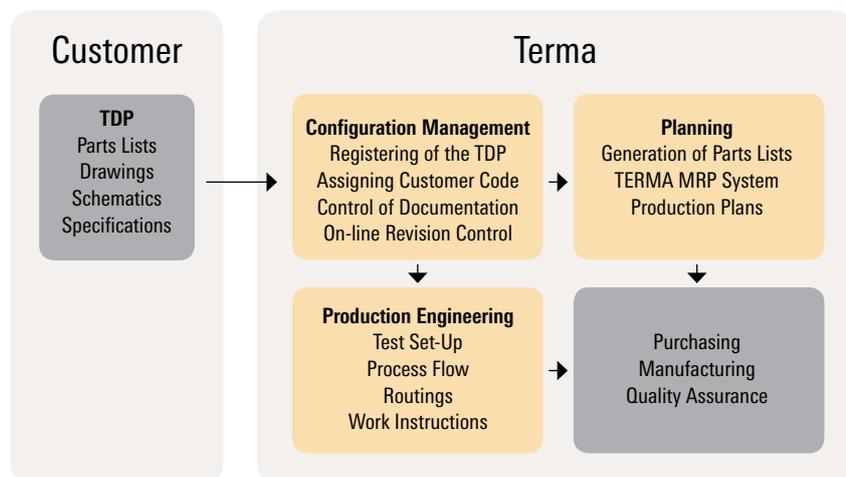
control, with greater accuracy and with better coverage of the European area than the US system can offer.

Galileo is a joint European Union/ European Space Agency (EU/ESA) project. The total cost is estimated to be well over EUR 3 billion and the system is expected to be ready for operational use by 2013.

Initially, Terma is to deliver power supplies to the satellites – an area

where Terma has vast experience from previous satellite programs. However, in order to meet the even more stringent quality requirements for the Galileo project, it has been necessary to establish new state-of-the-art facilities, including an upgraded clean room environment and increased surface mounted devices assembly capacity and capability.

As shown in this illustration, Terma's Electronics Manufacturing Services, EMS, focuses on products where formally documented quality assurance, program management and maturing of the product design are essential elements of the finished product.



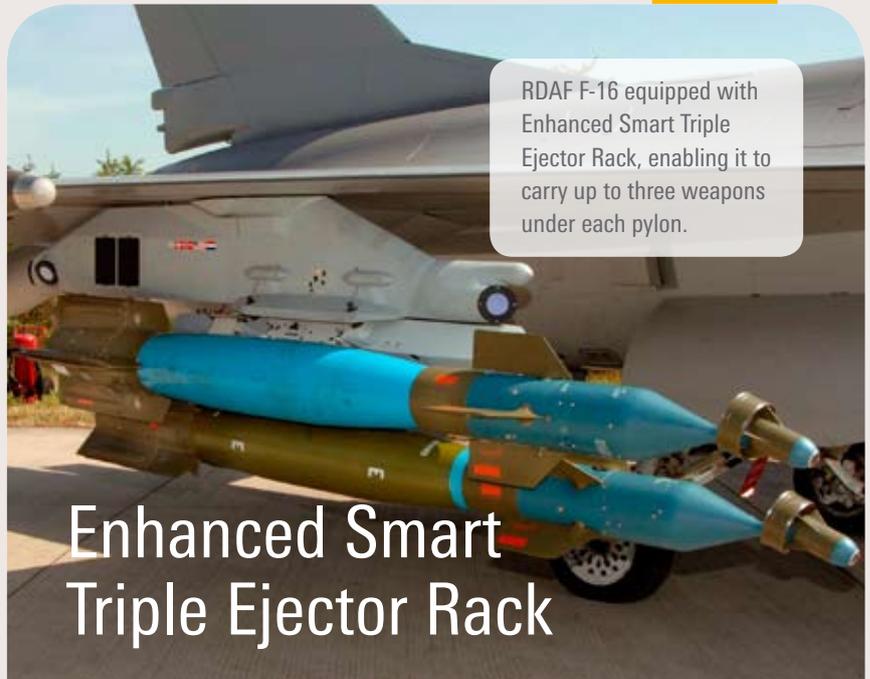
### The Joint Strike Fighter Program

It is still undecided which aircraft type will replace the F-16 for the Royal Danish Air Force. Even so, Denmark as a nation and Danish Industry, including Terma, are taking part in the development and initial production of this aircraft.

Terma has developed and produced structural parts for the Joint Strike Fighter for quite some time, and this has now been expanded to also comprise electronic components such as modules for the radar, advanced wiring harnesses and power supplies for the flaps and rudder actuators.

The Joint Strike Fighter and Galileo programs have made it possible for Terma to invest significantly in advanced electronics manufacturing processes, including advanced machinery, manufacturing technologies and IT support systems. These investments combined with the increased level of activity will result in a significant expansion of capacity and competencies.

All in all, this technological upgrade makes Terma well prepared for the future, for the benefit of the customers of Terma's Electronics Manufacturing Services.



## Enhanced Smart Triple Ejector Rack

**One multi-carriage rack for the weapons of yesterday, today, and tomorrow**

The Enhanced Smart Triple Ejector Rack, ESTER, jointly developed by Terma and EDO, constitutes a unique carrier for legacy Mk-82/-83 iron bombs, current J-class weapons including GBU-49 and JDAM, and next generation stores, such as the Small Diameter Bombs.

The basic requirement from the F-16 MLU community was a multiple carriage of J-class weapons using aircraft BRU-57 software. The Terma/EDO team decided to expand the capability of the ESTER beyond these basic requirements, and by applying their combined capabilities, the TER-9/A, above and beyond the BRU-57, has been developed.

The rack has only one hardware configuration which supports all three operation modes. These modes include:

- TER-9/A mode where the ESTER will operate identically to a TER-9/A carrying MK-82/-83 500 and 100 lbs iron bombs. The aircraft interface is identical to TER-9/A, and the

operator will not experience any changes from a TER-9/A

- BRU-57 mode where the ESTER will interface with the aircraft as a BRU-57. The aircraft only needs BRU-57 software which will support carriage of two or three J-class bombs, such as JDAM and GBU-49
- ESTER mode where all the capabilities are utilized. The rack will carry up to three J-class weapons or Small Diameter Bombs, SDB, in class I or class II Universal Armament Interface as well as Launch Acceptability Region, LAR, calculations.

For improved performance and reliability, the team has selected the Field Replaceable Connector System, FRCS, to replace the standard MIL type bomb interface connector on the J- and SDB-class bombs.

The team has secured contracts with two customers for provision of hardware and services, and the first lot of prototypes has been delivered.

Ground tests and initial flight tests were conducted successfully during the summer of 2007.

# Royal Danish Air Force Installs MWS on F-16s

In today's asymmetric warfare, the F-16s often operate from forward deployment bases that may themselves be safe, but the corridors for take-offs and landings may provide potential hidings for launching of shoulderborne infrared-seeking missiles which cannot be detected by the current F-16 equipment. Therefore, to protect crew and equipment, the Royal Danish Air Force has decided to install integrated Missile Warning Systems, MWS, on its F-16 aircraft.

## Missile Warning System Performance

It is essential that a missile attack is detected as soon as possible and that false alarms are kept to a minimum. For this purpose, the RDAF has selected the EADS AAR-60(V)2 MILDS-F. This system is a fighter version of the MILDS system of which more than 4,000 units have been ordered. It is an ultraviolet-based system, characterized by low false alarm rate and a broad operational envelope, up to 45,000 feet+.

## Weapons Pylon Installation

Three MWS sensors installed in each of the weapons pylons on stations 3 and 7 give a near-360 deg spherical coverage against missile attack, even with a full weapons load. A Terma-developed Countmeasures Signal Processor, CSP, correlates inputs from the sensors to avoid duplication of warning messages.

The MILDS(V)2 version includes ruggedizing and repackaging of the sensors to fit into the limited space of the F-16 pylon. The software has been updated with vastly improved processing speed. Advantages of the pylon installation are reduced aircraft downtime for modification, reduced cost because of minimum impact on the airframe, and the possibility of sharing modified pylons across the F-16 fleet.

## Operating the Missile Warning and Countermeasures System

The AAR-60(V)2 is integrated and controlled by Terma's AN/ALQ-213 Electronic Warfare Management System, EWMS, which receives the threat information. Based on the aircraft parameters, such as attitude, speed, altitude - and not least trial results - the EWMS selects the optimum flare



F-16 wing pylon showing position of missile warning sensors. With six sensors a near - 360 deg spherical coverage is achieved.

dispense program. Dispensing is automatic, initiated by MWS sensor signals. To facilitate countermeasures of new generation missiles, additional dispensers have been integrated in the weapons pylons. Up to four additional dispensers can be installed, resulting in 200 % additional capacity compared to a preblock 40 F-16.

**Reduced Reaction Time with 3-D Audio Warning**

Since the flight time for a missile may be as low as 3-7 seconds, immediate reaction is essential. Within this time frame countermeasures must be initiated, and the pilot must start evasive maneuvers. The pilot is warned against missile attack through a warning signal in his earphones from the direction of the attack. This enables him to initiate evasive maneuvering instinctively and without delay. This 3-D Audio Warning actually reduces reaction time by close to one second, corresponding to more than 50 %. At the same time, the threat warning appears on the Advanced Threat Display, ATD. The 3-D Audio System and the ATD are part of the Terma-developed ALQ-213 EW Management System. They are fully integrated with aircraft avionics system and the Joint Helmet Mounted Cueing System, JHMCS, in a manner that compensates for aircraft maneuvers and head movements. The ATD is an advanced full color, night vision goggle-compatible display that provides a total picture of the EW situation, including status of all on-board EW systems.

**Aircraft Audio Management System**

The 3-D Audio Warning System is also part of the Terma-developed Aircraft

The 3-D Audio system is fully compatible with the Joint Helmet Mounted Cueing System, JHMCS



**Audio Management System, AAMS.**

The following are examples of additional applications that increase the pilot's situational awareness and reduce his workload:

- In aircraft with two or more radios, each radio can receive from its own direction, thus making it possible for the pilot to distinguish between simultaneous transmissions.
- In a formation, a wingman can talk to his lead from his actual position, thus giving the lead an immediate clue to the wingman's position.
- In case of aircraft malfunction, the warning panel can 'speak' to the pilot, alerting him to the situation.

**Active Noise Reduction, ANR**

The noise level in an aircraft cockpit can be very high. Levels of up to 114 dB have been measured. This means stress on the crew and risk of developing hearing damage. As part of the AAMS Terma has introduced a high performance Active Noise Reduction

system, ANR, which significantly lowers the noise level perceived by the pilot. This eliminates the need for earplugs and allows for reduced volume of the intercom system. The result is reduced pilot fatigue and stress levels.

**F-16 MWS Integration Contract**

Terma received the integration contract from the RDAF in late 2004, and design and manufacturing are progressing as planned. The first phase of the program focused on data collection of the F-16 physical and operational environment. These data have been used for designing sensor hardware and software as well as pylon installation. The sensors have been installed to optimize coverage against the most likely attack directions. The first flight tests of the AAR-60(V)2 were performed in late 2007 and early 2008. The system is now being certified by the USAF Seek Eagle office. The complete system will then be operational and ready for the F-16 Midlife Update M5 software.

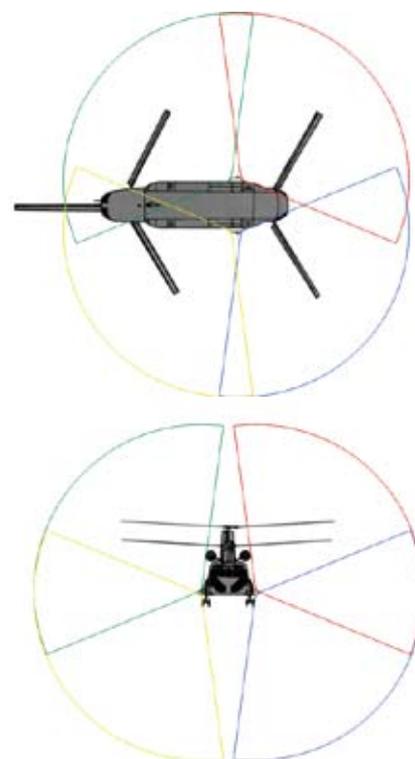


## New Modular Aircraft Survivability Equipment for the Royal Netherlands Air Force CH-47F Chinook Helicopters

Building on the experience from the AMASE program for the Dutch Apache helicopters, Terma and the Royal Netherlands Air Force have developed a similar solution for the new Chinook, CH-47F, soon to be delivered to the RNLAf. The system has been labeled CHASE for Chinook Aircraft Survivability Equipment.

The Dutch Defence Materiel Organisation, DMO, and Terma jointly decided on a pod solution for installation and integration of DIRCM, Directional Infrared Countermeasures, with a laser beam to divert attacking missiles. The DIRCM system is manufactured by Northrop Grumman.

Initial flight tests were carried out in July 2007, and final delivery will take place as an integrated part of Boeing's delivery of the new helicopters during 2008 and onwards. The illustration on the opposite page shows the initial mechanical integration of the CHASE pod on the CH-47D. It gives a good impression of the final pod solution.



Full 360 deg spherical coverage

## CHASE in detail:

The Chinook will carry two CHASE pods installed on each side of the helicopter. Each pod contains three missile warning sensors and one laser turret. The pods are mounted directly on the helicopter main frame to minimize dynamic in-flight impact, which could otherwise cause optical sensor distortion.

The six-sensor solution provides a 360 deg spherical coverage against missile attack as shown on the sketch to the left. The collocation of the sensors and the DIRCM in the same pod ensures easy mechanical integration, which is of utmost importance to the overall performance of the system with respect to the level of false alarms and

handover from one laser turret to the other. Installation of sensors elsewhere on the fuselage would have to deal with airframe twist, which on a CH-47 can be significant during extreme maneuvers – an effect which causes misalignment between the sensors and the DIRCM system, which again results in distortion of overall performance and an increasing number of false alarms.

From an overall view, operational, technical as well as economic, the CHASE solution provides the following advantages, similar to those of the AMASE solution:

- Minimum impact on aircraft modifications, and thus downtime for the upgrade

- Easy and cost-effective routes for future technical upgrades, such as active jammers
- Possibilities of sharing of CHASE units across the Chinook fleet rather than each helicopter being fully equipped.



Illustration showing the installation of the CHASE Pod which hosts all of the missile warning sensors and laser-based Directional Infrared Countermeasures, DIRCM.

To attain the required static and dynamic accuracy, the CHASE pods are mounted on both sides of the helicopter.

The sensors and DIRCM system, together with the ACMDS system, will be controlled by the ALQ-213A EW Management System installed as an integrated part of the CH-47 suite and cockpit.

## Terma Develops New Version of the ALQ-213

The ALQ-213, Electronic Warfare Management System, was originally developed in the early nineties. Over the past fifteen years, it has gone through a large number of upgrades and add-on's. Terma has therefore taken the natural next step, combining these improvements and additional units into a new version called AN/ALQ-213A(V) Defensive Aids Controller, DAC.

Like its predecessor, the ALQ-213A, DAC is a universal controller, that will integrate and control any combination of EW subsystems into any type of aircraft. The ALQ-213A combines the functionalities of the EW Management Unit, the Tactical Data Unit, the Programmable Interference Blanking Unit, and the Countermeasures Signals

Processor into one single unit that can be operated from Terma's Advanced Threat Display or from an existing Threat Display, MPD or MFD.

The ALQ-213A makes use of the latest novel and sophisticated technology, including additional processing power and memory capacity, inertial measurements, time and position,

provisions for special interfaces, and at the same time, significantly lower weight.

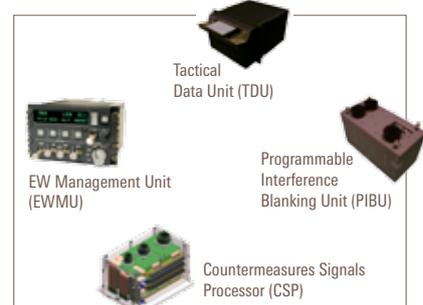
The launch customer for the ALQ-213A will be the Royal Netherlands Air Force for the new CH-47F Chinook helicopters, where it will control the entire EW suite including the Terma-developed Chinook Aircraft Survivability Equipment, CHASE (see article on page 8).



Advanced Threat Display+  
Controls for ALQ-213A



AN/ALQ-213A (V)



## New RSIP for AWACS Japan

Terma is awarded contracts to deliver major parts of the Radar System Improvement Program, RSIP, for the Japanese 767 AWACS fleet.

RSIP increases the radar sensitivity of the AWACS aircraft, allowing it to detect and track smaller targets. It also improves the radar's existing computer with a new high-reliability multi-processor and rewrites the software to facilitate future maintenance and enhancements.

The RSIP kit, built by Terma for Northrop Grumman Electronic Systems, Baltimore, MD, under a

subcontract to Boeing, consists of a new radar computer, a radar control maintenance panel, and upgrade of other electronic units.

The RSIP upgrades will improve E-767 surveillance capability by increasing the Pulse Doppler radar sensitivity and enables the aircraft to detect and track smaller targets. It also improves the radar's electronic countermeasures, human-machine interface, and reliability and maintainability.

RSIP kits built by Terma have been installed on the US, UK, NATO, and French AWACS fleets. The 767 AWACS program takes advantage of modern

manufacturing facilities and processes which ensure a high-quality Boeing defense product.

The basic 767 airplane is manufactured by the Boeing Commercial Airplane Group in Everett, WA, and is modified to accommodate the prime mission equipment.

Production of the first derivative airframe was completed in October 1994. First flight with the rotodome installed occurred in August 1996.

# Programmable Interference Blanker Unit for C-130J Block 7 Aircraft

Terma has been selected by Lockheed Martin to provide 254 Programmable Interference Blanker Units, PIBUs, for C-130J aircraft to be delivered to nine countries.

This contract award to Terma can be seen as a recognition of Terma's qualifications in this special area, where Terma by request had already developed a Programmable Interference Blanker Unit for the Danish C-130Js.

The necessity for a PIBU stems from the numerous receivers and transmitters on board the airplane: radios, radars, jammers, and other

electronic warfare systems, where interference and degraded performance would be a serious problem unless corrective action was taken. As an example, the PIBU will shut down the Radar Warning Receiver as long as jamming takes place. Since receivers are being blinded when blanking is in effect, it is essential that the duration of the blanking is minimized. The blanking period is typically in the range of a few microseconds.

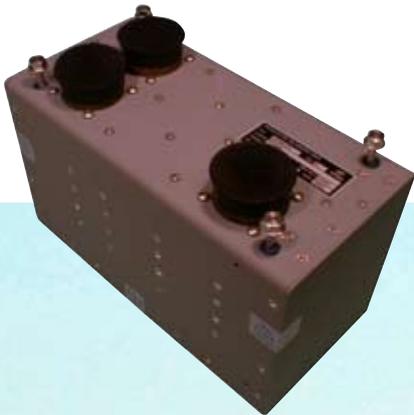
The programmable feature of the unit ensures that the PIBU can easily be reprogrammed in accordance with upgrades or changes in aircraft configuration. Furthermore, a late optimization of the blanking "scheme" is achieved, thereby reducing the risk

and integration effort by allowing programmable correction of actually measurable interferences, thus avoiding costly updates of hardwired schemes.

Although pricing is always a factor, the impression is that among the available suppliers, Terma was selected primarily because of the proven performance and the maturity of the Terma PIBU.

The delivery has two phases. Nine trial kits will be delivered in 2009 and 2010. The remaining sets, up to the total of 254, will be delivered from 2012 onwards.

As part of the agreement, a PIBU maintenance facility will be set up at Terma's site in Warner Robins, Georgia in order to keep the repair turnaround within 30 days.





**Financial Highlights**

USD million	2007/08	2006/07	2005/06	2004/05	2003/04
Sales	195	171	165	202	183
Profit for the year before tax	18	14	12	14	12
Equity Capital, year-end	83	62	57	57	53
Assets, total	215	173	151	167	189
Order intake	270	163	166	189	145
Order book, year-end	325	227	227	228	241
Number of full-time employees – Average for the year	1,020	965	1,014	1,034	1,010

# We Provide **Mission Customized** Solutions

**Terma develops and markets high-tech solutions, systems, and products for civilian and military applications.**

Terma's high-tech solutions and products are developed and designed for use in extreme mission critical environments and situations, where human lives and valuable material assets are at stake.

In Denmark, Terma facilities are located at Aarhus, Copenhagen, and Grenaa.

Terma's international locations include Leiden, the Netherlands; Darmstadt near Frankfurt, Germany; Washington, DC; and Warner Robins, GA, USA; and Singapore.

Terma A/S was established in 1949. For years, Terma has worked closely with defense forces, public authorities, and international organizations around the world. Through these relationships, Terma has gained in-depth knowledge of and insight into our customers' working environment and an equally deep understanding of their situations and needs.

Terma is fully owned by the Thomas B. Thrige Foundation.

**Terma's business areas cover:**

- Aerostructures for Aircraft
- Airborne Systems, including
  - Self-Protection Systems for Aircraft
  - Audio Systems Solutions
  - Reconnaissance Systems for Fighter Aircraft
  - Electronics Manufacturing
- Integrated Systems, including
  - Self-Protection Systems for Naval Vessels
  - Command and Control Systems for Navy, Army, and Air Force Applications
  - Air Traffic Management Systems
  - Public Safety & Emergency
- Radar Surveillance Systems
- Solutions, Services, and Products for Space Applications

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