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RTO AGARDograph 300
Flight Test Techniques Series – Volume 24

SCI-125

Precision Airdrop

(Largage de précision)

This AGARDograph has been sponsored by the Systems Concepts and Integration Panel.

Published December 2005

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- AVT Applied Vehicle Technology Panel
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- SAS Studies, Analysis and Simulation Panel
- SCI Systems Concepts and Integration Panel
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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. Annex B of this paper reproduces current such listings.

Precision Airdrop

(RTO-AG-300-V24)

Executive Summary

This AGARDograph describes the basic principles and testing considerations for precision airdrop systems. A variety of precision airdrop systems available as commercial-off-the-shelf and others in various stages of development will be described in general terms. Some of the systems described are currently in use while other systems are in development. This report also concentrates on the aircraft navigation to the airdrop release point and on the trajectory control and concepts of airdropped payloads to enable accurate ground impacts. In addition, the report outlines the need for precision airdrop systems and introduces the reader to potential Concepts of Operations.

Of particular note is the recent growing interest in precision airdrop by NATO. The NATO Conference of National Armaments Directors (CNAD) has recently prioritized precision airdrop for Special Operations Forces (SOF) as the eighth highest priority within NATO for Defence Against Terrorism (DAT). Other current activities within NATO to meet this short term requirement will be outlined.

A list of useful reference documents is included in the report. These can be helpful to the reader looking for appropriate details if the full background should be needed for information contained in this AGARDograph.

Largage de précision

(RTO-AG-300-V24)

Synthèse

Le présent AGARDograph décrit les principes de base et les conditions d'essais des systèmes de largage de précision. Il donne une description générale d'un certain nombre de systèmes de largage de précision disponibles dans le commerce et de systèmes à différentes étapes de développement. Certains de ces systèmes sont actuellement utilisés et d'autres sont en cours de développement. Ce rapport est également ciblé sur la navigation vers le point de largage et sur le contrôle de trajectoire et les concepts de charges utiles larguées permettant un impact au sol précis. En outre, ce rapport souligne le besoin en matière de systèmes de largage de précision et présente les concepts d'opérations potentiels.

L'intérêt croissant de l'OTAN pour le largage de précision est à noter. La Conférence des directeurs nationaux des armements (CDNA) a récemment accordé au largage de précision pour les forces d'opérations spéciales (FOS) un niveau de priorité huit dans le cadre de l'OTAN pour la lutte contre le terrorisme (DAT). D'autres activités actuelles au sein de l'OTAN en vue de répondre à cette exigence à court terme seront présentées.

Ce rapport contient une liste des documents de référence utiles. Ceux-ci peuvent s'avérer utiles si vous recherchez des détails particuliers au cas où le contexte global serait nécessaire pour les informations contenues dans le présent AGARDograph.

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The authors would like to thank Mr. John Phillips, AFFTC, Edwards AFB, CA, USA for his significant contribution to the aircraft navigation sections of this report. Thanks also to Dr. Henk W. Jentink of the National Aerospace Laboratory (NLR), Amsterdam, the Netherlands, Mr. Rob Humphries of the Airborne Forces Equipment Project Team, QinetiQ Ltd, Boscombe Down, UK and Mr. Mark Kuntavanish of the USAF Air Transportability Test Loading Agency (ATTLA), Wright-Patterson AFB, OH, USA for their outstanding support in providing material and reviewing the paper. In addition, the authors would like to thank members of the U.S. Army Natick Soldier Center, Natick, Massachusetts, and the U.S. Joint Forces Command (JFCOM), Norfolk, Virginia, for their contributions to the overview descriptions of many of the precision airdrop systems and the concept of operations outline. Finally we would like to thank the USAF Air Mobility Command for their support in the development of precision airdrop systems.

Biographical Sketch

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Mr. Michael Wuest is an aerospace engineer in the Engineering Directorate, U.S. Air Force Flight Test Center, Edwards AFB, California, USA. He graduated with a Bachelor of Science in Aerospace Engineering from the University of Arizona in 1968. Mr. Wuest is an Associate Fellow of the American Institute of Aeronautical and Astronautics (AIAA) since 1990. He has served three terms on the AIAA Aerodynamic Decelerator Systems Technical Committee.

Mr. Wuest began his government career in 1974 with the 6511th Flight Test Squadron at the National Parachute Test Range located at El Centro, California, USA. He worked as a flight test engineer in support of cargo aerial delivery systems projects. His first projects included supporting the successful effort to air-launch a Minuteman III missile from a C-5 aircraft and evaluating the aerial delivery system of the lengthened C-141B aircraft. He continued as a flight test engineer until 1989, when he was appointed chief of the Mission Systems engineering branch, 6520 Test Group at Edwards AFB. In this position, he supervised engineers and technicians as they evaluated missions systems and aerial delivery systems on C-17, C-130, C-141, C-5 AND UH-1 aircraft. Since 1996 through 2005, he has worked for the 412th Test Wing at Edwards AFB serving as an Avionics Engineering Branch Chief. He and his teams have evaluated various avionics systems on virtually all of the cargo, fighter, tanker, bomber and unmanned aircraft tested at Edwards AFB during that time. He also continues to support parachute test projects for the USAF.

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He began his government career in 1991 as an aerospace engineer in the Engineering Technology Division at Natick, where he served as a highly successful research engineer making breakthrough advances in high performance computer modeling of parachute systems, work for which he received an Army Research and Development (R&D) Achievement Award in 1994. Mr. Benney was promoted in 1999 to Team Leader, Airdrop Technology Team (ATT), where he took on additional responsibilities for research and technology development for all ATT projects, as well as the corresponding supervision of approximately 15 research engineers. Mr. Benney is currently the Technical Manager for the Joint Precision Airdrop System (JPADS) Advanced Concept Technology Demonstration (ACTD) Program.

Mr. Benney is an Associate Fellow of the American Institute of AIAA, of which he has been a member since May 1992. He has served as Treasurer of the AIAA Aerodynamic Decelerator Systems Technical Committee (ADC-TC) since 1989 and as Chairman of the ADS-TC from June 1999 – June 2001. Mr. Benney has been recognized for his accomplishments with numerous awards throughout his career, including: Ten Outstanding AMC Personnel Of The Year, 2005; Army Materiel Command (AMC) Small Business Award, 2004; AMC Top 10 Inventions Program – Certificate of Excellence, 2003; U.S. Army Soldier Systems Center Outstanding Team Leader, 2002; Civilian graduate of the U.S. Army Airborne School, 1999; Department of the Army R&D Achievement Award, 1994; Certificate of Achievement, 1993 and 1994; and Natick Soldier Center Technical Director's Award for Research Silver Pin, 1993. He has published over 60 technical papers on airdrop systems to include a number of refereed journal articles.

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List of Acronyms

AATV	Airborne All-Terrain Vehicle
ACTD	Advanced Concept Technology Demonstration
ADS	Aerial Delivery System
AFFTC	Air Force Flight Test Center
AFWA	Air Force Weather Agency
AGAS	Affordable Guided Airdrop System
AGL	Above Ground Level
AGU	Airborne Guidance Unit
AMC	Air Mobility Command
ATR	Airborne Trailer
ATTLA	Air Force Air Transportability Test Loading Agency
CARP	Computed Air Release Point
CEA	Computed/Circular Error Average
CEP	Computed/Circular Error Probable
CNAD	Conference of National Armaments Directors
CNIU	Common Navigation Interface Unit
CPU	Central Processing Unit
CTII	Combat Track II
DAT	Defense Against Terrorism
DGPS	Differential Global Positioning System
DZ	Drop Zone
ECDS	Enhanced Container Delivery System
FSS	Force Sustainment Systems
GAINR	GPS-Aided Inertial Navigation Reference
GDS	Generic Delivery System
GN&C	Guidance, Navigation and Control
GPS	Global Positioning System
HARP	High-Altitude Release Point
HD	High Drag
HMD	Helmet-Mounted Display
HMMWV	High-Mobility Multiwheeled Vehicle
HUD	Head-Up Display

JAAWIN	Joint Air Force Army Weather Information Network
JPADS-MP	Joint Precision Airdrop System-Mission Planning
KIAS	Knots Indicated Air Speed
LAPES	Low-Altitude Parachute Extraction System
LCAT	Low-Cost Actuator Technology
LTCR	Long-Term Capability Requirement
LIDAR	Laser Radar
MEW	Mean Effective Winds
MFD	Multiple Flight Display
MP	Mission Planner (includes aircraft mission computer)
MSL	Mean Sea Level
NATO	North Atlantic Treaty Organization
NLR	National Aerospace Laboratory, The Netherlands
NSC	Natick Soldier Center
OUE	Operational Utility Evaluation
PATCAD	Precision Airdrop Technology Conference and Demonstration
PDA	Personal Data Assistant
PI	Point of Impact
PIP	PADS Interface Processor
PM	Product Manager
RAD	Ram-Air Drogue
RDECOM	Research Development and Engineering Command
RTK	Retransmission Kit
SBIR	Small Business Innovative Research
SOCOM	Special Operations Command
SOF	Special Operations Forces
SPADES	Small Parafoil Autonomous Delivery System
TRL	Technology Readiness Level
TSPI	Time, Space and Position Information
UAV	Unmanned Aerial Vehicle
YPG	Yuma Proving Ground

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14. Abstract

This AGARDograph describes the basic principles and testing considerations for precision airdrop systems. A variety of precision airdrop systems available as commercial-off-the-shelf and others in various stages of development will be described in general terms. Some of the systems described are currently in use while other systems are in development. This report also concentrates on the aircraft navigation to the airdrop release point and on the trajectory control and concepts of airdropped payloads to enable accurate ground impacts. In addition, the report outlines the need for precision airdrop systems and introduces the reader to potential Concepts of Operations. A list of useful reference documents is included in the report. These can be helpful to the reader looking for appropriate details if the full background should be needed for information contained in this AGARDograph.

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