

CONSEIL DE L'ATLANTIQUE NORD
NORTH ATLANTIC COUNCIL

NATO UNCLASSIFIED

ORIGINAL: ENGLISH
6th March 1997

NOTICE
AC/141(NG/1)N/11

NATO NAVAL ARMAMENTS GROUP

NAVAL GROUP 1 ON ABOVE WATER WARFARE

AGARD REPORT 342 ON PRECISION TERMINAL GUIDANCE FOR MUNITIONS

Note by the Secretary

1. Please find attached the Executive Summary, Outline of the Study on Precision Terminal Guidance for Munitions and the list of members of the working group.
2. The Study may be helpful for the work of the Specialist Team on Naval Fire Support.

(Signed) E. DRANSFELD

NATO,
1110 Brussels.

Handwritten note:
19970326 035

NATO UNCLASSIFIED

-1-

19970326 035

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

AGARD-AR-342

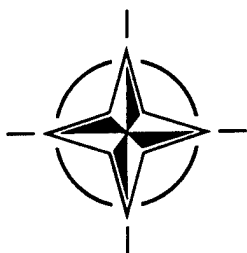
AGARD

ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT
7 RUE ANCELLE, 92200 NEUILLY-SUR-SEINE, FRANCE

AGARD ADVISORY REPORT 342

Precision Terminal Guidance for Munitions (le Guidage terminal précis pour les munitions)

This report has been prepared as a summary of the deliberations of Working Group 02 of the Mission Systems Panel of AGARD.



NORTH ATLANTIC TREATY ORGANIZATION

Published February 1997

Distribution and Availability on Back Cover

Precision Terminal Guidance for Munitions

(AGARD AR-342)

Executive Summary

Working Group 02 (originally Guidance and Control Panel working Group 13) was approved by the AGARD National Delegates Board in the Spring of 1991, shortly after the Gulf War with Iraq. The effectiveness of the guided munitions used in that conflict emphasised their importance in "conventional" warfare. Following this experience, the lessons learned from military interventions by NATO nations has often yielded less clear-cut results. In spite of these recent events, it seems clear that the future of precision guidance is assured, for reasons similar to those prevailing during the Gulf War, that is, their usefulness as a "force multiplier". This enables them to:

- maximise the effective fire power of launch platforms;
- minimise the number of missions required to carry out a given task;
- reduce collateral damage to non-combatants to a minimum.

The Working Group oriented its aims towards NATO military needs and the review of terminal guidance technology in relation to those needs, using the two following items as a starting point:

- the AGARD planning guidelines, which give a top-down view, derived from the NATO strategic concept;
- an analysis by GCP of the implications of the Gulf War for guidance and control.

The review of terminal guidance technologies was also aimed at identifying new capabilities not currently part of NATO's armoury. Projections into the future often produce speculative concepts that, in the light of deeper study, turn out to be unworkable, unaffordable or even misguided. But new ideas, however impractical at first sight, are the stimulus NATO needs to stay at the forefront of technology advances.

Contents

	Page
Executive Summary	iii
Synthèse	iv
Working Group Membership	vii
Acronyms and Abbreviations	viii
CHAPTER 1 INTRODUCTION	1
1.1 Background	1
1.2 Content of the Report	2
CHAPTER 2 TERMINAL GUIDANCE SYSTEMS	3
2.1 Guidance Concepts	3
2.2 Seeker Functions	7
2.3 Target Characteristics	12
2.4 Seeker Programmes	13
CHAPTER 3 MILITARY NEEDS	17
3.1 NATO Strategic Needs	17
3.2 Operational Experience	19
3.3 Future PGM Needs	21
3.4 Summary of Needs	24
CHAPTER 4 TECHNOLOGY TRENDS	25
4.1 Sensors	25
4.2 Signal/Data Processing	29
4.3 Guidance Laws (Tracking & Homing Processes)	30
4.4 Seeker Stabilization	39
4.5 Inertial Sensors	41
4.6 Global Positioning System (GPS)	47
4.7 GPS/INS Integration	49
4.8 Communications/Command Links	53
4.9 Countermeasures & Counter-Countermeasures	54
4.10 Chapter Four Overview	57
CHAPTER 5 USER CONCERNS	61
5.1 Mission Planning	61
5.2 Identification of Friend or Foe (IFF)	65
5.3 Battle Damage Assessment (BDA)	66
5.4 Cost - Schedule	67
5.5 Environmental Issues	73
5.6 Chapter Five Overview	74
CHAPTER 6 FUTURE CAPABILITIES	75
6.1 Global Targeting and Force Projection	75
6.2 All-Weather Operation	75

6.3	Miniaturized Munitions	76
6.4	Rationalised Inventories and "On-Demand" Munitions	76
6.5	Integral IFF	78
6.6	Unmanned Aircraft	78
6.7	Novel Weapon Concepts	78
6.8	Chapter Six Overview	79
CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS		81
7.1	Potential to Meet NATO Needs	81
7.2	NATO Cooperation	82
Appendix A — Basic Definitions		85
Appendix B — Terrain Referenced Navigation		89
Appendix C — Countermeasures		97
Appendix D — Relative GPS Techniques		103

Members of the Working Group

*Dr Pedro SANZ-ARANGUEZ
Profesor Universidad
ETS de Ingenieros Aeronauticos
Madrid Polytechnical University
Pza Cardenal Cisneros, 3
28040 MADRID
SPAIN

Dr George SCHMIDT
M/S 2A
The Charles Stark Draper Laboratory
555 Technology Square
CAMBRIDGE, MA 02139
UNITED STATES

Dr Steven BUTLER
Technical Director
HQ AFMC/EN
4375 Chidlaw Rd, Ste 6
WRIGHT-PATTERSON AFB, OH 45433-5006
UNITED STATES

Mr Thierry URING
THOMSON-CSF/CNI
160 Bd de Valmy, BP 82
92704 COLOMBES CEDEX
FRANCE

Mr S LEEK
8 Sunnyfield
HATFIELD, HERTFORDSHIRE AL9 5DX
UNITED KINGDOM

Other contributors to the Working Group or to this report are listed below:

Dr Drayton BOOZER
Sandia National Laboratories
Organization 4400
PO Box 5800
ALBUQUERQUE, NM 87185-5800
UNITED STATES

Mr Gonzalo FERNANDEZ DE LA MORA
SENER Ingenieria y Sistemas SA
C/Severo Ochoa s/n
Parque Tecnologico
28760 TRES CANTOS (MADRID)
SPAIN

REPORT DOCUMENTATION PAGE																			
1. Recipient's Reference	2. Originator's Reference AGARD-AR-342	3. Further Reference ISBN 92-836-1048-2	4. Security Classification of Document UNCLASSIFIED/ UNLIMITED																
5. Originator Advisory Group for Aerospace Research and Development North Atlantic Treaty Organization 7 rue Ancelle, 92200 Neuilly-sur-Seine, France																			
6. Title Precision Terminal Guidance for Munitions																			
7. Presented at/sponsored by																			
8. Author(s)/Editor(s) Multiple			9. Date February 1997																
10. Author's/Editor's Address Multiple			11. Pages 132																
12. Distribution Statement There are no restrictions on the distribution of this document. Information about the availability of this and other AGARD unclassified publications is given on the back cover.																			
13. Keywords/Descriptors <table border="0" style="width: 100%;"> <tr> <td>Precision guided munitions</td> <td>Terrain</td> </tr> <tr> <td>Conventional warfare</td> <td>Military planning</td> </tr> <tr> <td>NATO forces</td> <td>Strategic analyses</td> </tr> <tr> <td>Terminal guidance</td> <td>Requirements</td> </tr> <tr> <td>Persian Gulf War (1991)</td> <td>International cooperation</td> </tr> <tr> <td>Reviews</td> <td>Countermeasures</td> </tr> <tr> <td>Global positioning system</td> <td>Guidance</td> </tr> <tr> <td>Navigation</td> <td></td> </tr> </table>				Precision guided munitions	Terrain	Conventional warfare	Military planning	NATO forces	Strategic analyses	Terminal guidance	Requirements	Persian Gulf War (1991)	International cooperation	Reviews	Countermeasures	Global positioning system	Guidance	Navigation	
Precision guided munitions	Terrain																		
Conventional warfare	Military planning																		
NATO forces	Strategic analyses																		
Terminal guidance	Requirements																		
Persian Gulf War (1991)	International cooperation																		
Reviews	Countermeasures																		
Global positioning system	Guidance																		
Navigation																			
14. Abstract <p>This report summarises the deliberations of Working Group 02 of the Mission Systems Panel (originally Working Group 13 of the Guidance and Control Panel) of AGARD. The broad objectives of the Working Group were to review present and future terminal guidance technology in relation to NATO military needs.</p> <p>The report includes: a review of existing terminal guidance capabilities and shortcomings; an analysis of NATO military needs; reviews of relevant technology trends, user concerns and future capabilities; and a statement of conclusions and recommendations in respect of the potential to meet NATO needs and for NATO cooperation. Appendices provide basic definitions, plus background outline descriptions of terrain referenced navigation, countermeasures, and relative GPS (Global Positioning System).</p>																			