# SYSTEM INTEGRATION AND FLIGHT TESTING OF A LASER DESIGNATION POD AND LASER-GUIDED BOMBS ON THE ITALIAN TORNADO INTERDICTION STRIKE AIRCRAFT

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**Abstract. Since the beginning of the 90's, the Italian Air Force Flight Test Centre (CSV-RSV) has been involved in various activities related to laser-guided weapons and infrared laser designation systems for airborne and ground applications. The Thomson Convertible Laser Designation Pod (CLDP) with both TV and IR capabilities have been integrated on the TORNADO Interdiction Strike (IDS) aircraft, together with Laser Guided Bombs (LGBs) PAVEWAY II and III. Ground laser target designators and laser warning receivers have also been tested. Further activities, currently ongoing, include the integration of the CLDP and improved LGBs on the AM-X aircraft. This paper begins with a review of the military requirements and flight test activities carried out on the Italian TORNADO-IDS, followed by a description of the CLDP/LGBs characteristics and performance. It then goes on to present the simulation tools which have been implemented for systems integration and performance/safety analysis with an emphasis on the inherent advantages introduced during development and flight test activities (that is, aerodynamics and safe-separation analysis, preliminary performance estimation, laser hazards determination and laser/ballistic safety assessment, test activities speed-up).**

## INTRODUCTION

The theory of operation of laser guided weapons is simple. The Laser Target Designator (LTD) is an accurate pointing system which provides the laser source and the precision optics and stabilisation required to shine the laser beam accurately on to the target. The LGB detector assembly generates an electric signal when light in received at the wavelength of the laser, consequently the laser light reflecting off of the target is "visible" to the weapon. This provides signals on which the weapon can "home" toward the target by actuation of its aerodynamic control surfaces. Obviously, the pointing accuracy of the laser is important, as any pointing error will degrade the accurate delivery of the weapon.

On the TORNADO-IDS the CLDP is a non-jettisonable store and is carried on the forward section of the aircraft left shoulder pylon. The GBU-16 (PAVEWAY II) LGB is the second generation of LGB and has a MK-83 1000 pound warhead, and the modular electronics and mechanical assemblies designed to provide the weapon with the capability for laser terminal guidance. The GBU-16 is designed for medium- and high-altitude attacks, performed both in level and dive conditions. Theoretically the bomb may be dropped in loft conditions but the associated release envelope is narrowed and the delivery accuracy is degraded.

The GBU-24 (PAVEWAY III) is the third generation of LGB and is specifically designed to enhance low-altitude delivery (hence the name Low Level Laser Guided Bomb—LLLGB). The weapon characteristics also greatly simplify medium- and high-altitude deliveries.

The TORNADO CLDPs main functions are selected by the Weapon System Operator (WSO) whose controls are located in the rear cockpit. The pod Line of Sight (LOS) controls are located both in the front and rear of the cockpit. The system allows both self-designation and co-operative attacks, and can also perform accurate navigation fixes by range finding.

For the CLDP and LGB flight testing a new tailored philosophy was adopted in order to reduce the costs associated with the development process and to obtain the highest possible levels of efficiency. Particularly, instead of carrying out flight trials at the end of the systems integration process, there was a constant involvement of flight test human resources in the various integration design phases, and participation of systems engineers in the flight test planning activities.

**Figure 1. TORNADO—PAVEWAY II flight trials.**

Various simulation tools were implemented during the development and experimental activity and progressively improved as a flight test activity spin-off:

- Store Separation Simulation;
- Aerodynamic Simulation;
- Guided/Unguided Weapon Simulation;
- Masking Analysis and Simulation;
- Aircraft Weapon Aiming Simulation;
- CLDP Performance Simulation; and
- Ballistic and Laser Safety.

Simulation tools were considered essential for correctly planning flight test activities, analysing flight test data, and verifying the validity of the models/algorithms loaded in the operational aircraft software.