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# Preface

Anthropomorphic dummies for crash and escape system testing have been used by military and civilian agencies for many years to assess, develop and standardize safer occupant protective systems for land and air vehicles. The automotive industry has spent considerable effort in designing crash test dummies that are biofidelic; i.e., dummies that duplicate the properties of a representative human subject on which injury risk is to be assessed. The major adult crash test dummies currently in use are the Hybrid II and its development into the Hybrid III for frontal impacts, and Side Impact Dummy (SID), Biofidelic Side Impact Dummy (BIOSID) and European Side Impact Dummy (EUROSID 1) for side impact tests. The US Air Force developed the Advanced Dynamic Anthropomorphic Manikin (ADAM) to test advanced ejection systems. More recently, biodynamic analytical models such as MATHematical DYNAMical MOdel (MADYMO) and Articulated Total Body (ATB) model have been developed to simulate human responses and injuries associated with vehicular impacts.

The Aerospace Medical Panel (AMP) held a very successful symposium on Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques (AGARD-CP-532) in Cesme, Turkey, 27 April - 1 May 1992. At that symposium, several papers described the use of dummies and mathematical simulations for studying crash phenomena. That Fall, at its 74th Business Meeting, the AMP accepted a proposal from its Biodynamics Committee for the formation of a Working Group to review the status and direction of the technology of aircraft ejection and car crash test dummies and identify the salient research and development advances in manikins that will enhance future aerospace capabilities for reducing aircrew injury risk. Dr Ints Kaleps, Armstrong Laboratory, Wright-Patterson AFB (WPAFB), OH was brought in as an AMP Consultant to help define the objectives of the Working Group. Furthermore, it was mandated by the AGARD National Delegates Board that lessons learned by the automotive industry in developing crash test dummies were to form an essential part of the activities of the Working Group.

Working Group 21 (WG21): Anthropomorphic Dummies for Crash and Escape System Testing met four times. Meetings of WG21 were held at Armstrong Laboratory, WPAFB, US, 5-6 May 1994; Mariners Hotel, Frensham, Farnham, Surrey, UK, 29-30 September 1994; Defence and Civil Institute of Environmental Medicine (DCIEM), North York (Toronto), CA, 4-5 May 1995; and Hotel "Alt Heidelberg", Heidelberg, GE, 5-6 October 1995. Teams were formed to address eight topics:

- Adult Dummies: Past and Present†  
**Smrcka\***, Kaleps, Mertz, Bendjellal and Obergefell
- Biomechanical Impact Response Requirements: Current Adult Dummies  
**Mertz\***, Guccione, Schueler and Bendjellal
- Anthropometry: Current Adult Dummies  
**Kaleps\*** and Obergefell
- Injury Assessment  
**Morgan\***, Schueler, Poirier, Guccione, Mertz and Kaleps
- Instrumentation and Data Acquisition  
**Blaker\***, Malo and Kaleps
- New Developments and Special Features††  
**Kaleps\***, Mertz, Bendjellal, Morgan and Schueler
- Data Bases and Analytical Modeling  
**Wismans\*** and Obergefell
- Dummy Users  
**Glaister**

## \*Topic Leader

†Mr Phil Brown, First Technology Safety Systems, 2 Columbus Drive, Summit Ave., Southwood, Farnborough, Hants GU14 0NZ, UK was a technical contributor at the WG21 Meetings in Frensham, UK and Heidelberg, GE.

††Dr James A. Newman, President, Biokinetics and Associates, Inc. 2470 Don Reid Drive, Ottawa, Ontario, K1H 8P5, CA joined WG21 as a technical contributor, commencing with the meeting at DCIEM.

Jack P. Landolt, PhD  
Chairman  
AGARD/AMP/WG21

# Aerospace Medical Panel

**Chairman:** Dr P. Vandenbosch  
Loriesstraat, 44  
B-1500 HALLE  
Belgium

**Deputy Chairman:** LtCol E. Alnaes  
Oslo Military Clinic  
Oslo Mil/Akershus  
N-0015 Oslo  
Norway

## Working Group 21 Members

Mr Farid Bendjellal  
Safety Engineering Department  
Advanced Projects — Renault  
67 rue des Bons-Raisins, Build BM2-G  
92508 Rueil Malmaison Cedex  
France

Dr David H. Glaister  
RAF School of Aviation Medicine  
Farnborough, Hants GU14 6SZ  
United Kingdom

Dr Ints Kaleps  
Biodynamics and Biocommunications Division  
Armstrong Laboratory  
AL/CFBV, 2610 7th Street  
Wright-Patterson AFB, OH 45433-7901  
United States

Dr Jack P. Landolt (Chairman)  
Defence and Civil Institute of  
Environmental Medicine  
1133 Sheppard Avenue West, PO Box 2000  
North York, ON M3M 3B9  
Canada

Mr Robert Malo  
Motor Vehicle Test Centre, Transport Canada  
100 Du Landais  
Blainville, Québec J7C 5C9  
Canada

Dr Harold J. Mertz  
Engineering Building S3-S29  
GM Technical Center  
30200 Mound Road, PO Box 9010  
Warren, MI 48090-9010  
United States

Mr Richard Morgan  
Office of Crashworthiness Research  
US Dept of Transport/NHTSA  
400 7th Street SW NRD-12  
Washington, DC 20590-0002  
United States

Médecin en chef Jean-Louis Poirier  
DRET/SDR G9.3  
26, Boulevard Victor  
00460 Armées  
France

Dipl.-Ing. Florian Schueler  
Institute for Legal Medicine  
Accident and Biomechanics Research Unit  
University of Heidelberg  
Postfach 10 30 69, 69020 Heidelberg  
Germany

Dr ir Jac Wismans  
TNO Crash-Safety Research Centre  
Schoemakerstraat 97, Post Office Box 6033  
2600 JA Delft  
The Netherlands

## Other Technical Contributors

Mr James L. Blaker  
Robert A. Denton Inc  
1220 W Hamlin Road  
Rochester Hls, MI 48309-3359  
United States

Dr Sal J. Guccione  
Naval Biodynamics Laboratory  
PO Box 29407  
New Orleans, LA 70189-0407  
United States

Dr Louise Obergefell  
Biodynamics and Biocommunications Division  
AL/CFBV Bldg 441, 2610 7th Street  
Wright-Patterson AFB, OH 45433-7901  
United States

Mr Joseph Smrcka  
First Technology Safety Systems Inc  
47460 Galleon Drive  
Plymouth, MI 48170-2467  
United States

## Panel Executive

Major R. Poisson, CAF

**Mail from Europe and Canada:**  
AGARD-OTAN  
Attn: AMP Executive  
7, rue Ancelle  
92200 Neuilly-sur-Seine  
France

**Mail from US:**  
AGARD-NATO  
Attn: AMP Executive  
Unit 21551  
APO AE 09777

Telephone: 33 (1) 47 38 57 60/62  
Telex: 610176 (France)  
Telefax: 33 (1) 47 38 57 99

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# List of Acronyms

A/D	analog to digital
ADAC	Allgemeiner Deutscher Automobil Club
ADAM	Advanced Dynamic Anthropomorphic Manikin
AFB	Air Force Base
AFGS	Air Force Guide Specifications
AGARD	Advisory Group for Aerospace Research and Development
AIS	Abbreviated Injury Scale
AL	Armstrong Laboratory
AMP	Aerospace Medical Panel
AMRL	Aerospace Medical Research Laboratory (now AL)
ams	"auto motor und sport" magazine
APR	Association Peugeot-Renault (now LAB)
APROD	Association Peugeot-Renault Omnidirectional Dummy
ARL	Alderson Research Laboratories
AS	SAE Aerospace Standard
ASCC	Air Standardization Coordinating Committee
ASIS	anterior-superior iliac spine
ATB	Articulated Total Body
ATCOM	Army Aviation Applied Technology Directorate
ATD	anthropomorphic test device
ATF	Airdrop Test Flight
BAST	Bundesanstalt für Strassenwesen Bergisch Gladbach
BB	Bean Bag
BIOSID	Biofidelic Side Impact Dummy
BSI	British Standards Institution
CAA	Civil Aviation Authority
CAMAC	Computer Automated Measurement and Control
CAMI	Civil Aeromedical Institute
CAMIX	Experimental child dummy from CAMI
CEV	Centre d'Essais en Vol
CEVA	Centre d'Essais Véhicules Automobiles
CFC	Channel Frequency Class
CFR	Code of Federal Regulations
CG	center of gravity
CHS	Centre for Human Sciences
CMVSS	Canadian Motor Vehicle Safety Standard
CPU	Central Processing Unit
CRABI	Child Restraint Air Bag Interaction
CREST	Crew Escape Systems Technologies
CVS	Crash Victim Simulator
DAS	data acquisition system
DCIEM	Defence and Civil Institute of Environmental Medicine
DRA	Defence Research Agency
DR	dynamic response
DRI	Dynamic Response Index
ECE	Economic Commission of Europe
EEC	European Economic Community
EEVC	European Experimental Vehicle Committee
EU	European Union
EUROSID	European Side Impact Dummy
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FE	finite element

FM	frequency modulation
FMVSS	Federal Motor Vehicle Safety Standard
FTSS	First Technology Safety Systems
GARD	Grumman-Alderson Research Dummy
GEBOD	GEnerator of BOdy Data
GM	General Motors Corporation
GSI	Gadd Severity Index
HIC	Head Injury Criterion
HSRI	Highway Safety Research Institute (now UMTRI)
HUD	Head-Up Display
LARV	Injury Assessment Reference Value
IBM	International Business Machines
IDDAS	Intelligent Dummy Data Acquisition System
IEEE	Institute of Electrical and Electronics Engineering
INRETS	Institut National de Recherche sur les Transports et leur Sécurité
IRIG	International Range Instrumentation Group
ISO	International Organization for Standardization
JAR	Joint Aviation Regulations
JPATS	Joint Primary Aircraft Training System
KEAS	Knots Equivalent Air Speed
KIAS	Knots Indicated Air Speed
KT	Kayser Threde
LAB	Laboratoire d'Accidentologie et de Biomécanique
LAMAS	Laboratoire de Médecine Aéronautique
LRE	Limb Restraint Evaluator
MADYMO	MAThematical DYNAMical MOdel
MHD	magnetohydrodynamic
MIDAS	Manikin Integrated Data Acquisition System
MIL STD	Military Standard
MIRA	Motor Industry Research Association
MPL	Medical Plastics Laboratory
MSC	Maximal Strain Criterion
MVMA	Motor Vehicle Manufacturers Association
NASA	National Aeronautics and Space Administration
NASS	National Accident Sampling System
NATO	North Atlantic Treaty Organization
NAWC	Naval Air Warfare Center
NBDL	Naval Biodynamics Laboratory
NBS	National Bureau of Standards
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NIAR	National Institute for Aviation Research
NIST	National Institute of Standards and Technology
ONSER	Organisme National de la Sécurité Routière (now INRETS)
OPAT	Occupation Protection Assessment Test
OSU	Ohio State University
PC	personal computer
PCM	pulse code modulation
RAE	Royal Aerospace Establishment (now DRA (Farnborough))
RAF SAM	Royal Air Force School of Aviation Medicine
SAE	Society of Automotive Engineers
SID	Side Impact Dummy
SRL	Systems Research Laboratory

TAD	Trauma Assessment Device
3D	three dimensions
TLI	Triplex Laceration Index
TNO	Netherlands Organisation for Applied Scientific Research
TRC	Transport Research Center
TRL	Transport Research Laboratory
TRRL	Transport and Road Research Lab (now TRL)
TSO	Technical Standards Order
TTI	Thoracic Trauma Index
2D	two dimensions
UMTRI	University of Michigan Transportation Research Institute
USAARL	United States Army Aeromedical Research Laboratory
USAF	United States Air Force
UTAC	Union Technique de l'Automobile, du Motocycle et du Cycle
V*C	Viscous Criterion
VIP	Very Important People
WADC	Wright Air Development Center (now WPAFB)
WG3	Working Group 3 (Instrumentation) of ISO/Technical Committee (TC) 22/Sub-Committee (SC) 12
WG5	Working Group 5 (Anthropomorphic Test Devices) of ISO/Technical Committee (TC) 22/Sub-Committee (SC) 12
WPAFB	Wright-Patterson Air Force Base