APPENDIX A
1996 DOD MCTL MASTER LOCATOR

APPENDIX A
DoD MCTL MASTER LOCATOR*

MCTL Parts

This master locator lists the 18 MCTL technology sections for Part I and their included technology areas and indicates for Parts II and III where supporting data are located. The Locator also lists additional technology areas which are addressed only for Parts II and III. A short description of the three MCTL parts is shown below.

Part I *Weapons Systems Technologies (WST)*
Contains a list of technologies critical to the development and production of superior weapons.

Part II *Weapons of Mass Destruction (WMD) Technologies*
Contains a list of technologies required for development, integration, or employment of nuclear, biological, or chemical weapons and their means of delivery.

Part III *Developing Critical Technologies (DCT)*
Contains a list of technologies which, when fully developed and incorporated into a military system, will produce increasingly superior performance or maintain a superior capability more affordably.

	PART I WST	PART II WMD	PART III DCT
AERONAUTICS SYSTEMS TECHNOLOGY			
Advanced Concept Turbine Engines			X
Aircraft, Fixed Wing	1.1	1.4	X
Aircraft, Rotary Wing			X
Air Vehicles, Unmanned		1.3	X
Full Authority Digital Electronic Controls (FADEC)			X
Gas Turbines Engines	1.2		X
Guidance, Navigation, and Controls		1.4	X
Human (Crew) Systems Interfaces	1.3		X
Ramjet and Scramjet		1.3	X
Systems Integration		1.3,1.4	X
Test Facility, Propulsion System			X

	PART I WST	PART II WMD	PART III DCT
ARMAMENTS AND ENERGETIC MATERIALS TECHNOLOGY			
Air-Dispersed Explosives Systems			X
Ammunition, Small and Medium Caliber	2.1		X
Ballistic Missiles		1.1, .2	X
Bombs, Warheads, and Large-Caliber Projectiles	2.2	1.5,3.2, 4.2	X
Cruise Missiles		1.3	X
Energetic Materials	2.3	4.2	X
Gun and Artillery Systems	2.5	1.5	X
Mines, Countermines, and Demolition Systems	2.6		X
Non-Lethal Weapons			X
Penetrators			X
Regenerative Liquid Propellant Gun			X
Safing, Arming, Firing, and Fuzing	2.4	5.7	X
Survivability, Armor and Warhead Defeat			X

***These listings are subject to change as Part III is developed. Technology areas may be added or deleted.**

	PART I WST	PART II WMD	PART III DCT
BIOLOGICAL SYSTEMS TECHNOLOGY			
Biological Defense Systems	3.1	3.4	X
Biological Dispersion		3.2	
Biological Detection, Warning, and Identification	3.2	3.3	X
Biological Material Production		3.1	X
CHEMICAL SYSTEMS TECHNOLOGY			
Chemical Defense Systems	3.1	4.4	X
Chemical Dispersion		4.2	
Chemical Material Production		4.1	
Chemical Detection, Warning, and Identification	3.2	4.3	X
DIRECTED AND KINETIC ENERGY SYSTEMS TECHNOLOGY			
Coil Gun and Railgun			X
Electrothermal and Electrothermal Chemical Gun			X
High-Power Microwaves			X
Lasers, Gas Dynamic and Pulsed Electrical Atomic and Molecular			X
Lasers, High Energy Chemical	4.1		X
Lasers, High Energy Excimer			X
Lasers, High Energy Free Electron			X
Lasers, High Energy Optically Pumped Gas and Solid State			X
Lasers, High Energy Solid State			X
Lasers, High Energy Transfer			X
Lasers, Short Wavelength			X
Particle Beam, Charged			X
Particle Beam, Neutral			X
Supporting Technologies for Directed Energy (DE) Systems	4.2		X

	PART I WST	PART II WMD	PART III DCT
ELECTRONICS TECHNOLOGY			
Electronic Components	5.1		X
Electronic Materials	5.2		X
Fabrication Equipment	5.3		X
General Purpose Electronic Equipment	5.4		X
Microelectronics	5.5		X
Opto-Electronics	5.6		X
ENVIRONMENT TECHNOLOGY			
Camouflage			X
Control of Combat Environment			X
Micrometerology			X
Obscurants			X
Particle Dispersion, Coagulation, Recyling, and Reverse Disposal			X
GROUND SYSTEMS TECHNOLOGY			
Advanced Diesel Engines	6.1		
Human Systems Interfaces for Ground Systems			X
Hybrid-Electric Propulsion Systems			X
Sensors for Ground Systems			X
Signature Control for Ground Systems			X
Structures for Ground Systems			X
Systems Integration for Ground Systems		1.1	X
Vetronics	6.2		X
GUIDANCE, NAVIGATION, AND VEHICLE CONTROL TECHNOLOGY			
Aircraft and Vehicle Control Systems	7.1	1.3,1.4	X
Inertial Navigation Systems and Related Components	7.2	1.1,1.2, 1.3	X
Radio and Data-Based Referenced Navigation Systems	7.3	1.1,l.3	

	PART I WST	PART II WMD	PART III DCT
INFORMATION SYSTEMS TECHNOLOGY			
Command, Control, Communications, Computing Intelligence and Information Systems	8.1	2.1, .5	X
Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM)	8.2		X
High-Performance Computing	8.3		X
Human Systems Interfaces	8.4		X
Information Security	8.5	2.4	X
Intelligent Systems	8.6		X
Modeling and Simulation	8.7		X
Networks and Switching	8.8	2.6	X
Signal Processing	8.9	2.3	X
Software	8.10		X
Transmission Systems	8.11	2.2	X
INFORMATION WARFARE TECHNOLOGY			
Combat Identification			X
Electronic Attack	9.1		X
Electronic Deception			X
Electronic Protection	9.2		X
Optical Countermeasures	9.3		X
Optical Counter-Countermeasures	9.4		X
Psychological Operations			X
MANUFACTURING AND FABRICATION TECHNOLOGY			
Advanced Fabrication and Processing	10.1	5.9	X
Bearings	10.2		X
Computer-Aided Design, Manufacturing, Engineering, Test, and Maintenance			X
Metrology	10.3	1.1,5.9	X
Non-Destructive Inspection and Evaluation	10.4	1.1	X
Production Equipment	10.5	1.1	X
Robotics	10.6	5.9	X

	PART I WST	PART II WMD	PART III DCT
MATERIALS TECHNOLOGY			
Armor and Anti-Armor Materials	11.1		X
Biomaterials			X
Electrical Materials	11.2		X
Magnetic Materials	11.3		X
Optical Materials	11.4		X
Signature Control Materials			X
Special Function Materials	11.6		X
Structural Materials, High Strength and High Temperature	11.5		X
MARINE SYSTEMS TECHNOLOGY			
Advanced Hull Forms			X
Human Systems Interfaces			X
Ocean Salvage and Deep-Sea Implant			X
Propulsors and Propulsion Systems	12.1		X
Signature Control and Survivability	12.2		X
Subsurface and Deep Submergence Vehicles	12.3		X
Systems Integration			X
MEDICAL TECHNOLOGY			
Advanced Field Expedient Treatment			X
Artificial Skin			X
Blood Substitute			X
Human System Monitoring and Assessment			X
Immunizations and Neutralization			X
Performance Enhancement			X

	PART I WST	PART II WMD	PART III DCT
NUCLEAR SYSTEMS TECHNOLOGY			
Enrichment Feedstocks Production		5.1	
Fissile Materials Enrichment		5.2	
Heavy Water Production		5.12	
Inertial Confinement Fusion			X
Lithium Production		5.5	X
Manufacturing of Nuclear Components		5.9	X
Nuclear Fission Reactors	13.1	5.3	
Nuclear Materials Processing	13.2	5.2,5.4, 5.13	X
Nuclear-Related Materials		5.1,5.5, 5.12	X
Nuclear Weapons	13.3	5.6, 5.7	X
Nuclear Weapons Custody, Transport, and Control		5.11	X
Nuclear Weapons Development Testing	13.3	5.10	X
Nuclear Weapons Design and Development		5.6	X
Plutonium Extraction (Reprocessing)	13.2	5.4	
Radiological Weapons		5.8	X
Safing, Arming, Fuzing, and Firing		5.7	X
Tritium Production	13.2	5.13	
Uranium Enrichment Processes	13.2	5.2	
POWER SYSTEMS TECHNOLOGY			
Biological Power			X
High-Density Conventional Systems	14.1		X
Magnetohydrodynamics			X
Mobile Electric Platform Power	14.2		X
Pulsed- and High-Power Systems	14.3		X
Superconductive Power Applications			X

	PART I WST	PART II WMD	PART III DCT
SENSORS AND LASERS TECHNOLOGY			
Acoustic Sensors, Air and Terrestrial Platform	15.1		X
Acoustic Sensors, Marine, Active Sonar	15.2		X
Acoustic Sensors, Marine, Passive Sonar	15.3		X
Acoustic Sensors, Marine Platform	15.4		X
Electro-Optical Sensors	15.5		X
Gravity Meters and Gravity Gradiometers	15.6		
Lasers	15.7		X
Magnetometers and Magnetic Gradiometers	15.8		X
Radar	15.10		
SIGNATURE CONTROL TECHNOLOGY	16.1	1.3,1.4	X
Manufacturing and Validation			X
Readiness and Mission Support			X
Special Materials			X
System Concept Design and Integration			X
Test and System Validation			X
SPACE SYSTEMS TECHNOLOGY			
Astronics			X
Electronics and Computers	17.1		X
Launch Vehicles for Space Systems			X
Optronics	17.2		X
Power and Thermal Management	17.3		X
Propulsion for Space Systems	17.4		X
Qualification and Testing			X
Sensors for Space Systems	17.5		X
Signature Control and Survivability			X
Structures for Space			X
Systems Integration			X

	PART I WST	PART II WMD	PART III DCT
WEAPONS EFFECTS AND COUNTER-MEASURES			
Blast and Shock Effects from Nuclear Detonations		6.2	X
High-Altitude Electromagnetic Pulse (HEMP) Effects		6.6	X
High-Power Microwave Weapons Effects			X
Induced Shock Waves From Penetrating Weapons	18.1		X
Laser Weapons			X
Nuclear Effects on Electromagnetic Signal Propagation		6.5	
Nuclear Thermal Radiation Effects		6.3	X

	PART I WST	PART II WMD	PART III DCT
WEAPONS EFFECTS AND COUNTER-MEASURES (cont'd)			
Particle Beam Weapons			X
Pulsed-Power Nuclear Weapons Effects Simulation		6.8	X
Source Region Electromagnetic Pulse (SREMP) Effects		6.7	X
Transient Radiation Effects in Electronics (TREE) and System-Generated Electromagnetic Pulse Effects (SGEMP)		6.4	X
Underground Nuclear Weapons Testing		6.1	

APPENDIX B
EXPLANATION OF TABLE ELEMENTS

APPENDIX B
EXPLANATION OF TABLE ELEMENTS

Table B-1. Technology Parameters

Technology	Sufficient Technology Level	Export Control Reference	Critical Materials	Unique Test, Prlduction, and Inspection Equipment	Unique Software and Parameters
Technology is defined, giving specific information necessary for the development, production, or use of a product. This includes the hardware and software necessary to achieve that purpose.	The level of technology required for a proliferant to produce entry-level WMD, delivery systems, or other hardware or software useful in WMD development, integration or use.	International and National export control references that address the technology	Critical materials associated with this technology.	Critical/unique production, testing and inspection equipment. If these items were not available for some time, it would be expected that the capability would degrade.	Unique software needed to produce, operate or maintain this technology.

Table B-2. Reference Data

Technology	Technical Issues	Military Applications	Alternative Technologies
Technology is defined, giving specific information necessary for the development, production, or use of a product. This includes the hardware and software necessary to achieve that purpose.	Technical issues that drive/ significantly influence this technology.	Military uses of this technology.	Other technologies that could accomplish this step in WMD processes.

APPENDIX C
GLOSSARY OF ACRONYMS AND ABBREVIATIONS

APPENDIX C
GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ITEM	DESCRIPTION	SECTION
A	ampere	6.3
A/s	ampere/second	6.7
ACIPS	Advanced Collective Integrated Protection System	3.4
ACM	Attitude Control Module	1.1, 1.2, 1.3
ADTS	Asynchronous Digital Transmission Systems	2.2
AG	Australia Group	All
AGL	above ground level	1.1, 1.4
AGR	Advanced Gas Reactor	5.3
Am	Americium	6.7
AS-l5s	FSU Cruise Missile	1.3
ASTM	American Society for Testing Materials	5.12
ATCC	American Type Culture Collection	3.0, 3.1
ATACMS	Army Tactical Missile System	1.5
ATM	Asynchronous transfer mode	2.2, 2.5
AVLIS	Atomic Vapor Laser Isotope Separation System	5.2
B	Biological	3.0, 3.1, 3.2, 3.3, 3.4
B/T	Biological/Toxin	3.1, 3.3
BGO	Berium Germanate	5.10
BLOS	Beyond Line-of-Sight	2.1
BLSRs	Bi-directional Line-switched Rings	2.1, 2.2, 2.5
BLU 80/B	Bigeye Weapon	4.2
BRM	Biological response modifier	3.1, 3.4
BTU	British Thermal Units	1.1, 1.4
BW	Biological Weapon(s)	3.0, 3.1, 3.2, 3.3, 3.4
BWC	Biological Weapons Convention	3.0
BWR	Boiling Water Reactor	5.3

ITEM	DESCRIPTION	SECTION
C2I	Command, Control, and Intelligence	2.1, 2.3, 2.4, 2.5, 2.6
C3	Command, Control, and Communications	6.0, 6.2, 6.4
C3I	Command, Control, Communications, and Intelligence	2.0, 3.3
C4I	Command, control, communications, computers, and intelligence	5.11
CAD	Computer-Aided Design	2.3
CAD/CAE	Computer-Aided Design/ Computer-Aided Engineering	1.1, 1.3
CAM	Chemical Agent Monitor, Computer-Aided Manufacturing	4.3
CANDU	Canadian Deuterium Uranium (Reactor)	5.12, 5.13
CAS	Chemical Abstract Service	4.1, 4.4
CBPS	Chemically and Biologically Protected Shelter	3.4
CC	Combinatorial Chemistry	3.0
CCD	Charge Coupled Device	5.10
CCL	Commerce Control List	All
CCM	Computer-Controlled Machines	5.9
CCS	Common Channeling Signaling	2.5
CEP	circular error probable	1.1, 1.2, 1.3
CFD	Computational Fluid Dynamics	1.3, 1.4, 5.2
CHEMEX	Chemical Exchange Process	5.2, 5.5, 5.12
CID	Charged Injection Device	5.10
CMIP	Common Management Information Protocol	2.5
CMM	Coordinate Measuring Machines	5.9
CNC	Computerized Numerically Controlled	5.0, 5.9
CNM	Customer Network Management	2.5
CO	Central Office	2.2

ITEM	DESCRIPTION	SECTION
COCOM	Coordinating Committee for Multilateral Strategic Export Controls	2.5
COLEX	Column Exchange	5.0, 5.5
CONUS	Continental United States	6.6
COTS	Commercial-off-the-shelf	2.0, 2.1, 2.2, 2.3, 2.4
CPE	Customer Premises Equipment	2.1, 2.5
CPU	Central processing unit	1.3
CSUs	Channel Service Units	2.1
CT	Computed Tomography	1.1, 1.2
CTBT	Comprehensive Test Ban Treaty	2.5, 5.10, 6.1
CVD	Chemical Vapor Deposition	1.4
CW	Chemical Weapon(s)	4.0, 4.1, 4.2, 4.3, 4.4
CWC	Chemical Weapons Convention	4.0, 4.1, 4.4
D	Deuterium	5.5, 5.6, 5.13
D.C.	Direct Current	4.1, 5.5, 5.7
dB	decibel	1.3
DCE	Distributed Computing Environment	2.3
DCN	Data Communication Networks	2.5
DCS	Digital Cross-Connect Systems	2.1, 2.2
DD/DT	Deuterium Deuterium/Deuterium Tritium	5.6
DEMP	Dispersed Electromagnetic Pulse	6.6
DES	Data Encryption Standard	1.1
DF	Difluor: methyl phosphonyl difluoride	4.1
DGZs	Designated Ground Zeros	2.1
DLC	Digital Loop Carrier	2.6
DMSO	Dimethyl sulfoxide	3.2
DNA	Desoxyribonucleic acid	3.0, 3.1, 3.3
DNHR	Dynamic Non-Hierarchical Routing	2.1
DoD	Department of Defense	2.3, 5.10, 5.11
DOE	Department of Energy	5.1, 5.2
DS	Digital Signals	2.2
DS-0	Digital Signal level 0	2.2
DS-I	Digital Signal level 1 = 544 mbytes	2.2
DS-N	Digital Signal Hierarchy	2.2
DSUs	Data Service Units	2.1
DT	Deuterium Tritium	5.6
e.b.b	Equivalent blackbody	6.2, 6.3
EAA	Export Administration Act	Preface
EAR	Export Administration Regulations	1.4, 2.1, 2.2, 2.3, 2.5, 4.2, 4.4
EBR-II	Experimental Breeder Reactor II	5.4
ECCM	Electronic Counter-countermeasures	4.2, 5.7
ECM	Electronic Countermeasures	4.2, 5.7, 5.9
EDM	Electrical Discharge Machines	5.9
EHF	Extremely High Frequency	6.5
ELEX	Electroexchange	5.5
EM	Electromagnetic	5.0, 5.2, 6.6, 6.7
EMIS	Electromagnetic Isotope Separation	5.0, 5.1, 5.2
EMP	Electromagnetic Pulse	5.9, 6.0, 6.1, 6.4, 6.6, 6.7, 6.8
EO	Electro-Optical	5.7
EOD	Explosive Ordinance Disposal	5.11
EOS	Equation of State	5.10
ESA	Electronic Safe and Arm	4.2
FA	Functional Areas	2.0, 2.2, 2.3, 2.4, 2.5, 2.6
FAC	Fast-Acting Closure	6.1
FID	Flame Ionization Detector	4.3
FPD	Flame Photometric Detector	4.3
FRG	Federal Republic of Germany	5.6
FSU	Former Soviet Union	1.1, 1.2, 1.3, 1.4, 1.5, 4.0, 4.1, 5.0, 6.0
FTA	Foreign Technology Assessment	All
FWHM	full width at half maximun	6.7
FXR	Flash x-ray	6.8
G-7	Group of Seven Industrial Nations	1.4
G-8	G-7 Nations plus Russia	2.1

ITEM	DESCRIPTION	SECTION
G agents	Nerve Agents	4.0, 4.1
GA	Tabun (nerve agent)	4.0, 4.1
GB	Sarin (nerve agent)	4.0, 4.1, 4.2
GC	Gas Chromatography	4.3
GD	Soman (nerve agent)	4.0, 4.1
GDP	Gross Domestic Product	5.10
GDSS	Group Decision Support System	2.3
GHz	Gigahertz (10^{+9} hertz)	1.4, 5.2, 5.10, 6.6, 6.8
GMP	Good Manufacturing Practices	3.1
GPa	Gigapascals	6.3
GPS	Global Positioning System	1.1, 1.2, 1.3, 1.4, 2.3, 6.0
GS	Girdler Sulfide	5.12
g's	Measure of Acceleration	1.1, 1.2, 1.5
GSAC	Gas Seal Auxiliary Closure	6.1
Gy	Gray (Gy) is a unit of absorbed dose of ionizing radiation equal to 1 joule per kilogram of absorber	2.6
HDO	Singly Deuterated Water	5.12
HE	High Explosives	1.5, 5.0, 5.6, 5.10
HEMP	High-Altitude Electromagnetic Pulse	6.0, 6.6, 6.7, 6.8
HEPA	High-Efficiency Particulate Air	3.1
HEU	Highly Enriched Uranium	5.0, 5.2, 5.3, 5.5, 5.10
HF	Hydrofluoric Acid	5.1, 5.4
HLOS	Horizontal Line-of-Sight	6.1
HNO3	Nitric Acid	5.1, 5.4
HOB	Height of Burst	4.2, 5.7, 6.0, 6.2, 6.3
HSD	High Strength-to-Density	5.0, 5.2
HTO	Singly Tritiated Water	5.13
HTT	Horizontal Tunnel Tests	6.1
HVAC	Heating, ventilation, and air conditioning	2.6
HWR	Heavy Water Reactor	5.3

ITEM	DESCRIPTION	SECTION
Hz	hertz	1.1, 1.2, 1.3, 1.4, 1.5, 5.0, 5.2, 5.7
IAEA	International Atomic Energy Agency	5.0, 5.4
IC	Intelligence Community	5.0
ICBM	Intercontinental Ballistic Missiles	Introduction, 1.0, 1.1, 1.2, 5.0, 6.2
IEEE	Institute of Electrical Engineers	2.5
IM&C	Information System Management and Control	2.1, 2.5
IMS	Ion Mobility Spectrometry	3.3, 4.3
IMUs	Inertial Measurement Units	1.2, 1.3, 1.4
IND	Improvised Nuclear Device	5.11
INFOSEC	Information Security	2.4
INMS	Integrated Network Management Systems	2.5
IP	Information Processing	2.3
IR	Infrared	1.3, 1.4, 4.3, 5.7, 6.3, 6.5
IS	Information System	2.0, 2.2, 2.3, 2.4, 2.5, 2.6
ISO	International Standards Organization	2.5, 5.10
ITU	International Telecommunications Union	2.1, 2.2, 2.5
IX	Information Exchange	2.2
IXCs	Inter-exchange Carrriers	2.1, 2.5
JSLIST	Joint Service Lightweight Suit Technology	4.4
JSTARs	Joint Surveillance Target Attack Radar System	1.4
K	Kelvin temperature	5.9, 5.10, 6.2, 6.3
kA	kiloamperes	6.7
kbar	kilobar	6.3
kbps	kilobits per second	2.2
keV	kilo (thousand) electron volt	5.9, 5.9, 5.10, 5.13, 6.1, 6.3, 6.8

ITEM	DESCRIPTION	SECTION
kHz	kilohertz	1.1, 6.5
kJ	kilojoule	6.3, 6.8
km	kilometer	1.1, 1.2, 1.3, 1.5, 3.2, 4.3, 5.10, 6.5, 6.6, 6.7
kPa	kilopascal (0.00987 atmospheres)	1.1, 1.2, 6.2
kT	kilotons	5.6, 6.0, 6.2, 6.3
ktap	one thousand dyne centimeters per second	6.3
kV	kilovolt	6.6, 6.7
kV/m	thousand volts per meter	6.6, 6.8
kV/ns	thousand volts per nanosecond	6.6
kW	kilowatts	1.4, 5.2, 5.9, 6.3
L	Lithium	5.0, 5.5
LANS	Local Area Networks	2.2
LBTS	Large Blast/Thermal Simulator	6.3
LECs	Local Exchange Carriers	2.1, 2.5
LEU	Low Enriched Uranium	5.0, 5.1, 5.3
LIDAR	Light detection and ranging	3.2, 3.3, 4.3
LIHE	Light-Initiated High Explosive	6.3
LIS	Laser Isotope Separation	5.0, 5.2
LMFBR	Liquid Metal Fast Breeder Reactor	5.3
LTBT	Limited Test Ban Treaty	5.10, 6.0, 6.3, 6.5, 6.6
LWIR	long-wave infrared	6.5
m/s	meters per second	6.1
MA	mega-ampere	6.8
mA	milliamperes	1.5
MAC	Modified Auxiliary Closure	6.1
MAN/WANS	Metropolitan Area and Wide-area Networks	2.2
Mbps	Megabytes per second	2.2
MC-1	Chemical Bomb	4.2
MCTL	Militarily Critical Technologies List	All
MeV	million electron volts	5.6, 5.9, 5.13, 6.1, 6.8

ITEM	DESCRIPTION	SECTION
MHD-EMP	Magnetohydrodynamic Electro-magnetic Pulse	6.6
MHz	megahertz	2.1, 5.10, 6.1
MIB	Management Information Base	2.5
MIRV	Multiple Independently Targetable Reentry Vehicles	5.0
MIS	Management Information System	2.0
ML	Munitions List (Wassenaar Arrangement)	All
MLIS	Molecular Laser Isotope Separation	5.0, 5.2
MLRS	Multiple Launch Rocket System	1.0, 1.1, 1.2, 1.5, 4.0
mm	millimeter	1.4, 1.5, 4.1, 6.2
MMD	Mass Medium Diameter	3.2
MOD	Means of Delivery (of WMD)	Introduction
MOPP	Mission-Oriented Protective Posture	3.4
MOS	Metal-Oxide Semiconductor	6.4
MPa	megapascal	5.2, 5.12, 6.2
mph	mile per hour	6.2
ms	millisecond	6.1, 6.8
MS-MS	Mass Spectrometry–mass spectrometry	4.3
MT	metric ton	5.4, 6.0, 6.3
MTBF	Mean Time Between Failures	5.2
MTCR	Missile Technology Control Regime	All
MW	megawatt	5.2, 5.3, 6.3
NATO	North Atlantic Treaty Organization	4.4, 6.0, 6.2, 6.3, 6.6, 6.7
NC	numerically controlled	1.1, 1.3, 5.9
NCP	Network Control Points	2.5
NDUL	Nuclear Dual-Use List (NSG)	Introduction, 1.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.9, 5.10, 5.12, 5.13
NE	Network Element	2.5
nm	nanometer	6.2, 6.3
NNWS	Non-Nuclear Weapons States	Appendix E

ITEM	DESCRIPTION	SECTION
NOC	Network Operations Center	2.5
NPT	Nuclear Non-Proliferation Treaty	Appendix E
NRC	Nuclear Regulatory Commission	Introduction, 5.0
ns	nanosecond	5.10, 6.1, 6.2, 6.4, 6.6, 6.8
NSG	Nuclear Suppliers Group	Introduction, 5.0, 5.13
NTL	Nuclear Trigger List (Supplement of NSG)	Introduction, 5.3
NUDET	Nuclear Denotation	6.3
NWE	Nuclear Weapons Effects	6.0, 6.1, 6.2, 6.8
NWES	Nuclear Weapons Effects Simulation	6.8
NWSs	Nuclear Weapons States	5.0
OC	Optical Carrier	2.2
OLAP	On-Line Analytical Processing	2.3
OLTP	On-Line Transaction Processing	2.3
OOT	Object-Oriented Technologies	2.3
OPSEC	Operations Security	2.4, 5.11
OTS	off-the-shelf	5.10
Pa/s	pascals per second	6.3
PALs	Permissive Action Links	5.0, 5.7
PBV	Post-Boost Vehicle	1.2
PBX	Plastic-Bonded Explosives	5.9
PC	Personal Computer	1.3, 1.4, 2.3, 5.0
PD	Photo Detectors	5.10
PINs	Personal Identification Numbers	2.4
PM	Photo Multipler	5.10
psi	pounds per square inch	1.2, 5.2, 6.1, 6.2, 6.3
PSP	Plasma Separation Process	5.2
PTT	Postal, Telephone, and Telegraph	2.5
Pu	Plutonium	5.0, 5.6
PUREX	Plutonium Uranium Recovery by Extraction	5.4
PWR	Pressurized Water Reactor	5.3

ITEM	DESCRIPTION	SECTION
QL	CW Precursor	4.1
R&D	Research and Development	1.4
rad(si)	Radiation Absorbed Dose (in Silicon)	6.4, 6.7
rads	Radiation Absorbed Dose	6.4
RaLa	Radio Lanthanum	5.10
RBMK	(Russian) High-power Pressure-tube Reactor	5.3
rcs	radar cross section	1.3, 1.4
rf	radio frequency	6.5
RMS	root-mean-square	1.4, 5.9
rpm	Revolutions per minute	1.1, 1.2
RSCAAL	Remote Sensing Chemical Agent Alarm	4.3
RV	Reentry Vehicles	1.1, 1.2, 6.2, 6.3, 6.4, 6.5
SAFF	Safing, Arming, Fuzing, and Firing	5.0, 5.7
SAW	Surface acoustic wave	3.3, 4.3
SCPE	Simplified Collective Protection Equipment	3.4
SCUD	Short-Range Missile	1.0, 1.2
SDH	Synchronous Digital Hierarchy	2.1, 2.2
SDN	Software-Defined Network	2.1, 2.2
SELT	Sheet-Explosive Loading Technique	6.3
SEU	Single-Event Upset	6.4
SGEMP	System-Generated Electromagnetic Pulse	6.0, 6.4, 6.8
SHF	Super High Frequency	6.5
SI	Système Internationale d'Unités (the International System of Units)	2.6, 5.9
SLAM	Standoff Land Attack Missile	1.3
SMNP	Simple Management Network Protocol	2.5
SMR	Specialized Mobile Radio	2.1, 2.6
SMS	System Management System	2.5
SNM	Special Nuclear Material	5.0, 5.6, 6.0
SONET	Synchronous Optical Network	2.1, 2.2, 2.5

ITEM	DESCRIPTION	SECTION
SPES	Synchronous Payload Envelopes	2.2
SPLAT	Spray Lead at Target	6.3
SREMP	Source Region Electromagnetic Pulse	6.0, 6.1, 6.7, 6.8
SS	Signaling System	2.5
STS	Stockpile to Target Sequence	5.7
T	Tritium	5.5, 5.6, 5.13
TAPS	Tunnel and Pipe Seals	6.1
TBM	Theater Ballistic Missiles	1.1, 1.2
TBP	Tri-n-butyl-phosphate	5.1, 5.4
TDD	Target Detection Device	5.7
TEL	Transporter/Erector Launcher	1.1, 1.3
TERCOM	Terrain Contour Matching	1.3
TFC	Transverse Field Compensation	4.3
TMNs	Telecommunication Management Networks	2.2, 2.5
TMS	Thermomechanical Shock	6.8
TN	Thermonuclear	5.6, 5.13
TNT	Trinitrotoluene	5.0, 5.7, 5.10, 6.2
TREE	Transient Radiation Effects on Electronics	6.0, 6.4, 6.8
TSR	Thermostructural Shock	6.8
TSS	Telecommunications System Sector	2.5
TV	Television	3.1, 5.10
TVC	Thrust Vector Control	1.2
TW	Toxin weapon; throw weight	3.1, 6.8
TWG	Technology Working Group	Introduction, 5.0
U	Uranium	5.0, 5.1
UAV	Unmanned Aerial Vehicles	1.3, 1.5, 5.8
UGT	Underground Testing	6.0, 6.1
UGWET	Underground Weapons Evaluation and Testing	6.1

ITEM	DESCRIPTION	SECTION
UHF	Ultra High Frequency	6.5
UK	United Kingdom	All
UN	United Nations	1.1, 4.1
USAMRIID	United States Army Medical Research Institute of Infectious Diseases	3.0
USML	United States Munitions List	All
USSR	Union of Soviet Socialist Republics	3.0
UV	Ultraviolet	3.1, 6.5
V/m	volts/meter	6.7
V-A	volt-ampere	5.2
V Agents	Nerve Agents	4.0, 4.1
VCNs	Voice Communications Network	2.5
VIS	Visible	6.5
VPNs	Virtual Private Networks	2.5
VSATs	Very-Small-Aperture Terminals	2.1
VX	Nerve Agent	4.0, 4.1, 4.2, 4.3
WA	Wassenaar Arrangement	All
WA Cat	Wassenaar Arrangement—Dual-use List Category	All
WA ML	Wassenaar Arrangement—Munitions List	All
WEB	Weapons Effects Test	2.3
WMD	Weapons of Mass Destruction	Introduction, 1.0, 1.3, 1.4, 1.5, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.0, 5.7
WSMR	White Sands Missile Range	6.2
WST	Weapons Systems Technologies	Introduction
WWI	World War I	4.0
WWMCCS	World-Wide Military Command and Control Systems	2.6

APPENDIX D
DEFINITIONS

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Accuracy. (*Usually measured in terms of inaccuracy*) is maximum deviation, positive or negative, of an indicated value from an accepted standard of true value.

Active. Guidance by which a missile, warhead, or projectile emits radiation (usually radio frequency) and homes in on the signal reflected from a selected target.

Active cooling. Optical components use flowing fluids in the subsurface of the optical component to remove heat from the system.

Active flight control systems. Function to prevent undesirable "aircraft" and missile motions or structural loads by autonomously processing outputs from multiple sensors and then providing necessary preventive commands to effect automatic control.

Active pixel. A minimum (single) element of the solid-state array which has a photoelectric transfer function when exposed to light (electromagnetic) radiation.

Active tooling unit. A device for applying motive power, process energy, or sensing to the workpiece.

Adaptive control. A control system that adjusts the response from conditions detected during the operation. (Reference: ISO 2806-1980.)

Additives. Substances used in explosive formulations to improve their properties.

Aircraft. A fixed-wing, swivel-wing, rotary-wing (helicopter), tilt-rotor, or tilt-wing airborne vehicle. (See also "**Civil aircraft**.")

Alkylation. A reaction that introduces an alkyl group. For CWC purposes, a phosphorus-carbon bond is produced.

Alloyed aluminide coatings. Coatings of nickel or titanium aluminides modified with other metals such as chromium.

Aluminum alloys. Alloys having an ultimate tensile strength of 190 MPa or more measured at 293 K (20 °C).

Angular position deviation. The maximum difference between angular position and the actual, very accurately measured angular position after the workpiece mount of the table has been turned out of its initial position. (Reference: VDI/VDE 2617, Draft: "Rotary tables on coordinate measuring machines.")

Antibodies. See "**Anti-idiotypic antibodies**," "**Monoclonal antibodies**," and/or "**Polyclonal antibodies**."

Anti-idiotypic antibodies. Antibodies which bind to the specific antigen binding sites of other antibodies.

Application Specific Integrated Circuit (ASIC). Preprogrammed VLSI (Very Large Scale Integrated) or LSI (Large Scale Integrated) circuit used for a specific application.

Assemblies. A number of electronic components (i.e., circuit elements, discrete components, integrated circuits, etc.) connected together to perform a specific function, replaceable as an entity and normally capable of being disassembled.

Asynchronous transfer mode (ATM). A transfer mode in which the information is organized into cells; it is asynchronous in the sense that the recurrence of cells depends on the required or instantaneous bit rate. (CCITT Recommendation L. 113.)

Australia Group. An informal international forum, chaired by Australia, that seeks to discourage and impede the proliferation of chemical and biological weapons by harmonizing national export controls on chemical materials, biological organisms, and dual-use equipment that could be used in chemical and biological weapons production.

Automatic target tracking. A processing technique that automatically determines and provides as output an extrapolated value of the most probable position of the target in real time.

Bandwidth of one voice channel. In the case of data communication equipment designed to operate in one voice channel of 3,100 Hz, as defined in CCITT Recommendation G.151.

Bar. A unit of pressure that is equal to 10^6 dynes/cm^2, or 14.5 psi (i.e., approximately sea-level atmospheric pressure).

Basic scientific research. Experimental or theoretical work undertaken principally to acquire new knowledge of the fundamental principles of phenomena or observable facts, not primarily directed towards a specific practical aim or objective.

Bias (accelerometer). An accelerometer output when no acceleration is applied.

Biocatalysts. "Enzymes" or other biological compounds which bind to and accelerate the degradation of CW agents.

Biological Agent. A microorganism, or toxin derived from it, which causes disease in humans, animals or plants, or which causes the deterioration of material.

Biopolymers. Biological macromolecules as follows: "enzymes," "antibodies," "monoclonal," "polyclonal," or "anti-idiotypic," specially designed or specially processed "receptors."

Black body. A perfect emitter (radiator) of electromagnetic radiation having a characteristic temperature that is the sole determinant of its radiated energy spectrum.

Blast. The brief and rapid movement of air, vapor, or fluid away from a center of outward pressure.

Blister agent (vesicant). An agent that burns and blisters the skin, eyes, respiratory tract, and lungs.

Blood agent. An agent that prevents the normal transfer of oxygen from the blood to body tissues.

Brilliant munition. A many-on-many munition that operates autonomously to search for, detect, identify, acquire, and attack specific classes of targets. The sensor on each munition acquires and attacks one among the class of targets, so that in a battlefield situation two munitions may attack the same target leaving others inviolate.

Bulk. A comparatively large quantity of a substance or commodity that is manufactured, shipped, and stored as such, but which is characteristically broken down into smaller lots before application or further processing.

Burnout (electronics). A type of failure that implies the destruction of a component caused by a permanent change in one or more characteristics beyond an acceptable amount.

CAD (computer-aided design). The use of a computer and computer graphics in the design of parts, products, and others.

CAE (computer-aided engineering). Analysis of a design for basic error-checking, or to optimize manufacturability, performance, and economy (for example, by comparing various possible materials or designs).

Calorie. The amount of heat required to raise the temperature of 1 gram of water from 15 °C to 16 °C at 760 mm Hg pressure.

CAM (computer-aided manufacturing). The effective utilization of computer technology in the management, control, and operations of the manufacturing facility through either direct or indirect computer interface with the physical and human resources of the company.

C3I System. See "**Integrated C3I systems**."

Camming (axial displacement). Axial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle faceplate, at a point next to the circumference of the spindle faceplate. (Reference: ISO 230.1 1986, paragraph 5.63.)

Cathodic Arc Deposition. See "**Thermal evaporation-physical vapor deposition (TE-PVD)**."

CEP. Circular Error Probable or Circle of Equal Probability. A measure of accuracy at a specific range, expressed in terms of the radius of the circle, centered on the target, in which 50 percent of the payloads impact.

Chemical Abstract Service (CAS) registry number. A unique number which links the molecular structure of a chemical with its Chemical Abstracts index name and other data. Each number designates a single substance so far as its structure has been elucidated and can be defined in terms of atoms (composition), valence bonds (structure), and stereochemistry.

Chemical laser. A "laser" in which the excited species is produced by the output energy from a chemical reaction.

Chemical vapor deposition (CVD). An overlay coating or surface modification coating process wherein a metal, alloy, "composite," dielectric or ceramic is deposited upon a heated substrate. Gaseous reactants are decomposed or combined in the vicinity of a substrate resulting in the deposition of the desired elemental, alloy or compound material on the substrate. Energy for this decomposition or chemical reaction process may be provided by the heat of the substrate, a glow discharge plasma, or "laser" irradiation.

Chemical weapons (CW). (From the CWC)

"(a) Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes;

(b) Munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals specified in subparagraph (a), which would be released as a result of the employment of such munitions and devices;

(c) Any equipment specifically designed for use directly in connection with the employment of munitions and devices specified in subparagraph (b)." (CWC, Article II)

Chemical Weapons Convention (CWC). A multilateral treaty that bans the development, production, acquisition, stockpiling, retention, and direct or indirect transfer and use of chemical weapons. It also prohibits the use or preparation for use of CW and the assistance, encouragement, or inducement of anyone else to engage in activities prohibited by the treaty. It further requires participating states to destroy existing chemical weapons and any CW production facilities.

Chip. Micromechanical/microelectronic devices on a single substrate.

Choking agent. An agent that attacks the eyes and respiratory tract from the nose to the lungs, primarily causing pulmonary edema ("dry drowning").

Circuit element. A single active or passive functional part of an electronic circuit, such as one diode, one transistor, one resistor, one capacitor, etc.

Circumvention (electronics). A system protection technique in which detection of the onset of nuclear radiation or EMP puts a critical portion of the system in a protected condition. A system-level technique using special hardware and software for recovering from a transient upset.

Civil aircraft. Those "aircraft" listed by designation in published airworthiness certification lists by the civil aviation authorities to fly commercial civil internal and external routes or for legitimate civil, private, or business use. (See also **"Aircraft."**)

CLOS. A "command-to-line-of-sight" guided-munition system in which an operator looks through a sight, searches, detects, and acquires a target, then aims and fires a missile. Guidance commands are automatically generated at the launcher by continually comparing the aimpoint to the current missile location. Corrective commands are transmitted to the missile through a wire link between the launcher and the missile, causing the missile to fly along the line of sight between the launcher and the target (for example, the TOW missile).

Cluster tool. A set of process chambers or modules linked by a wafer transport, in a controlled environment, and with a communication system that can control sequential processing in a semiconductor fab line.

Commingled. Filament-to-filament blending of thermoplastic fibers and reinforcement fibers in order to produce a fiber reinforcement/"matrix" mix in total fiber form.

Comminution. A process to reduce a material to particles by crushing or grinding.

Common channel signaling. A signaling method in which a single channel between exchanges conveys, by means of labeled messages, signaling information relating to a multiplicity of circuits or calls and other information such as that used for network management.

Communications. The process of representing, transferring, interpreting or processing information (data) among persons, places, or machines. Communications implies a sender, a receiver, and a transmission medium over which the information travels. The meaning assigned to the data must be recoverable without degradation. (See also Telecommunications)

Communications channel controller. The physical interface which controls the flow of synchronous or asynchronous digital information. It is an assembly that can be integrated into computer or telecommunications equipment to provide communications access.

Compensation (TREE). A general category of techniques employed to divert primary and secondary photocurrents or to nullify their effects as an aid to circuit hardening against ionizing radiation.

Composite. A "matrix" and an additional phase or additional phases consisting of particles, whiskers, fibers, or any combination thereof present for a specific purpose or purposes.

Composite theoretical performance (CTP). A measure of computational performance given in millions of theoretical operations per second (MTOPS), calculated using the aggregation of "computing elements (CE)."

Compound rotary table. A table allowing the workpiece to rotate and tilt about two nonparallel axes, which can be coordinated simultaneously for "contouring control."

Computer operating area. The immediate contiguous and accessible area around the electronic computer, where the normal operating, support, and service functions take place.

Computer using facility. The end-user's contiguous and accessible facilities housing the "computer operating area" and those end-user functions which are being supported by the stated application of the electronic computer and its related equipment; *and* not extending beyond 1,500 meters in any direction from the center of the "computer operating area."

Computing element (CE). The smallest computational unit that produces an arithmetic or logic result.

Contouring control. Two or more "numerically controlled" motions operating in accordance with instructions that specify the next required position and the required feed rates to that position. These feed rates are varied in relation to each other so that a desired contour is generated. (Reference: ISO/DIS 2806-1980.)

Control. The process of steering a missile, while stabilizing it against disturbances such as wind gusts or blast, by the operation of aerodynamic surfaces, air or jet vanes, gas jets, or attitude control of rocket motors. Control subsystems respond to guidance (q.v.) signals to correct the attitude and position of a missile, and to activate power sources, servomechanisms, and other components.

Conventional unguided projectiles. Those which do not incorporate directional warheads, including warheads employing multi-point initiation to achieve focused blast/fragmentation characteristics; submunitions or submunition capacity; fuel/air explosives; provisions for increasing the range or impact velocity; kinetic energy armor penetration capability; mid-flight guidance; terminal guidance.

Correlated munition. See **"Sentient"** munition.

Corrosion-resistant steel. Steel which is AISI (American Iron and Steel Institute) 300 series or equivalent national standard steels.

Co-spray. Simultaneously but separately injecting both ceramic and metal powders/particulates into a high-temperature plasma stream to form a metal matrix composite upon solidification on a substrate.

Critical Temperature. (Sometimes referred to as the transition temperature) of a specific "superconductive" material is the temperature at which the material loses all resistance to the flow of direct electrical current.

Cruise Missile. An unmanned self-propelled guided vehicle that sustains flight through aerodynamic lift for most of its flight path and whose primary mission is to place an ordnance or special payload on a target.

Cryptanalysis. The analysis of a cryptographic system or its inputs and outputs to derive confidential variables or sensitive data, including clear text. [ISO 7498-2-1988 (E), paragraph 3.3.18.]

Cryptography. The discipline which embodies principles, means, and methods for the transformation of data in order to hide its information content, prevent its undetected modification, or prevent its unauthorized use. "Cryptography" is limited to the transformation of information using one or more secret parameters (e.g., crypto variables) or associated key management.

Cryptomaterial. All material including documents, devices, equipment, and apparatus essential to the encryption, decryption, or authentication of telecommunications. When classified, it is designated CRYPTO and subject to special safeguards.

CWC Schedules. In the CWC, the three categories into which toxic chemicals and their precursors are divided based on the threat the chemicals/precursors pose to the purpose and objectives of the Treaty and the extent of their commercial use.

Cyanation. A reaction in which a cyanide group is added. For CWC purposes, a cyanide group is bonded to a phosphorus atom.

Data device. Equipment capable of transmitting or receiving sequences of digital information.

Designed or modified. Equipment, parts, components, or software that, as a result of "development or modification," have specified properties that make them fit for a particular application. The designed or modified equipment, parts, components, or software can be used for other applications. For example, a titanium-coated pump designed for a missile can be used with corrosive fluids other than propellants. (MTCR.)

Detonation (high-explosive). A violent chemical reaction with a chemical compound or mechanical mixture evolving heat and pressures.

Detonation, nuclear. A nuclear explosion resulting from fission or fusion reactions in nuclear materials, such as that from a nuclear weapon.

Developing Critical Technologies. Technologies which when fully developed and incorporated into a military system will produce increasingly superior performance or maintain a superior capability more affordably.

Digital computer. Equipment which can, in the form of one or more discrete variables, accept data, store data or instructions in fixed or alterable writable storage devices, process data by means of a stored sequence of instructions which is modifiable, and provide output of data.

Digitizing rate. The rate (in samples per second) at which the acquired signal can be converted to digital information.

Discrete component. A separately packaged circuit element with its own external connection.

Dose, absorbed. The amount of energy imparted by nuclear (or ionizing) radiation to unit mass of absorbing material. The unit is the rad. In current usage, the rad unit has been replaced by the SI unit, the gray (Gy) [1 Gy = 100 rads].

Doppler. The special radiation line broadening attributable to the motion of the source or of the target, and sensed by detection and tracking systems.

Drift. Environmental or thermal effects on response of a machine or device to gradually move away from the desired response.

Drift rate (gyro). The time rate of output deviation from the desired output. It consists of random and systematic components and is expressed as an equivalent input angular displacement per unit time with respect to inertial space.

Dynamic adaptive routing. Automatic rerouting of traffic based on sensing and analysis of current actual network conditions.

Dynamic signal analyzers. "Signal analyzers" which use digital sampling and transformation techniques to form a Fourier spectrum display of the given waveform including amplitude and phase information. (See also **"Signal analyzers."**)

Electron Beam PVD. See **"Thermal evaporation-physical vapor deposition (TE-PVD)."**

Electronically steerable phased array antenna. An antenna which forms a beam by means of phase coupling; i.e., the beam direction is controlled by the complex excitation coefficients of the radiating elements, and the direction of that beam can be varied in azimuth or in elevation, or both, by application, both in transmission and reception of an electrical signal.

End-effectors. "End-effectors" include grippers, "active tooling units" and any other tooling that is attached to the baseplate on the end of a "robot" manipulator arm.

Energetic materials. A collective term for military high explosives, propellants, and pyrotechnics, which is synonymous with the term "military explosives" (the preferred NATO/COCOM usage). Although the term has been adopted by some also to cover commercial explosives, it is used in the MCTL only to refer to military technology.

Ensembling. A process to improve clock performance by using multiple clocks and to improve reliability by redundancy, self-monitoring, or reduction of signal perturbations.

Enzymes. "Biocatalysts" for specific chemical or biochemical reactions.

Equivalent density. The mass of an optic per unit optical area projected onto the optical surface.

Expression vectors. Carriers (e.g., plasmid or virus) used to introduce genetic material into host cells.

Fast select. A facility applicable to virtual calls which allows data terminal equipment to expand the possibility to transmit data in call set-up and clearing "packets" beyond the basic capabilities of a virtual call.

Fault tolerance. The capability of a computer system, after any malfunction of any of its hardware or "software" components, to continue to operate without human intervention, at a given level of service that provides continuity of operation, data integrity and recovery of service within a given time.

Fibrous and filamentary materials. These materials include continuous monofilaments; continuous yarns and rovings; tapes, fabrics, random mats and braids; chopped fibers, staple fibers and coherent fiber blankets; whiskers, either monocrystalline or polycrystalline, of any length; aromatic polyamide pulp.

Film type integrated circuit. An array of "circuit elements" and metallic interconnections formed by deposition of a thick or thin film on an insulating "substrate."

Firmware. Implementation of software in hardware circuitry or read-only memory.

Fixed. The coding or compression (e.g., cryptographic or key variables) that cannot be modified by the user.

Fixed ammunition. Ammunition rounds in which the cartridge with propellant and the loaded shell or "bullet" are all in one unit. With semifixed rounds the cartridge case is not permanently fixed to the projectile, so that zone charges within cases can be adjusted to obtain desired ranges, but each round is inserted into a weapon as a unit.

Fixed-sequence manipulation mechanisms. Automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic, or electrical means.

Fluoride fibers. Fibers manufactured from bulk fluoride compounds.

Frequency agility (frequency hopping). A form of "spread spectrum" in which the transmission frequency of a single communication channel is made to change by discrete steps.

Frequency agility (radar). See **"Radar frequency agility."**

Frequency switching time. The maximum time (i.e., delay) taken by a signal, when switched from one selected output frequency to another selected output frequency, to reach a frequency within 100 Hz of the final frequency *or* an output level within 1 dB of the final output level.

Frequency synthesizer. Any kind of frequency source or signal generator, regardless of the actual technique used, providing a multiplicity of simultaneous or alternative output frequencies, from one or more outputs, controlled by, derived from, or disciplined by a lesser number of standard (or master) frequencies.

Gas atomization. A process to reduce a molten stream of metal alloy to droplets of 500-micrometer diameter or less by a high-pressure gas stream.

Gateway. The function, realized by any combination of equipment and "software," to carry out the conversion of conventions or representing, processing, or communicating information used in one system into the corresponding but different conventions used in another system.

Generic software. A set of instructions for a "stored program controlled" switching system that is the same for all switches using that type of switching system.

Geneva Protocol of 1925. A multilateral agreement that prohibits the use of poisonous gases and bacteriological weapons in war. It was opened for signature in 1925 and was ratified by the United States in 1975.

Geographically dispersed. Sensors are considered "geographically dispersed" when each location is distant from any other more than 1,500 m in any direction. Mobile sensors are always considered "geographically dispersed."

Global interrupt latency time. The item taken by the computer system to recognize an interrupt due to the event, service the interrupt, and perform a context switch to an alternative memory-resident task waiting on the interrupt.

Gray. The gray (Gy) is a unit of absorbed dose of ionizing radiation; one Gy is an absorbed dose of ionizing radiation equal to one joule per kilogram of absorber. The gray replaces the rad. One rad = 0.01 Gy.

Guidance. The data collection and command process whereby a missile or space vehicle is directed to a specified destination. Guidance subsystems may be internal or external to a missile system; may be preset, active, passive or semi-active; and function independently over initial, midcourse, and terminal phases of a flight path.

Guidance munition. A "one-on-one" munition: a specific munition engages a specific target, which is advantageous during close combat situations. An operator is required in the loop to select the target and often assist in the guidance. The munitions may be either CLOS or "terminal homing" devices.

Guidance sets. A device that integrates the data collection and command process that directs a missile or space vehicle to its target.

High Energy Laser (HEL). A laser which has an average or CW power level of nominally tens of kilowatts of power and which operates for nominally a few seconds, providing energies of 10^4 Joules or larger. When the HEL is operated in a pulsed mode, the energy is averaged over 1 second or the duration of the laser train of pulses, whichever is longer.

"Hit-to-kill". A munition system incorporating integrated seeker, guidance and control, and fuze subsystems, the warhead of which is initiated upon target impact or in close proximity thereto.

Hot isostatic densification. A process of pressurizing a casting at temperatures exceeding 375 K (102 °C) in a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal force in all directions to reduce or eliminate internal voids in the casting.

Hybrid computer. Equipment which can accept and process data in both analog and digital representations *and* provide output of data.

Hybrid integrated circuit. Any combination of integrated circuit(s), or integrated circuit with "circuit elements" or "discrete components" connected to perform specific function(s), and having all of the following characteristics: containing at least one unencapsulated device; connected using typical IC production methods; replaceable as an entity; *and* not normally capable of being disassembled.

Image enhancement. The processing of externally derived information-bearing images by algorithms such as time compression, filtering, extraction, selection, correlation, convolution, or transformations between domains (e.g., fast Fourier transform or Walsh transform). This does not include algorithms using only linear or rotational transformation of a single image, such as translation, feature extraction, registration, or false coloration.

Impulse, specific. The thrust developed in burning unit weight of a propellant, corrected for standard operating and discharge pressures. Specific impulse may be measured, or they may be estimated theoretically from the thermochemical properties of propellant formulations and their decomposition products.

Impulse, total. The integral of the thrust of a rocket motor over the burning time. Other factors being equal the same total impulse can result from a small thrust over a long burn time as from a high thrust over a short burn time.

In the public domain. Means technology or software which has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove technology or software from being in the public domain.)

In-bulk. See **"Bulk."**

Inertial environmental test conditions.

(1) Input random vibration with an overall "g" level of 7.7 g rms in the first half hour and a total test duration of 1-1/2 hour per axis in each of the three perpendicular axes, when the random vibration meets the following:
   (a) A constant power spectral density (PSD) value of 0.04 g^2/Hz over a frequency interval of 15 to 1,000 Hz; and
   (b) The PSD attenuates with frequency from 0.04 g^2/Hz to 0.001 g^2/Hz over a frequency interval from 1,000 to 2,000 Hz;

(2) A roll and yaw rate of equal to or more than + 2.62 radian/s (150 deg/s); or

(3) According to national standards equivalent to (1) or (2) above.

Information security. All the means and functions ensuring the accessibility, confidentiality or integrity of information or communications, excluding the means and functions intended to safeguard against malfunctions. This includes "cryptography," "cryptanalysis," protection against compromising emanations, and computer security.

Information system. People, technologies, and machines used to capture or generate, collect, record, store, retrieve, process, display and transfer or communicate information to multiple users at appropriate levels of an organization to accomplish a specified set of functions.

Information systems. The entire infrastructure, organization, personnel, and components that collect, process, store, disseminate, and act on information.

Information warfare. Actions taken to achieve information superiority by affecting adversary information, information-based processes, information systems, and computer-based networks while defending one's own information, information-based processes, information systems, and computer-based networks.

Instantaneous bandwidth. The bandwidth over which output power remains constant within 3 dB without adjustment of other operating parameters.

Instrumented range. The specified unambiguous display range of a radar.

Integrated C3I systems. Fabricated combinations of platforms; sensors and weapons; "software" and data-processing equipment; related communications subsystems; and user-system interfaces specifically designed for the control of U.S. armed forces and weapons systems. Command, control, communications, and intelligence systems are integrated combinations of military *command information processing, communications network,* and *intelligence gathering subsystems* (including surveillance, warning, and identification subsystems) that make up the U.S. C^2I systems. These combined technologies support U.S. authorities at all echelons with the "integrated C^2I systems" that provide the timely and adequate data "required" to plan, direct, and control U.S. military forces and operations in the accomplishment of their missions.

Integrated services digital network (ISDN). A unified end-to-end digital network, in which data originating from all types of communication (e.g., voice, text, data, still and moving pictures) are transmitted from one port (terminal) in the exchange (switch) over one access line to and from the subscriber.

Interconnected radar sensors. Two or more radar sensors are interconnected when they mutually exchange data in real time.

Interpolation. The means in NC by which curved sections are approximated by a series of straight lines or parabolic segments.

Intrinsic magnetic gradiometer. A single magnetic field gradient sensing element and associated electronics, the output of which is a measure of magnetic field gradient. (See also **"Magnetic Gradiometers."**)

Ion implantation. A surface modification coating process in which the element to be alloyed is ionized, accelerated through a potential gradient, and implanted into the surface region of the substrate. This includes processes in which ion implantation is performed simultaneously with electron beam physical vapor deposition or sputter deposition.

Ion plating. A special modification of a general TE-PVD process in which a plasma or an ion source is used to ionize the species to be deposited, and a negative bias is applied to the substrate to facilitate the extraction of the species to be deposited from the plasma. The introduction of reactive species, evaporation of solids within the process chamber, and the use of monitors to provide in-process measurement of optical characteristics and thicknesses of coatings are ordinary modifications of the process.

Isostatic presses. Equipment capable of pressurizing a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity.

K-factor. A standard method for expressing the surface hardness and finish of a machined gear tooth.

Laser. An assembly of components which produce both spatially and temporally coherent light that is amplified by stimulated emission or radiation.

Latch-Up Free. A device or an integrated circuit which does not have an intentional or non-intentional four-layer p-n-p-n structure. For example, integrated circuits properly fabricated on silicon on insulator (SOI) substrates would be latch-up free.

Linearity. (Usually measured in terms of non-linearity) is the maximum deviation of the actual characteristics (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to equalize and minimize the maximum deviations.

Line of sight. Guidance by which the missile, warhead, or projectile is commanded to follow a trajectory that will cause it to intercept a target in a direction defined by a target tracker. The method requires two-way communication with the missile, warhead, or projectile either by means of an IR, RF, wire, or fiber-optic link.

Local area network. A data communication system which allows an arbitrary number of independent "data devices" to communicate directly with each other *and* is confined to a geographic area of moderate size (e.g., office building, plant, campus, warehouse).

Mach number. The ratio of the speed of an object to the speed of sound in the surrounding medium.

Magnetic gradiometers. Instruments designed to detect the spatial variation of magnetic fields from sources external to the instrument. They consist of multiple "magnetometers" and associated electronics, the output of which is a measure of magnetic field gradient. (See also **"Intrinsic magnetic gradiometer."**)

Magnetometers. Instruments designed to detect magnetic fields from sources external to the instrument. They consist of a single magnetic field sensing element and associated electronics, the output of which is a measure of the magnetic field.

Main storage. The primary storage for data or instructions for rapid access by a central processing unit. It consists of the internal storage of a "digital computer" and any hierarchical extension thereto, such as cache storage or non-sequentially accessed extended storage.

Maraging steels. A special class of high-strength, low-carbon, nickel-alloy steels, wherein the high strength (greater than 1,030 MPa) is derived from age hardening or precipitation of intermetallic compounds in the grain structure and does not involve carbon. These steels typically contain no less than 10 percent nickel; no more than 0.03 percent carbon; and Co, Mo, Ti, and Al, as alloying elements.

Mass fraction. The ratio of the weight of the propellant to the weight of the loaded rocket. The larger the ratio the longer the range of the rocket.

Matrix. A substantially continuous phase that fills the space between particles, whiskers, or fibers.

Maximum bit transfer rate. Of a disk drive or solid-state storage device: the number of data bits per second transferred between the drive or the device and its controller.

Measurement uncertainty. The characteristic parameter that specifies in what range around the output value the correct value of the measurable variable lies with a confidence level of 95 percent. It includes the uncorrected systematic deviations, the uncorrected backlash, and the random deviations. (Ref.: VDI/VDE 2617.)

Mechanical alloying. An alloying process resulting from the bonding, fracturing and rebonding of elemental and master alloy powders by mechanical impact. Non-metallic particles may be incorporated in the alloy by the addition of the appropriate powders.

Mechanically controlled variable sequence manipulation mechanisms. Automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed, but adjustable, stops such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed program pattern. Variations or modifications of the program pattern (e.g., changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations.

Media access unit. Equipment which contains one or more communication interfaces ("network access controller," "communications channel controller," modem, or computer bus) to connect terminal equipment to a network.

Median Lethal Dosage (vapor/aerosol, LCt_{50}). The amount of agent (vapor, aerosol) expected to kill 50 percent of exposed, unprotected people.

Median Lethal Dose (liquid, LD_{50}). The single dose of a substance that causes death of 50 percent of a population from exposure to the substance by any route other than inhalation.

Melt extraction. A process to "solidify rapidly" and extract a ribbon-like alloy product by the insertion of a short segment of a rotating chilled block into a bath of a molten alloy.

Melt spinning. A process to "solidify rapidly" a molten metal stream impinging upon a rotating chilled block, forming a flake, ribbon or rod-like product.

Microcomputer microcircuit. A "monolithic integrated circuit" or "multichip integrated circuit" containing an arithmetic logic unit capable of executing general-purpose instructions from an internal storage on data contained in the internal storage. (The internal storage may be augmented by an external storage.)

Microprogram. A sequence of elementary instructions, maintained in a special storage, the execution of which is initiated by the introduction of its reference instruction into an instruction register.

Militarily critical technologies. Technologies, the technical performance parameters of which are at or above the minimum level necessary to ensure continuing superior performance of U.S. military systems.

Military high explosives. Solid, liquid, or gaseous substances or mixtures of substances which are required to detonate in their application as primary, booster, or main charge in warhead, demolition, and other military applications.

Military propellants. Solid, liquid, or gaseous substances or mixtures of substances used for propelling projectiles and missiles or to generate gases for powering auxiliary devices for embargoed military equipment and which, when ignited, burn or deflagrate to produce quantities of gas capable of performing work; but in their application these quantities are required not to undergo a deflagration- to-detonation transition.

Military pyrotechnics. Mixtures of solid or liquid fuels and oxidizers which, when ignited, undergo an energetic chemical reaction at a controlled rate intended to produce specific time delays, or quantities of heat, noise, smoke, visible light, or infrared radiation. Pyrophorics are a subclass of pyrotechnics which contain no oxidizers but ignite spontaneously on contact with air.

Minimum smoke. A descriptive term used for propellants that produce the least amount of smoke under specified conditions. The term is difficult to quantify, but AGARD identifies these as class AA propellants.

Mirrors. Reflective optical elements.

Monoclonal antibodies. Proteins which bind to one antigenic site and are produced by a single clone of cells.

Monolithic integrated circuit. A combination of passive or active "circuit elements" or both which are formed by means of diffusion processes, implantation processes or deposition processes in or on a single semiconducting piece of material, a so-called "chip;" can be considered as indivisibly associated *and* perform the function(s) of a circuit.

Most immediate storage. The portion of the "main storage" most directly accessible by the central processing unit:

a. For single level "main storage," the inertial storage; or

b. For hierarchical "main storage," the cache storage; the instruction stack; or the data block.

Motion control board. An electronic assembly of a number of connected electronic components (i.e., "circuit element," "discrete components," integrated circuits, etc.), specially designed to provide a computer system with the capability to coordinate simultaneously the motion of axes of machine tools for "contouring control."

Multichip integrated circuit. Two or more "monolithic integrated circuits" bonded to a common "substrate."

Multi-data-stream processing. The "Microprogram" or equipment architecture technique which permits simultaneous processing of two or more data sequences under the control of one or more instruction sequences by means such as:

Single Instruction Multiple Data (SIMD) architectures such as vector or array processors;

Multiple Single Instruction Multiple Data (MSIMD) architectures;

Multiple Instruction Multiple Data architectures, including those which are tightly coupled, closely coupled or loosely coupled; or

Structured arrays of processing elements, including systolic arrays.

Multilevel security. A class of system containing information with different sensitivities that simultaneously permits access by users with different security clearances and needs-to-know, but prevents users from obtaining access to information for which they lack authorization.

Multiple transverse mode. Any laser, the average divergence of which is larger than that allowed for a "single transverse mode" laser will be considered to be multimode.

Multispectral imaging sensors. Sensors capable of simultaneous or serial acquisition of imaging data from two or more discrete spectral bands. Sensors having more than 20 discrete spectral bands are sometimes referred to as hyperspectral imaging sensors.

Nerve agent. Extremely toxic compounds that produce convulsions and rapid death by inactivating an enzyme (acetylcholinesterase) essential for the normal transmission of nerve impulses.

Network access controller. A physical interface to a distributed switching network. It uses a common medium which operates throughout at the same "digital transfer rate" using arbitration (e.g., token or carrier sense) for transmission. Independently from any other, it selects data packets or data groups (e.g., IEEE 802) addressed to it. It is an assembly that can be integrated into computer or telecommunications equipment to provide communications access.

Neural computer. A computational device designed or modified to mimic the behavior of a neuron or a collection of neurons; i.e., a computational device which is distinguished by its hardware capability to modulate the weights and numbers of the interconnections of a multiplicity of computational components based on previous data.

Neural networks. Computational devices designed to emulate in a simplistic manner the computational processes of the brain by utilizing a variety of simple computational devices (artificial neurons) arranged in large networks that can be trained.

Noble metal modified aluminide. Nickel or titanium aluminide modified with noble metals such as platinum or rhodium.

Noise level. An electrical signal given in terms of power spectral density. Th relation between "noise level" expressed in peak-to-peak is given by $S^2_{pp} = 8N_o(f_2 - f_1)$, where S_{pp} is the peak to peak value of the signal (e.g., nanoteslas), N_o is the power spectral density [e.g., (nanotesla)2/Hz] and $(f_2 - f_1)$ defines the bandwidth of interest.

Non-servo-controlled variable sequence manipulation mechanisms. Automated moving devices operating according to mechanically fixed programmed motions. The program is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops.

Nuclear reactor. Includes the items within or attached directly to the reactor vessel, the equipment which controls the level of power in the core, and the components which normally contain or come into direct contact with or control the primary coolant of the reactor core.

Numerical control. The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress. (Reference: ISO 2382.)

Object code (or object language). The machine-readable code. (See also **"Source code."**)

Obscurant. A substance or radiation absorber that blocks the radiation emitted from a target, thereby preventing the continuous tracking or detection of the target.

Observable. The parameters (such as distance, speed, or shape) of a vehicle that can be seen optically, electronically, magnetically, acoustically, or thermally.

One-point safe. A nuclear weapon is one-point safe if there is a probability of less than one part in a million of a nuclear energy release greater than or equal to 4 pounds TNT equivalent when the high explosives are detonated at the single point most likely to produce nuclear yield.

Operate autonomously. Refers to the ability of a vehicle to move between two or more known locations without the need for human intervention.

Operate-through. The ability of an electronic system to function without major degradation during transient nuclear events.

Optical amplification. In optical communications, an amplification technique that introduces a gain of optical signals that have been generated by a separate optical source without conversion to electrical signals (i.e., using semiconductor optical amplifiers, optical fiber luminescent amplifiers).

Optical computer. A computer designed or modified to use light to represent data and with computational logic elements based on directly coupled optical devices.

Optical fiber preforms. Bars, ingots, or rods of glass, plastic, or other materials which have been specially processed for use in fabricating optical fibers. The characteristics of the preform determine the basic parameters of the resultant drawn optical fibers.

Optical integrated circuit. A "monolithic integrated circuit" or a "hybrid integrated circuit" containing one or more parts designed to function as a photosensor or photoemitter or to perform (an) optical or (an) electro-optical function(s).

Optical switching. The routing of or switching of signals in optical form without conversion to electrical signals.

Overall current density. The total number of ampere-turns in the coil (i.e., the sum of the number of turns multiplied by the maximum current carried by each turn) divided by the total cross section of the coil (comprising the superconducting filaments, the metallic matrix in which the superconducting filaments are embedded, the encapsulating material, any cooling channels, etc.).

Pack cementation. Any surface modification coating or overlay coating process wherein a substrate is immersed in a powder mixture (a pack) that consists of:

(1) The metallic powders that are to be deposited (usually aluminum, chromium, silicon, or combinations thereof);

(2) An activator (normally a halide salt); *and*

(3) An inert powder, most frequently alumina.

The substrate and powder mixture are contained within a retort which is heated to between 1,030 K (757 °C) to 1,375 K (l,102 °C) for sufficient time to deposit the coating.

Passive. Missile or warhead guidance by which the device homes in on the natural radiation (RF, IR, or visible) from the target. The device is autonomous, incorporating a seeker that requires no external illumination of the target

Peak power. Energy per pulse in joules divided by the pulse duration in seconds.

Plasma spraying. Any overlay coating process wherein a gun (spray torch), which produces and controls a plasma, accepts powder or wire coating materials, melts them, and propels them towards a substrate, whereon an integrally bonded coating is formed.

Polyclonal antibodies. A mixture of proteins which bind to the specific antigen and are produced by more than one clone of cells.

Positioning accuracy. Of "numerically controlled" machine tools is to be determined and presented in accordance with ISO/DIS 230/2, paragraph 2.13, in conjunction with the requirements below:

1. Test conditions (paragraph 3):
   a. For 12 hours before and during measurements, the machine tools and accuracy measuring equipment will be kept at the same ambient temperature. During the premeasurement time the slides of the machine will be continuously cycled in the same manner that the accuracy measurements will be taken;
   b. The machine shall be equipped with any mechanical, electronic, or software compensation to be exported with the machine;
   c. Accuracy of measuring equipment for the measurements shall be at least four times more accurate than the expected machine tool accuracy;
   d. Power supply for slide drives shall be as follows:
      (1) Line voltage variation shall not be greater than ±10 percent of nominal rated voltage;
      (2) Frequency variation shall not be greater than ±2 Hz of the normal frequency;
      (3) Lineouts or interrupted service is not permitted.

2. Test program (paragraph 4):
   a. Feed rate (velocity of slides) during measurement shall be the rapid traverse rate. In case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute;
   b. Measurements shall be made in an incremental manner from one limit of the axis travel to the other without returning to the starting position for each move to the target position;
   c. Axes not being measured shall be retained at mid travel during test of an axis.
3. Presentation of test results (paragraph 2): the results of the measurements must include:
   a. "Positioning accuracy" (A); and
   b. The mean reversal error (B).

Power management. Changing the transmitted power of the altimeter signal so that received power at the "aircraft" altitude is always at the minimum necessary to determine the altitude.

Precision-guided munition. A munition equipped with a sensor that interacts with its aerodynamic control surfaces that falls into one of the following categories: "guided," "smart," or "brilliant."

Precursors. Specialty chemicals used in the manufacture of military explosives.

Primary smoke. The solid particulates from the combustion of a fuel, pyrotechnic, or propellant. Metal and elemental fuels and other additives in energetic materials or by themselves contribute significantly to primary smoke. (See **"Secondary smoke."**)

Principal element. An element is a "principal element" when its replacement value is more than 34 percent of the total value of the system of which it is an element. Element value is the price paid for the element by the manufacturer of the system, or by the system integrator. Total value is the normal international selling price to unrelated parties at the point of manufacture or consolidation of shipment.

Producibility. The elements of a design by which a product or a commodity, while meeting all of its performance objectives within the design constraints, may be produced in the shortest total time, at the lowest cost, with the most readily available materials using the most advantageous processes and assembly methods. (U.S. Army, AMC definition.)

Production. All production stages, such as product engineering, manufacture, integration, assembly (mounting), inspection, testing, and quality assurance.

Progressivity. The rate of increase of the burning rate or of the surface area of burning propellant. (See **"Propellant grain."**)

Proof test. The on-line or off-line production screen testing that dynamically applies a prescribed tensile stress over a 0.5 to 3 m length of fiber at a running rate of 2 to 5 m/s while passing between capstans approximately 15 cm in diameter. The ambient temperature is a nominal 293 K and relative humidity 40 percent.

Propellant grain. A single piece of propellant, the dimensions of which may vary from a few millimeters to several meters and are known as the configuration for single grains or the granulation for charges consisting of more than one grain. Configurations are changed to vary the exposed surface of grains and thus vary the burning surface. A grain that maintains a constant burning surface has a neutral configuration; a grain with a surface area or burning rate that increases has a progressive configuration; a grain with a burning surface that decreases has a degressive configuration.

Public domain. See **"In the public domain."**

Pulse compression. The coding and processing of a radar signal pulse of long time duration to one of short time duration, while maintaining the benefits of high pulse energy.

Pulse duration. Duration of a "laser" pulse measured at Full-Width Half-Intensity (FWHI) levels.

Pyrophorics. See **"Military Pyrotechnics."**

Q-switched laser. A "laser" in which the energy is stored in the population inversion or in the optical resonator and subsequently emitted in a pulse.

Radar frequency agility. Any technique which changes, in a pseudo-random sequence, the carrier frequency of a pulsed-radar transmitter between pulses or between groups of pulses by an amount equal to or larger than the pulse bandwidth.

Radar spread spectrum. Any modulation technique for spreading energy origination from a signal with a relatively narrow frequency band over a much wider band of frequencies, by using random or pseudo-random coding.

Real-Time. (a) In solving a problem, a speed sufficient to give an answer within the actual time the problem must be solved; (b) Pertaining to the actual time during which a physical process occurs; and (c) Pertaining to the performance of a computation during the actual time that the related physical process occurs so that results of the computation can be used in guiding the physical process.

Real-time bandwidth. For "dynamic signal analyzers," the widest frequency range the analyzer can output to display or mass storage without causing any discontinuity in the analysis of the input data. For analyzers with more than one channel, the channel configuration yielding the widest "real-time bandwidth" shall be used to make the calculation.

Real-time processing. The processing of data by a computer system providing a required level of service, as a function of available resources, within a guaranteed response time, regardless of the load of the system, when stimulated by an external event.

Real-time spectrum analyzers. See **"Dynamic signal analyzers."**

Receptors. Biological macromolecular structures capable of binding ligands, the binding of which affects physiological functions.

Reduced smoke. A descriptor for propellants that have been tailored to produce less smoke than standard formulations of aluminum and ammonium perchlorate (see **"Smoky"**). They may be classified by AGARD as either class AC or BC.

Repeatability. Closeness of agreement of repeated position movements to the same indicated location and under the same conditions.

Required. As applied to "technology," refers to only that portion of "technology" which is peculiarly responsible for achieving or exceeding the embargoed performance levels, characteristics, or functions. Such "required" "technology" may be shared by different products.

Resistive heating PVD. See **"Thermal evaporation-physical vapor deposition (TE-PVD)."**

Resolution. The least increment of a measuring device; on digital instruments, the least significant bit. (Reference: ANSI B-89.1.12.)

Riot control agents. Substances which in low concentrations produce temporarily irritating or disabling physical effects that disappear within minutes of removal from exposure. There is minimal risk of permanent injury, and medical treatment is rarely required.

Robot. A manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and has all the following characteristics:

a. Is multifunctional;

b. Is capable of positioning or orienting material, parts, tools, or special devices through variable movements in three-dimensional space;

c. Incorporates three or more closed- or open-loop servo-devices which may include stepping motors; *and*

d. Has "user-accessible programmability" by means of the teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.

N.B. The above definition does not include the following devices:

1. Manipulation mechanisms which are only manually/teleoperator controllable.
2. Fixed sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic, or electrical means.
3. Mechanically controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed but adjustable stops, such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed program pattern. Variations or modifications of the program pattern (e.g., changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations.
4. Non-servo-controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops.
5. Stacker cranes defined as Cartesian coordinate manipulator systems manufactured as an integral part of a vertical array of storage bins and designed to access the contents of those bins for storage or retrieval.

Rocket motor. A non-airbreathing reaction propulsion device consisting of a thrust or combustion change in which formulations of solid fuels, oxidizers, and additives are burned and expanded through an exhaust nozzle.

Rotary atomization. A process to reduce a stream or pool of molten metal droplets to a diameter of 500 micrometers or less by centrifugal force.

Run out (out-of-true running). Radial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle axis at a point on the external or internal revolving surface to be tested. (Reference: ISO 230/1-1986, paragraph 5.61).

Scale factor (gyro or accelerometer). The ratio of change in output to a change in the input intended to be measured. Scale factor is generally evaluated as the slope of the straight line that can be fitted by the method of least squares to input-output data obtained by varying the input cyclically over the input range.

S**canning spectrum analyzer.** See "**Signal analyzer.**"

Secondary smoke. Smoke that results from the interaction of propellant or pyrotechnics and water to form droplets that condense on submicron atmospheric particles. Low temperatures, high humidity, and acid vapors, such as the HCI combustion products of ammonium perchlorate, all contribute to secondary smoke formation.

Secret parameter. A constant or key kept from the knowledge of others or shared only within a group.

Seeker. A device that orients a munition's sensor to survey, acquire, lock-on, and track a target.

Semi-active. Missile or warhead guidance by which the target is illuminated by an auxiliary emitter (e.g., a laser or radar beam) and the missile or warhead homes in on the signal (reflection) from the target.

Sensor fuzed munition. A "shoot-to-kill," "smart" munition of relatively low complexity and cost, which is most effective "close-in" against targets with a narrowly defined location and for which there are small delivery errors.

Sentient (or correlated). A descriptor for a "brilliant" munition that is aware of itself and its surroundings; for example, a brilliant munition that responds to its environment, or communicates with others among the same payload or salvo to share out the targets and maximize interception.

Settling time. The time required for the output to come within 1/2 bit of the final value when switching between any two levels of the converter.

Shared aperture optical elements. Optics that reflect a portion of the impinging radiation similarly to conventional beam splitters and composed of buried lenses or buried "gratings."

Shoot-to-kill system. A sensor-fuzed munition that does not incorporate expensive seeker and guidance and control subsystems. The warhead is initiated tens of meters from the target while the munition is aimed at the target.

Signal analyzer. Apparatus capable of measuring and displaying basic properties of the signal-frequency components of multi-frequency signals.

Signal analyzers (dynamic). See "Dynamic signal analyzers."

Signal processing. The processing of externally derived information-bearing signals by algorithms such as time compression, filtering, extraction, selection, correlation, convolutions or transformations between domains (e.g., fast Fourier transform or Walsh transform).

Signature. Any or all of the properties of a gun or a rocket motor that may be used for the detection, identification, or interception of the device or its launch site. Plume signature characteristics include smoke, radiation emissions, visibility, radar absorption, self absorption, etc.

Single-transverse mode. Any laser with an average beam divergence measured on any two orthogonal axes equal to or less than 3.45 times the wavelength, divided by the aperture diameter along that axis for the angle containing 84 percent of the beam energy will be considered a single transverse mode laser.

Slurry deposition. A surface modification coating or overlay coating process wherein a metallic or ceramic powder with an organic binder is suspended in a liquid and is applied to a substrate by either spraying, dipping, or painting followed by air or oven drying and heat treatment to obtain the desired coating.

Smart materials. Materials that have the capability to respond to an external stimulus by changing, in a controlled manner according to prescribed functional relationships or control algorithms, their energy dissipation properties and geometric configuration, or by changing their stiffness.

Smart munition. A "many-on-many" munition with a minimal target selection capability that does not require an operator in the loop. There are two prime categories: terminally guided ("hit-to-kill") and sensor-fuzed ("shoot-to-kill").

Smoky. A particular term used to describe rocket and missile propellants with high aluminum and ammonium perchlorate contents. An AGARD class CC composition.

Software. Programs, data bases, and associated documentation available on human- and/or machine-readable media such as paper, magnetic tapes, disks, or embedded firmware that operate computers.

Software Documentation. Information in human-readable form, including computer source code listings and printouts, which documents the design or details of the computer software, explains the capabilities of the software, or provides operating instructions for using the software to obtain the desired results from a computer.

Software Support. Resources such as people, facilities, documentation, information, and instrumentation to operate, maintain, or produce software products.

Solidify rapidly. Solidification of molten material at cooling rates exceeding 1,000 K/sec.

Solids loading. The percentage of particulate matter in the total weight/volume of a propellant composition or grain. The solids loading attainable for a given fuel-oxidizer particulate composition depends on the binder and additives used to form a grain. Missile propellants are commonly rated in terms of a weight percentage; gun propellants, in terms of a volume percentage.

Source code (or source language). Source code, a subset of computer software documentation, is a set of symbolic computer instructions that is written in a high-level/human-readable language that cannot be directly executed by the computer without first being translated into object code.

Spacecraft. Active and passive satellites and space probes.

Space qualified. Products designed, manufactured and tested to meet the special electrical, mechanical, or environmental requirements for use in the launch and deployment of satellites or high-altitude flight systems operating at altitudes of l00 km or higher.

Spatial light modulators. Optical devices that dynamically modulate the spatial distribution of the amplitude or phase of an incident light waveform across an aperture in either a transmissive or reflective mode of operation under the control of an electronic or optical signal. "Spatial light modulators" are also known as non-linear adaptive optics.

Specific impulse (I_s). The total impulse per unit weight of propellant.

Specific modulus. Young's modulus in pascals, equivalent to N/m^2 (lb force/sq in.) divided by specific weight in N/m^3 (lb force/cu in.) measured at temperature of (296 ± 2 K; (23 ± 2) °C) and a relative humidity of (50 ± 5) percent.

Specific tensile strength. Ultimate tensile strength in pascals, equivalent to N/m^2 (lb force/sq in.) divided by specific weight in N/m^3 (lb force/cu in.) measured at a temperature of (296 ± 2) K and a relative humidity of (50 ± 5) percent.

Spectral efficiency. A figure of merit parameterized to characterize the efficiency of transmission system which uses complex modulation schemes such as QAM (quadrature amplitude modulation), Trellis coding, QPSK (Q-phased shift key), etc. It is defined as follows:

Spectral efficiency = $\frac{\text{“Digital transfer rate” (bits/second)}}{\text{6 dB spectrum bandwidth (Hz)}}$

Spherical Error Probable or Sphere of Equal Probability (SEP). A measure of accuracy at a specific range, expressed in terms of the radius of a sphere, centered on the target, in which 50 percent of the payloads impact.

Splat quenching. A process to “solidify rapidly” a molten metal stream impinging upon a chilled block, forming a flake-like product.

Spread spectrum. The technique whereby energy in a relatively narrow-band communication channel is spread over a much wider energy spectrum.

Spread spectrum (radar). See **“Radar spread spectrum.”**

Sputter deposition. An overlay coating process based on a momentum transfer phenomenon, wherein positive ions are accelerated by an electric field towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on an appropriately positioned substrate.

Sputtering. An overlay coating process wherein positively charged ions are accelerated by an electric field towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on the substrate.

N.B. Triode, magnetron, or radio frequency sputtering to increase adhesion of coating and rate of deposition are ordinary modifications of the process.

Stability. Standard deviation (1 sigma) of the variation of a particular parameter from its calibrated value measured under stable temperature conditions. This can be expressed as a function of time.

Stabilizers. Substances used in explosive formulations to improve their shelf life.

Stacker cranes. Cartesian coordinate manipulator systems manufactured as an integral part of a vertical array of storage bins and designed to access the contents of those bins for storage or retrieval.

Stored program control. A control using instructions stored in an electronic storage which a processor can execute to direct the performance of predetermined functions.

Strong mechanical bond. In solid rocket motors, the requirement to have a bond between the rocket propellant and the motor casing that is equal to or greater than the tensile strength of the propellant.

Substrate. A sheet of base material with or without an interconnection pattern and on which or within which “discrete components” or integrated circuits or both can be located.

Substrate blanks. Monolithic compounds with dimensions suitable for the production of optical elements such as mirrors or optical windows.

Sufficient Technology. The level of technology required for a proliferant to produce entry level WMD, delivery systems, or other hardware or software useful in WMD development integration or use.

Superalloys. Nickel-, Cobalt-, or Iron-Base alloys having strengths superior to any alloys in the AISI 300 series at temperatures of 922 K (649 °C) under severe environmental and operating conditions.

Superconductive. Materials (i.e., metals, alloys, or compounds) which can lose all electrical resistance (i.e., which can attain infinite electrical conductivity) and carry very large electrical currents without Joule heating.

Super high power laser (SHPL). A “laser” capable of delivering (the total or any portion of) the output energy exceeding 1 kJ within 50 ms or having an average or CW power exceeding 20 kW.

Superplastic forming. A deformation process using heat for metals that are normally characterized by low values of elongation (less than 20 percent) at the breaking point as determined at room temperature by conventional tensile strength testing, in order to achieve elongations during processing which are at least two times those values.

Swept frequency network analyzers. Involves the automatic measurement of equivalent circuit parameters over a range of frequencies, involving swept frequency measurement techniques but not continuous-wave point-to-point measurements.

Switch fabric. That hardware and associated “software” which provides the physical or virtual connection path for in-transit message traffic being switched.

Synchronous digital hierarchy (SDH). A digital hierarchy providing a means to manage, multiplex, and access various forms of digital traffic using a synchronous transmission format on different types of media. The format is based on the Synchronous Transport Module (STM) which is defined by CCITT Recommendation G.703, G.708, G.709, and others yet to be published. The first level rate of “SDH” is 155.52 Mbit/s.

Synchronous optical network (SONET). A network providing a means to manage, multiplex and access various forms of digital traffic using a synchronous transmission format on fiber optics. The format is the North America version of “SDH” and also uses the Synchronous Transport Module (STM). However, it uses the Synchronous Transport Signal (STS) as the basic transport module with a first level rate of 51.81 Mbit/s. The SONET standards are being integrated into those of “SDH.”

Systems tracks. Processed, correlated (fusion of radar target data to flight plan position), and updated aircraft flight position report available to the Air Traffic Control center controllers.

Systolic array computer. A computer where the flow and modification of the data are dynamically controllable at the logic gate level by the user.

Tear gases. Gases which produce temporarily irritating or disabling effects which disappear within minutes of removal from exposure.

Technical assistance. May take forms such as instruction, skills, training, working knowledge, consulting services.

N.B. "Technical assistance" may involve transfer of "technical data."

Technical data. May take forms such as blueprints, plans, diagrams, models, formulae, tables, engineering designs and specifications, manuals, and instructions written or recorded on other media or devices such as disk, tape, and read-only memories.

Technologies for weapons of mass destruction. Technologies required for development, integration, or employment of biological, chemical, or nuclear weapons and their means of delivery.

Technology. Specific information and know-how necessary for the development, production, or use of a product. This includes the hardware and software necessary to achieve that purpose.

Telecommunications. Any process that enables one or more users to pass to one or more other users information of any nature delivered in any usable form by wire, radio, visual, or other electrical, electromagnetic, or optical means. The word is derived from the Greek *tele*, "far off," and the Latin *communicare,* "to share." (See also **"Communications."**)

Terrain Contour Matching (TERCOM). A guidance and navigation system which measures the topography below a flight vehicle with radar or other electromagnetic energy and compares the results to onboard maps, in order to determine location.

Terminal interface equipment. Equipment at which information enters or leaves the telecommunication system, e.g., telephone, data device, computer, and facsimile device.

Thermal evaporation-physical vapor deposition (TE-PVD). An overlay coating process conducted in a vacuum with a pressure less than 0.1 Pa wherein a source of thermal energy is used to vaporize the coating material. This process results in the condensation, or deposition, of the evaporated species onto appropriately positioned substrates.

The addition of gases to the vacuum chamber during the coating process to synthesize compound coatings is an ordinary modification of the process.

The use of ion or electron beams, or plasma, to activate or assist the coating's deposition is also a common modification in this technique. The use of monitors to provide in-process measurement of optical characteristics and thickness of coatings can be a feature of these processes.

Specific TE-PVD processes are as follows:

(1) Electron Beam PVD uses an electron beam to heat and evaporate the material which forms the coating;

(2) Resistive Heating PVD employs electrically resistive heating sources capable of producing a controlled and uniform flux of evaporated coating species;

(3) "Laser" Evaporation uses either pulsed- or continuous-wave "laser" beams to heat the material which forms the coating; and

(4) Cathodic Arc Deposition employs a consumable cathode of the material which forms the coating and has an arc discharge established on the surface by a momentary contact of a ground trigger. Controlled motion of arcing erodes the cathode surface, creating a highly ionized plasma. The anode can be either a cone attached to the periphery of the cathode through an insulator or the chamber. Substrate biasing is used for non-line-of-sight deposition.

Three-dimensional vector rate. The number of vectors generated per second which have 10 pixel poly line vectors, clip tested, randomly oriented, with either integer or floating point X-Y-Z coordinate values (whichever produces the maximum rate).

Thrust. The force that propels a body or the rate of change of momentum of a burning propellant.

Tilting spindle. A tool-holding spindle which alters, during the machining process, the angular position of its center line with respect to any other axis.

Time constant. The time taken from the application of a line stimulus for the current increment to reach a value of 1-1/e times the final value (i.e., 63 percent of the final value).

Total digital transfer rate. The number of bits, including line coding, overhead, and so forth per unit time passing between corresponding equipment in a digital transmission system. (See also **"Digital transfer rate."**)

Total impulse (I_t). The thrust force F (which can vary with time) integrated over the burning time, t.

Toxic chemical. Any chemical which through its chemical action on life processes can cause death, temporary incapacitation, or permanent harm to humans or animals in military feasible quantities.

Transfer laser. A "laser" to produce a continuous output at all wavelengths over a range of several "laser" transitions. A line-selectable "laser" produces discrete wavelengths within one "laser" transition and is not considered "tunable."

Tunable. The ability of a "laser" to produce a continuous output at all wavelengths over a range of several "laser" transitions. A line-selectable "laser" produces discrete wavelengths within one "laser" transition and is not considered "tunable."

Turnkey plant. Consists of all the hardware, software, technical data, and technical assistance necessary for the installation of a complete operating facility for the production of the commodity, a chemical substance, at defined production rates and to specified product qualities. Hardware consists of all the equipment, components, control valves, instruments, reaction vessels, feed lines, and exposition proof barriers necessary for the conduct of the unit operations of the overall production process, whether the items are assembled or disassembled for transportation. The plant may be designed for installation at a prepared site that includes locally constructed and installed explosion-proof barricades.

Two-dimensional vector rate. The number of vectors generated per second which have 10-pixel polyline vectors, clip tested, randomly oriented, with either integral or floating point X-Y coordinate values (whichever produces the maximum rate).

Uranium enriched in the isotopes 235 or 233. Uranium containing the isotopes 235, 233, or both in the amount such that the abundance ratio of the sum of these isotopes to the isotope 238 is more than the ratio of the isotope 235 to the isotope 238 occurring in nature (isotopic ratio: 0.72 percent).

Use. Operation, installation (including on-site installation), maintenance (checking), repair, overhaul, and refurbishing.

User-accessible programmability. The facility allowing a user to insert, modify, or replace "programs" by means other than (1) a physical change in wiring or interconnections *or* (2) the setting of function controls including entry of parameters.

Vaccines. Materials that when injected into immune-competent responsive persons and animals will enable the human and animal recipient to become resistant to infection.

Vacuum atomization. A process to reduce a molten stream of metal to droplets of a diameter of 500 micrometers or less by the rapid evolution of a dissolved gas upon exposure to a vacuum.

Variable geometry airfoils. Trailing edge flaps or tabs or leading edge slats or pivoted nose droop, the position of which can be controlled in flight.

Vector rate. See **"Two-dimensional vector rate"** and/or **"Three-dimensional vector rate."**

Vehicle management system (VMS). A vehicle control system characterized by a high degree of physical and functional integration of manual and automatic flight controls, propulsion controls, and airframe utility subsystem controls.

Vesicant. Toxic chemicals that have a blistering effect on the skin.

Weapons of mass destruction technologies. Technologies used in weapons of mass destruction and their means of delivery.

Weapons Systems Technologies (WST). Technologies critical to the development and production of superior weapons.

Yield. In chemical reactions, the quantity of pure product divided by the starting material.

APPENDIX E
INTERNATIONAL REGIMES

APPENDIX E
INTERNATIONAL REGIMES

There are a number of international treaties, agreements, regimes, and informal arrangements that seek to constrain the spread of nuclear, biological, and chemical weapons and missiles as well as conventional weapons. Some address material/agents and equipment in general terms while others are more specific. Some have led to explicit export control arrangements limiting the transfer of technologies, materials and equipment while others contain broad prohibitions of activities. All have varying degrees of participation and adherence. The agreements, in many cases, establish an international norm of behavior that can be used to highlight aberrant actions.

NUCLEAR NON-PROLIFERATION TREATY (NPT)

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force in 1970 and is adhered to by over 170 nations. A fundamental objective of the NPT is to prevent the further spread of nuclear weapons. To this end, the nuclear weapons states (five had tested and manufactured nuclear weapons by the time the treaty was negotiated and available for signature) agreed not to transfer nuclear weapons or other nuclear explosive devices, and not to assist, encourage, or induce non-nuclear weapons states (NNWS) to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices. Each NNWS pledged not to receive nuclear weapons or other nuclear explosive devices, not to manufacture or otherwise acquire them, and not to seek or receive assistance in their manufacture. The treaty also obliged each NNWS party to the NPT to accept international safeguards through agreements negotiated with the International Atomic Energy Agency (IAEA). The intent of these safeguards is to prevent by deterring, via IAEA inspections, the diversion of nuclear material for nuclear explosive purposes. Nuclear material and specified equipment would be exported to NNWS only under IAEA safeguards.

An offshoot of the NPT, the Zangger Committee, which first met in 1971, maintains a list of nuclear exports that require IAEA safeguards as a condition of supply. The Committee is made up of 30 NPT members who export nuclear material and equipment. The **Nuclear Suppliers Group (NSG)** reinforces the work of the Zangger Committee through an expanded set of controls and by potentially including non-NPT states that are nuclear suppliers. In April 1992, the NSG approved a comprehensive arrangement to prohibit exports of some 65 dual-use items of equipment and materials to unsafeguarded nuclear activities and nuclear explosive programs. It also agreed to a common policy not to engage in significant, new nuclear cooperation with any NNWS that has not committed itself to full-scope safeguards on all present and future nuclear activities.

The NSG conditions for transfer apply to all NNWS whether or not they are NSG members. Nuclear transfers require acceptance of IAEA safeguards; dual-use transfers are prohibited for use in unsafeguarded nuclear fuel-cycle activities and nuclear explosives activities.

Legal authority in the United States for controlling the export of specialized nuclear items is the Atomic Energy Act and the NPT. The licensing agencies are the Nuclear Regulatory Commission and the Department of Energy. The Code of Federal Regulations (CFR) #110 and #810 address federal regulations regarding nuclear equipment and material and assistance to foreign atomic energy activities. On an international basis, CFR #110 controls items on the International Atomic Energy List.

GENEVA PROTOCOL OF 1925 (GP)

At the Geneva Conference for the Supervision of the International Traffic in Arms of 1925, the United States took the initiative of seeking to prohibit the export of gases for use in war. At French suggestion, it was decided to draw up a protocol on non-use of poisonous gases. Poland recommended that bacteriological weapons be covered in the prohibition. The Geneva Protocol was signed on June 17, 1925, and restated the prohibition previously laid down by the Versailles and Washington treaties and added a ban on bacteriological warfare.

The Protocol contained a one-paragraph prohibition against the use of chemical (and bacteriological) weapons. However, agents could be legally developed, produced, stockpiled, and transferred. Several countries, as conditions of their ratification or accession, reserved the right to respond in kind to aggressors using these weapons.

BIOLOGICAL WEAPONS CONVENTION (BWC)

The 1972 Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (BWC) entered into force in 1975 and has been signed and ratified by over 135 parties. The BWC prohibits the development, production, and stockpiling of toxins or of microbial or other biological agents of types and in quantities that have no justification for prophylactic, protective, or other peaceful purposes; also prohibited are development, production, and stockpiling of weapons, equipment, or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict. It does not provide a mechanism for controlling export of these items.

During the two decades since the BWC entered into force, there have been increasing concerns about biological weapons proliferation and the ability of the Convention to deter it. Efforts at periodic review conferences have centered on strengthening the implementation and effectiveness of the Convention. The treaty as written has no verification measures. Although confidence-building measures have been approved, there is still concern whether verification could be effective. There is no existing BWC committee comparable to the Zangger Committee in the NPT. The Convention does not prohibit exchange of equipment, materials, or scientific and technical information for peaceful purposes.

The Second Review Conference, held in 1986 in an effort to reduce the occurrence of ambiguities, doubts, and suspicions and to improve international cooperation in peaceful biological activities, adopted voluntary measures to strengthen confidence in treaty compliance and to help deter violations.

Because of continuing concerns about proliferation, possible noncompliance of some parties, and the rapid and significant advances in biotechnology, the Third Review Conference, held in 1991, reaffirmed and extended the voluntary confidence-building measures. As a result of a mandate of the Third Review Conference, an Ad Hoc Group of Government Experts convened to identify, examine, and evaluate potential measures for verifying the provisions of the BWC from a scientific and technical viewpoint.

The Ad Hoc Group (also known as "Verification Experts") assessed 21 potential off-site and on-site measures using six mandated evaluation criteria. They also considered some combination of measures. The group's final report concluded that because of the dual-use nature of nearly all biological-weapons-related facilities, equipment, and materials, and the huge overlap between prohibited and permitted purposes, no single approach could fulfill the mandated criteria for a stand-alone verification measure. Nevertheless, the group found that some measures, either singly or in combination, have the potential to strengthen the BWC by helping to differentiate between prohibited and permitted activities and thus to reduce ambiguities about compliance.

CHEMICAL WEAPONS CONVENTION (CWC)

The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction [referred to as the Chemical Weapons Convention (CWC)] was opened for signature in January 1993. Over 160 countries have signed the Treaty. It entered into force on April 29, 1997.

The CWC bans the production, acquisition, stockpiling, and use of chemical weapons. It charges each party not to develop, produce, otherwise acquire, stockpile, or retain chemical weapons; transfer, directly or indirectly, chemical agents to anyone; use chemical weapons; engage in any military preparations to use chemical weapons; and assist, encourage, or induce, in any way, anyone to engage in any activity prohibited to a party to the Convention. Each Party undertakes in accordance with the provisions of the Convention to destroy the chemical weapons it possesses or that are located in any place under its jurisdiction or control, destroy all chemical weapons it abandoned on the territory of another Party, and destroy any chemical weapons production facilities it owns or possesses or that are located in any place under its jurisdiction or control. Finally, each Party undertakes not to use riot control agents as a method of warfare.

The CWC provides for routine and challenge inspections to assist in the verification of compliance with the Convention. Routine inspections of declared facilities are mandated by the Convention. In accordance with CWC provisions, challenge inspections may be conducted at a facility where a Party suspects illegal activities.

The CWC does not include a specific list of controlled chemicals or equipment. It does contain an Annex on Chemicals in which are listed three "Schedules" of toxic chemicals and their precursors based on the threat they pose to the purpose and objectives of the CWC and the extent of their commercial use. The Verification Annex describes restrictions on transfers of scheduled chemicals in detail. Transfers of some chemicals to countries who have not ratified the Convention will be prohibited by the CWC.

AUSTRALIA GROUP (AG)

In 1984, several countries, reacting to the use of chemical weapons in the Iran-Iraq War, began informal consultations, the goal of which was to discourage and impede proliferation by harmonizing national export controls on chemical weapon (CW) materials. This informal, international forum was chaired by Australia and became known as the Australia Group.

At their December 1992 meeting the AG members, recognizing the need to take steps to address the increasing problem of the spread of biological weapons, agreed on measures to control the export of biological agents and dual-use equipment which could be used in the production of biological weapons. They also agreed on a framework paper for effective licensing arrangements for export controls, thereby further strengthening measures to address the problem of chemical and biological weapon (CBW) proliferation and use.

Today, the AG controls extend to 54 dual-use chemical precursors for CW, microorganisms and toxins that could be used in BW, and dual-use equipment and technology that could be used in chemical or biological weapons production. Controls agreed to during meetings of the AG are applied on a national basis, although all participants are agreed that controls will be more effective if similar measures are introduced by all potential exporters of relevant chemicals and equipment and by countries of possible transshipment. In the United States, the Commerce Control List (CCL) is the vehicle that implements AG agreements.

There are currently 30 members of the AG. It has no charter or constitution and operates on consensus. The AG's actions are viewed as complementary measures in

support of the 1925 Geneva Protocol, the 1972 Biological and Toxins Weapons Convention, and the 1993 Chemical Weapons Convention. In tandem with export controls, the AG has periodically used warning mechanisms to sensitize the public to CBW proliferation. The AG has issued an informal "warning list" of dual-use CW precursors and bulk chemicals and of CW-related equipment. Members develop and share the warning lists with their chemical industry and ask it to report on any suspicious transactions. The AG has also used an approach to warn industry, the scientific community, and other relevant groups of the risks of inadvertently aiding BW proliferation.

Meetings of the AG focus on sharing information about national export controls, considering proposals for "harmonization"—the adoption of common export controls by all members—and considering other measures to address CBW proliferation and use.

MISSILE TECHNOLOGY CONTROL REGIME (MTCR)

The Missile Technology Control Regime currently provides the central institutional arrangement as well as the base international norm for dealing with missile proliferation. The aim of the MTCR is to restrict the proliferation of missiles, unmanned air vehicles, and related technology for those systems capable of carrying a 500-kilogram payload at least 300 kilometers as well as systems intended for the delivery of weapons of mass destruction .

The MTCR is neither an international agreement nor a treaty but a voluntary arrangement among countries which share a common interest in limiting the spread of missiles and missile technology. The MTCR considers "missiles" to include ballistic missiles, space launch vehicles (SLV), and sounding rockets. Unmanned air vehicles (UAVs) include cruise missiles, drones, and remotely piloted vehicles (RPVs). The MTCR's members cooperate by applying on a national level common export control guidelines to an agreed list of items (the Equipment and Technology Annex).

When the MTCR was instituted in 1987 by the United States and six other concerned countries, it was intended to limit the risks of nuclear proliferation by controlling technology transfers relevant to nuclear weapon delivery other than by manned aircraft (i.e., by restricting the proliferation of missiles and related technology). In 1993, MTCR member states tightened export controls further, agreeing to also control transfers of rocket systems or UAVs (including cruise missiles) capable of a 300-km range regardless of range or payload. Also, if the seller has any reason to believe these systems would be used to deliver WMD, there is a "strong presumption to deny" the transfer regardless of the inherent range and/or payload of the system. There are now 29 MTCR members; other countries have agreed to abide by the basic tenets of the MTCR.

The annex of controlled equipment and technology is divided into "Category I" and "Category II" items. It includes equipment and technology, both military and dual-use, that are relevant to missile development, production, and operation. Category I consists of complete missile systems (including ballistic missile systems, space launch vehicles, and sounding rockets); unmanned air-vehicle systems such as cruise missiles, and target and reconnaissance drones; specially designed production facilities for these systems; and certain complete subsystems such as rocket engines or stages, reentry vehicles, guidance sets, thrust-vector controls, and warhead safing, arming, fuzing, and firing mechanisms. According to the MTCR Guidelines, export of Category I items is subject to a presumption of denial.

Category II covers a wide range of parts, components, subsystems, propellants, structural materials, test and production equipment, and flight instruments usable for the Category I systems and subsystems. These items are less sensitive components and technologies, most of which have dual-use applications. Category II also covers those systems that have a range of 300 km (but cannot carry a 500-kg payload to that range) and some associated subsystems. Category II items may be exported by MTCR members on a case-by-case basis, provided that the importing state furnishes sufficient end-use guarantees for the item.

The MTCR Guidelines specifically state that the Regime is "not designed to impede national space programs or international cooperation in such programs as long as such programs could not contribute to delivery systems for weapons of mass destruction." The United States maintains a strict interpretation of this statement. Despite some differences of opinion with regard to commercial space applications, all members agree that the technology used in an SLV is virtually identical to that used in a ballistic missile.

WASSENAAR ARRANGEMENT (WA)

In December 1995, 28 governments agreed to establish a new international regime to increase transparency and responsibility for the global market in conventional arms and dual-use goods and technologies. The official name of the regime is "The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies," Wassenaar being the town outside The Hague where five rounds of negotiations took place over a 2-year period. The arrangement will respond to the new security threats of the post Cold War by providing greater openness through information sharing about arms and technology transfers worldwide.

The Wassenaar Arrangement is an international framework that will need to be elaborated and defined more fully. It will focus on the threats to international and regional peace and security. A central part of the regime is the commitment by its members to prevent the acquisition of armaments and sensitive dual-use items for military end-users to states whose behavior today is, or becomes, a cause for serious concern, such as Iran, Iraq, Libya, and North Korea.

The regime will also undertake to prevent destabilizing accumulations of conventional arms worldwide. The Iraq war taught that indiscriminate exports of conven-

tional weapons and sensitive dual-use technologies can pose serious threats to U.S. interests, to foreign policy goals, and to international security. This regime will seek to apply the lessons of Iraq to prevent similar destabilizing buildups. It will also fill an important gap in the global non-proliferation regimes by covering conventional arms and associated dual-use technologies. The WA, by requiring its members to adhere to current non-proliferation regimes, will encourage non-members to also adhere to these regimes.

The WA seeks to prevent destabilizing buildups of weapons by establishing a formal process of transparency and consultation. Participants have agreed to control through their national policies those items and technologies contained in a list of Dual-Use Goods and Technologies and in a separate Munitions List.

OTHER NUCLEAR-RELATED AGREEMENTS

There are a number of other agreements that restrict nuclear weapons in some way. Many of them ban nuclear weapons from a location or geographic area (i.e., nuclear-weapon-free zones). The following lists the treaty/agreement, the year it entered into force, the number of signatories, and a brief description of its provisions.

Antarctic Treaty: 1961; 37 countries; internationalized and demilitarized the Antarctic Continent and provided for its cooperative exploration and future use. The treaty prohibits "any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military maneuvers, as well as the testing of any type of military weapons."

Limited Test Ban Treaty (LTBT): 1963; 117 countries; prohibits nuclear weapons tests "or any other nuclear explosion" in the atmosphere, in outer space, and under water.

Outer Space Treaty: 1967; 98 countries; parties undertake not to place in orbit around the Earth, install on the moon or any other celestial body, or otherwise station in outer space nuclear or other weapons of mass destruction .

Latin American Nuclear-Free Zone Treaty (Treaty of Tlatelolco): 1968; 29 countries (24 in force); obligates Latin American parties not to acquire or possess nuclear weapons, nor permit the storage or deployment of nuclear weapons on their territories by other countries.

Seabed Treaty: 1972; 94 countries; prohibits emplacing nuclear weapons or weapons of mass destruction on the sea bed and the ocean floor beyond the 12-mile coastal zone.

Threshold Test Ban Treaty (TTBT): 1974; United States, USSR; prohibits underground nuclear tests having a yield exceeding 150 kilotons.

South Pacific Nuclear Free-Zone Treaty (Treaty of Rarotonga): 1985; 15 countries; prohibits testing, deployment, or acquisition of nuclear weapons in the South Pacific.

Intermediate Range Nuclear Forces (INF) treaty: 1987; United States, USSR; eliminated ground-launched ballistic and cruise missiles with a range between 500 and 5,500 kilometers. All of these missiles, their launchers, and associated support structures and support equipment were destroyed.

START I: 1994; United States, USSR; reduces arsenals by about 30 percent. The original signatory, the USSR, has since dissolved and the states of Russia, Belarus, Kazakhstan, and Ukraine have endorsed the treaty by signing the START I Protocol.

African Nuclear Weapons Free-Zone (Treaty of Pelindaba): 1996; 53 signatories, three ratifications; prohibits building, testing, burying, or stockpiling nuclear materials.

Comprehensive Test Ban Treaty (CTBT): 1996; 148 signatories, 7 ratifications (as of 1 October 1997): bans any nuclear weapon test explosion or any other nuclear explosion.

SELECTED REGIME PARTICIPANTS

	NSG	GP	BWC	CWC**	AG	MTCR	WA
Argentina	●	●	●	●	●	●	●
Australia	●	●	●	●	●	●	●
Austria	●	●	●	●	●	●	●
Belgium	●	●	●	●	●	●	●
Brazil	●	●	●	●		●	
Bulgaria	●	●	●	●			●
Canada	●	●	●	●	●	●	●
China*	N	●	●	●			
Czech Republic	●	●	●	●	●		●
Denmark	●	●	●	●	●	●	●
Egypt	N	●	S				
Finland	●	●	●	●	●	●	●
France	●	●	●	●	●	●	●
Germany	●	●	●	●	●	●	●
Greece	●	●	●	●	●	●	●
Hungary	●	●	●	●	●	●	●
Iceland	N	●	●	●	●	●	
India		●	●	●			
Iran	N	●	●	●			
Iraq	N	●	●				
Ireland	●	●	●	●	●	●	●
Israel*		●		S			
Italy	●	●	●	●	●	●	●

	NSG	GP	BWC	CWC**	AG	MTCR	WA
Japan	●	●	●	●	●	●	●
Korea, North	N	●	●				
Korea, South	●	●	●	●	●		●
Libya	N	●	●				
Luxembourg	●	●	●	●	●	●	●
Netherlands	●	●	●	●	●	●	●
New Zealand	●	●	●	●	●	●	●
Norway	●	●	●	●	●	●	●
Pakistan		●	●	●			
Poland	●	●	●	●	●		●
Portugal	●	●	●	●	●	●	●
Romania*	●	●	●	●	●		●
Russian Fed.	●	●	●	●		●	●
Slovak Republic	●	●	●	●	●		●
South Africa	●	●	●	●		●	
Spain	●	●	●	●	●	●	●
Sweden	●	●	●	●	●	●	●
Switzerland	●	●	●	●	●	●	●
Syria	N	●	S				
Turkey	N	●	●	●		●	●
Ukraine	●		●	S			●
United Kingdom	●	●	●	●	●	●	●
United States	●	●	●	●	●	●	●

Regime	Total number of participants (as of date)
Nuclear Suppliers Group (**NSG**)	34 (N = NPT: 185) (1/97)
Geneva Protocol (**GP**)	145 (7/96)
Biological Weapons Convention (**BWC**)	140 (S = signed: 158) (5/97)
Chemical Weapons Convention (**CWC**)**	106 (S = signed: 168) (11/97)
Australia Group (**AG**)	30 (10/96)
Missile Technology Control Regime (**MTCR**)	29 (11/97)
Wassenaar Arrangement (**WA**)	33 (12/96)

* China, Israel, and Romania have pledged to abide by the basic tenets of the Missile Technology Control Regime.

** For the latest list of CWC signatories/parties, see http://www.opcw.nl/

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APPENDIX F-1
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APPENDIX F-2
CONTROL LIST REFERENCES

APPENDIX F-2
CONTROL LIST REFERENCES

CL-ITEM	DESCRIPTION	SECTION REFERENCE
AG LIST	Australia Group List	3.1, 3.2, 4.1, 4.2, 4.3
CCL Cat 0B	Nuclear Materials—Test, Inspection, and Production Equipment	5.2
CCL Cat 1A	Materials, Chemicals, Micro-organisms, and Toxins—Systems, Equipment, and Components	3.3, 3.4, 5.8, 5.12
CCL Cat 1B	Materials, Chemicals, Micro-organisms, and Toxins—Test, Inspection, and Production Equipment	1.1, 1.3, 5.9, 5.12
CCL Cat 1C	Materials, Chemicals, Micro-organisms, and Toxins—Materials	1.1, 1.2, 1.3, 3.1, 3.2, 4.2, 5.4
CCL Cat 1E	Materials, Chemicals, Micro-organisms, and Toxins—Technology	4.1
CCL Cat 2A	Materials Processing—Systems, Equipment, and Components	5.2
CCL Cat 2B	Materials Processing—Test, Inspection, and Production Equipment	1.1, 3.1, 3.2, 4.2, 4.3, 5.2, 5.4, 5.8, 5.9, 5.10
CCL Cat 2D	Materials Processing—Software	1.3
CCL Cat 2E	Materials Processing—Technology	1.4
CCL Cat 3A	Electronics Design, Development, and Production—Systems, Equipment, and Production	1.5, 3.3, 4.3, 5.2, 5.6, 5.7, 5.9, 5.10
CCL Cat 5.A-P1	Telecommunications—Systems, Equipment, and Components	1.1, 1.2, 2.1, 2.2, 2.5, 5.7, 5.10
CCL Cat 5.E-P1	Telecommunications—Technology	2.1, 2.2
CCL Cat 5A-P2	Information Security—Systems, Equipment, and Components	1.1, 1.2, 2.4, 2.5
CCL Cat 6A	Sensors and Sensors—Systems, Equipment, and Components	4.3, 5.2, 5.10
CCL Cat 7A	Navigation and Avionics—Systems, Equipment, and Components	1.1, 1.3, 1.4, 1.5, 5.7
CCL Cat 7E	Navigation and Avionics—Technologies	1.4
CCL Cat 9A	Propulsion Systems, Space Vehicles, and Related Equipment—Systems, Equipment, and Components	1.1, 1.2, 1.3
CCL Cat 9B	Propulsion Systems, Space Vehicles, and Related Equipment—Test, Inspection, and Production Equipment	1.1, 1.2, 1.3, 1.4, 5.9
CCL Cat 9D	Propulsion Systems, Space Vehicles, and Related Equipment—Software	1.4
CCL Cat 9E	Propulsion Systems, Space Vehicles, and Related Equipment—Technology	1.4
CCL EAR 99	Items subject to the EAR that are not elsewhere specified in any CCL Category are designated by EAR 99	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 2.5, 3.1, 3.2, 3.3, 3.4, 4.2, 4.3, 4.4, 5.2, 5.7, 5.10, 5.11, 5.13
CWC	Chemical Weapons Convention	4.1
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