ANNEX I

CATEGORY 9 – AEROSPACE AND PROPULSION
Systems, Equipment and Components

NB: *For propulsion systems designed or rated against neutron or transient ionizing radiation, SEE THE MILITARY GOODS CONTROLS.*

Aero gas turbine engines having any of the following:

NB: *SEE ALSO 9A101.*

a. Incorporating any of the "technologies" specified in 9E003.a., 9E003.h. or 9E003.i.; or

Note 1: 9A001.a. does not control aero gas turbine engines which meet all of the following:

a. *Certified by the civil aviation authorities of one or more EU Member States or Wassenaar Arrangement Participating States; and*

b. *Intended to power non-military manned "aircraf"t for which any of the following has been issued by civil aviation authorities of one or more EU Member States or Wassenaar Arrangement Participating States for the "aircraf"t with this specific engine type:*

1. *A civil type certificate; or*

2. *An equivalent document recognized by the International Civil Aviation Organisation (ICAO).*

Note 2: 9A001.a. does not control aero gas turbine engines designed for Auxiliary Power Units (APUs) approved by the civil aviation authority in a EU Member States or Wassenaar Arrangement Participating States.

b. Designed to power an "aircraft" to cruise at Mach 1 or higher, for more than thirty minutes.

‘Marine gas turbine engines’ designed to use liquid fuel and having all of the following, and specially designed assemblies and components therefor:

a. Maximum continuous power when operating in "steady state mode" at standard reference conditions specified by ISO 3977-2:1997 (or national equivalent) of 24 245 kW or more; and

b. ‘Corrected specific fuel consumption’ not exceeding 0,219 kg/kWh at 35 % of the maximum continuous power when using liquid fuel.

Note: The term ‘marine gas turbine engines’ includes those industrial, or aero-derivative, gas turbine engines adapted for a ship’s electric power generation or propulsion.

Technical Note:

For the purposes of 9A002, ‘corrected specific fuel consumption’ is the specific fuel consumption of the engine corrected to a marine distillate liquid fuel having a net specific energy (i.e. net heating value) of 42MJ/kg (ISO 3977-2:1997).

Specially designed assemblies or components, incorporating any of the "technologies" specified in 9E003.a., 9E003.h. or 9E003.i., for any of the following aero gas turbine engines:

a. Specified in 9A001; or

b. Whose design or production origins are either non-EU Member States or Wassenaar Arrangement Participating States or unknown to the manufacturer.

Space launch vehicles, "spacecraft", "spacecraft buses", "spacecraft payloads", "spacecraft" on-board systems or equipment, terrestrial equipment, and air-launch platforms as follows:

NB: SEE ALSO 9A104.

a. Space launch vehicles;

b. "Spacecraft";

c. "Spacecraft buses";

d. "Spacecraft payloads" incorporating items specified in 3A001.b.1.a.4., 3A002.g., 5A001.a.1., 5A001.b.3., 5A002.c., 5A002.e., 6A002.a.1., 6A002.a.2., 6A002.b., 6A002.d., 6A003.b., 6A004.c., 6A004.e., 6A008.d., 6A008.e., 6A008.k., 6A008.l. or 9A010.c.;

e. On-board systems or equipment, specially designed for "spacecraft" and having any of the following functions:

1. ‘Command and telemetry data handling’;

Note: For the purpose of 9A004.e.1., ‘command and telemetry data handling’ includes bus data management, storage, and processing.

2. ‘Payload data handling’; or

Note: For the purpose of 9A004.e.2., ‘payload data handling’ includes payload data management, storage, and processing.

3. ‘Attitude and orbit control’;

Note: For the purpose of 9A004.e.3., ‘attitude and orbit control’ includes sensing and actuation to determine and control the position and orientation of a "spacecraf"t.

NB: For equipment specially designed for military use, SEE MILITARY GOODS CONTROLS.

f. Terrestrial equipment specially designed for "spacecraft", as follows:

1. Telemetry and telecommand equipment specially designed for any of the following data processing functions:

a. Telemetry data processing of frame synchronisation and error corrections, for monitoring of operational status (also known as health and safe status) of the "spacecraft bus"; or

b. Command data processing for formatting command data being sent to the "spacecraft" to control the "spacecraft bus";

2. Simulators specially designed for ‘verification of operational procedures’ of "spacecraft";
Technical Note:

For the purposes of 9A004.f.2., ‘verification of operational procedures’ is any of the following:

1. Command sequence confirmation;

2. Operational training;

3. Operational rehearsals; or

4. Operational analysis.

g. "Aircraft" specially designed or modified to be air-launch platforms for space launch vehicles;

h. "Sub-orbital craft".

Liquid rocket propulsion systems containing any of the systems or components, specified in 9A006.

NB: SEE ALSO 9A105 AND 9A119.

Systems and components, specially designed for liquid rocket propulsion systems, as follows:

NB: SEE ALSO 9A106, 9A108 AND 9A120.

a. Cryogenic refrigerators, flightweight dewars, cryogenic heat pipes or cryogenic systems, specially designed for use in space vehicles and capable of restricting cryogenic fluid losses to less than 30 % per year;

b. Cryogenic containers or closed-cycle refrigeration systems, capable of providing temperatures of 100 K (– 173 °C) or less for "aircraft" capable of sustained flight at speeds exceeding Mach 3, launch vehicles or "spacecraft";

c. Slush hydrogen storage or transfer systems;

d. High pressure (exceeding 17,5 MPa) turbo pumps, pump components or their associated gas generator or expander cycle turbine drive systems;

e. High-pressure (exceeding 10,6 MPa) thrust chambers and nozzles therefor;

f. Propellant storage systems using the principle of capillary containment or positive expulsion (i.e., with flexible bladders);

g. Liquid propellant injectors with individual orifices of 0,381 mm or smaller in diameter (an area of $1{,}14 \times 10^{-3}$ cm^2 or smaller for non-circular orifices) and specially designed for liquid rocket engines;

h. One-piece carbon-carbon thrust chambers or one-piece carbon-carbon exit cones, with densities exceeding 1,4 g/cm^3 and tensile strengths exceeding 48 MPa.

Solid rocket propulsion systems having any of the following:

NB: SEE ALSO 9A107 AND 9A119.

a. Total impulse capacity exceeding 1,1 MNs;

b. Specific impulse of 2,4 kNs/kg or more, when the nozzle flow is expanded to ambient sea level conditions for an adjusted chamber pressure of 7 MPa;

c. Stage mass fractions exceeding 88 % and propellant solid loadings exceeding 86 %;

d. Components specified in 9A008; or

e. Insulation and propellant bonding systems, using direct-bonded motor designs to provide a ‘strong mechanical bond’ or a barrier to chemical migration between the solid propellant and case insulation material.
Technical Note:

‘Strong mechanical bond’ means bond strength equal to or more than propellant strength.

Components specially designed for solid rocket propulsion systems, as follows:

NB: SEE ALSO 9A108.

a. Insulation and propellant bonding systems, using liners to provide a ‘strong mechanical bond’ or a barrier to chemical migration between the solid propellant and case insulation material;
Technical Note:

‘Strong mechanical bond’ means bond strength equal to or more than propellant strength.

b. Filament-wound "composite" motor cases exceeding 0,61 m in diameter or having ‘structural efficiency ratios (PV/W)’ exceeding 25 km;
Technical Note:

‘Structural efficiency ratio (PV/W)’ is the burst pressure (P) multiplied by the vessel volume (V) divided by the total pressure vessel weight (W).

c. Nozzles with thrust levels exceeding 45 kN or nozzle throat erosion rates of less than 0,075 mm/s;

d. Movable nozzle or secondary fluid injection thrust vector control systems, capable of any of the following:

1. Omni-axial movement exceeding ± 5°;

2. Angular vector rotations of 20°/s or more; or

3. Angular vector accelerations of $40°/s^2$ or more.

Hybrid rocket propulsion systems having any of the following:

NB: SEE ALSO 9A109 AND 9A119.

a. Total impulse capacity exceeding 1,1 MNs; or

b. Thrust levels exceeding 220 kN in vacuum exit conditions.

Specially designed components, systems and structures, for launch vehicles, launch vehicle propulsion systems or "spacecraft", as follows:

NB: SEE ALSO 1A002 AND 9A110.

a. Components and structures, each exceeding 10 kg and specially designed for launch vehicles manufactured using any of the following:

1. "Composite" materials consisting of "fibrous or filamentary materials" specified in 1C010.e. and resins specified in 1C008 or 1C009.b.;

2. Metal "matrix""composites" reinforced by any of the following:

a. Materials specified in 1C007;

b. "Fibrous or filamentary materials" specified in 1C010; or

c. Aluminides specified in 1C002.a.; or

3. Ceramic "matrix""composite" materials specified in 1C007;

Note: The weight cut-off is not relevant for nose cones.

b. Components and structures, specially designed for launch vehicle propulsion systems specified in 9A005 to 9A009 manufactured using any of the following:

1. "Fibrous or filamentary materials" specified in 1C010.e. and resins specified in 1C008 or 1C009.b.;

2. Metal "matrix""composites" reinforced by any of the following:

a. Materials specified in 1C007;

b. "Fibrous or filamentary materials" specified in 1C010; or

c. Aluminides specified in 1C002.a.; or

3. Ceramic "matrix""composite" materials specified in 1C007;

c. Structural components and isolation systems, specially designed to control actively the dynamic response or distortion of "spacecraft" structures;

d. Pulsed liquid rocket engines with thrust-to-weight ratios equal to or more than 1 kN/kg and a ‘response time’ of less than 30 ms.
Technical Note:

For the purposes of 9A010.d., ‘response time’ is the time required to achieve 90 % of total rated thrust from start-up.

Ramjet, scramjet or ‘combined cycle engines’, and specially designed components therefor.

NB: SEE ALSO 9A111 AND 9A118.
Technical Note:

For the purposes of 9A011, ‘combined cycle engines’ combine two or more of the following types of engines:
— *Gas turbine engine (turbojet, turboprop and turbofan);*
— *Ramjet or scramjet;*
— *Rocket motor or engine (liquid/gel/solid-propellant and hybrid).*

"Unmanned aerial vehicles" ("UAVs"), unmanned "airships", related equipment and components, as follows:

NB: 1 SEE ALSO 9A112.

NB: 2 For "UAV"s that are "sub-orbital craf"t, see 9A004.h.

a. "UAVs" or unmanned "airships", designed to have controlled flight out of the direct ‘natural vision’ of the ‘operator’ and having any of the following:

1. Having all of the following:

a. A maximum ‘endurance’ greater than or equal to 30 minutes but less than 1 hour; and

b. Designed to take-off and have stable controlled flight in wind gusts equal to or exceeding 46,3 km/h (25 knots); or

2. A maximum ‘endurance’ of 1 hour or greater;

Technical Notes:

1. For the purposes of 9A012.a., ‘operator’ is a person who initiates or commands the "UA"V or unmanned "airshi"p flight.

2. For the purposes of 9A012.a., ‘endurance’ is to be calculated for ISA conditions (ISO 2533:1975) at sea level in zero wind.

3. For the purposes of 9A012.a., ‘natural vision’ means unaided human sight, with or without corrective lenses.

b. Related equipment and components, as follows:

1. Not used;

2. Not used;

3. Equipment or components, specially designed to convert a manned "aircraft" or manned "airship", to a "UAV" or unmanned "airship", specified in 9A012.a.;

4. Air breathing reciprocating or rotary internal combustion type engines, specially designed or modified to propel "UAVs" or unmanned "airships", at altitudes above 15 240 metres (50 000 feet).

Turbojet and turbofan engines, other than those specified in 9A001, as follows;

a. Engines having all of the following characteristics:

1. ‘Maximum thrust value’ greater than 400 N excluding civil certified engines with a ‘maximum thrust value’ greater than 8 890 N;

2. Specific fuel consumption of 0,15 kg N^{-1} h^{-1} or less;

3. ‘Dry weight’ less than 750 kg; and

4. ‘First-stage rotor diameter’ less than 1 m;

Technical Notes:

1. For the purpose of 9A101.a.1., ‘maximum thrust value’ is the manufacturer’s demonstrated maximum thrust for the engine type un-installed at sea level static conditions using the ICAO standard atmosphere. The civil type certified thrust value will be equal to or less than the manufacturer’s demonstrated maximum thrust for the engine type un-installed.

2. Specific fuel consumption is determined at maximum continuous thrust for engine type un-installed at sea level static conditions using the ICAO standard atmosphere.

3. ‘Dry weight’ is the weight of the engine without fluids (fuel, hydraulic fluid, oil, etc.) and does not include the nacelle (housing).

4. 'First-stage rotor diameter' is the diameter of the first rotating stage of the engine, whether a fan or compressor, measured at the leading edge of the blade tips.

b. Engines designed or modified for use in "missiles" or unmanned aerial vehicles specified in 9A012 or 9A112.a.

'Turboprop engine systems' specially designed for unmanned aerial vehicles specified in 9A012 or 9A112.a., and specially designed components therefor, having a 'maximum power' greater than 10 kW.

Note: 9A102 does not control civil certified engines.
Technical Notes:

1. For the purposes of 9A102, a 'turboprop engine system' incorporates all of the following:

a. *Turboshaft engine; and*

b. *Power transmission system to transfer the power to a propeller.*

2. For the purposes of 9A102, the 'maximum power' is achieved un-installed at sea level static conditions using ICAO standard atmosphere.

Sounding rockets, capable of a range of at least 300 km.

NB: SEE ALSO 9A004.

Liquid propellant rocket engines or gel propellant rocket motors, as follows:

NB: SEE ALSO 9A119.

a. Liquid propellant rocket engines or gel propellant rocket motors, usable in "missiles", other than those specified in 9A005, integrated, or designed or modified to be integrated, into a liquid propellant or gel propellant propulsion system which has a total impulse capacity equal to or greater than 1,1 MNs;

b. Liquid propellant rocket engines or gel propellant rocket motors, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, other than those specified in 9A005 or 9A105.a., integrated, or designed or modified to be integrated, into a liquid propellant or gel propellant propulsion system which has a total impulse capacity equal to or greater than 0,841 MNs.

Systems or components, other than those specified in 9A006 as follows, specially designed for liquid rocket propulsion or gel propellant rocket systems:

a. Not used;

b. Not used;

c. Thrust vector control sub-systems, usable in "missiles";
Technical Note:

Examples of methods of achieving thrust vector control specified in 9A106.c. are:

1. *Flexible nozzle;*

2. *Fluid or secondary gas injection;*

3. *Movable engine or nozzle;*

4. *Deflection of exhaust gas stream (jet vanes or probes); or*

5. *Thrust tabs.*

d. Liquid, slurry and gel propellant (including oxidisers) control systems, and specially designed components therefor, usable in "missiles", designed or modified to operate in vibration environments greater than 10 g rms between 20 Hz and 2 kHz;

Note: The only servo valves, pumps and gas turbines specified in 9A106.d., are the following:

a. *Servo valves designed for flow rates equal to or greater than 24 litres per minute, at an absolute pressure equal to or greater than 7 MPa, that have an actuator response time of less than 100 ms;*

b. *Pumps, for liquid propellants, with shaft speeds equal to or greater than 8 000 r.p.m. at a maximum operating mode or with discharge pressures equal to or greater than 7 MPa;*

c. *Gas turbines, for liquid propellant turbopumps, with shaft speeds equal to or greater than 8 000 r.p.m. at the maximum operating mode.*

e. Combustion chambers and nozzles for liquid propellant rocket engines or gel propellant rocket motors specified in 9A005 or 9A105.

Solid propellant rocket motors, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, other than those specified in 9A007, having total impulse capacity equal to or greater than 0,841 MNs.

NB: SEE ALSO 9A119.

Components, other than those specified in 9A008, as follows, specially designed for solid and hybrid rocket propulsion systems:

a. Rocket motor cases and "insulation" components therefor, usable in subsystems specified in 9A007, 9A009, 9A107 or 9A109.a.;

b. Rocket nozzles, usable in subsystems specified in 9A007, 9A009, 9A107 or 9A109.a.;

c. Thrust vector control sub-systems, usable in "missiles".
Technical Note:

Examples of methods of achieving thrust vector control specified in 9A108.c. are:

1. *Flexible nozzle;*

2. *Fluid or secondary gas injection;*

3. *Movable engine or nozzle;*

4. *Deflection of exhaust gas stream (jet vanes or probes); or*

5. *Thrust tabs.*

Hybrid rocket motors and specially designed components as follows:

a. Hybrid rocket motors usable in complete rocket systems or unmanned aerial vehicles, capable of 300 km, other than those specified in 9A009, having a total impulse capacity equal to or greater than 0,841 MNs, and specially designed components therefor;

b. Specially designed components for hybrid rocket motors specified in 9A009 that are usable in "missiles".

NB: SEE ALSO 9A009 AND 9A119.

Composite structures, laminates and manufactures thereof, other than those specified in 9A010, specially designed for use in 'missiles' or the subsystems specified in 9A005, 9A007, 9A105, 9A106.c., 9A107, 9A108.c., 9A116 or 9A119.

NB: SEE ALSO 1A002.
Technical Note:

In 9A110 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

Pulse jet or detonation engines, usable in "missiles" or unmanned aerial vehicles specified in 9A012 or 9A112.a., and specially designed components therefor.

NB: SEE ALSO 9A011 AND 9A118.
Technical Note:

In 9A111 detonation engines utilise detonation to produce a rise in effective pressure across the combustion chamber. Examples of detonation engines include pulse detonation engines, rotating detonation engines or continuous wave detonation engines.

"Unmanned aerial vehicles" ("UAVs"), other than those specified in 9A012, as follows:

a. "Unmanned aerial vehicles" ("UAVs") capable of a range of 300 km;

b. "Unmanned aerial vehicles" ("UAVs") having all of the following:

1. Having any of the following:

a. An autonomous flight control and navigation capability; or

b. Capability of controlled flight out of the direct vision range involving a human operator; and

2. Having any of the following:

a. Incorporating an aerosol dispensing system/mechanism with a capacity greater than 20 litres; or

b. Designed or modified to incorporate an aerosol dispensing system/mechanism with a capacity greater than 20 litres.

Technical Notes:

1. An aerosol consists of particulate or liquids other than fuel components, by products or additives, as part of the payload to be dispersed in the atmosphere. Examples of aerosols include pesticides for crop dusting and dry chemicals for cloud seeding.

2. An aerosol dispensing system/mechanism contains all those devices (mechanical, electrical, hydraulic, etc.), which are necessary for storage and dispersion of an aerosol into the atmosphere. This includes the possibility of

aerosol injection into the combustion exhaust vapour and into the propeller slip stream.

Launch support equipment as follows:

a. Apparatus and devices for handling, control, activation or launching, designed or modified for space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or ‘missiles’;
Technical Note:

In 9A115.a. ‘missile’ means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

b. Vehicles for transport, handling, control, activation or launching, designed or modified for space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or "missiles".

Reentry vehicles, usable in "missiles", and equipment designed or modified therefor, as follows:

a. Reentry vehicles;

b. Heat shields and components therefor, fabricated of ceramic or ablative materials;

c. Heat sinks and components therefor, fabricated of light-weight, high heat capacity materials;

d. Electronic equipment specially designed for reentry vehicles.

Staging mechanisms, separation mechanisms, and interstages, usable in "missiles".

NB: SEE ALSO 9A121.

Devices to regulate combustion usable in engines, which are usable in "missiles" or unmanned aerial vehicles specified in 9A012 or 9A112.a., specified in 9A011 or 9A111.

Individual rocket stages, usable in complete rocket systems or unmanned aerial vehicles, capable of a range of 300 km, other than those specified in 9A005, 9A007, 9A009, 9A105, 9A107 and 9A109.

Liquid or gel propellant tanks, other than those specified in 9A006, specially designed for propellants specified in 1C111 or ‘other liquid or gel propellants’ used in rocket systems capable of delivering at least a 500 kg payload to a range of at least 300 km.

Note: In 9A120 ‘other liquid or gel propellants’ includes, but is not limited to, propellants specified in THE MILITARY GOODS CONTROLS.

Umbilical and interstage electrical connectors specially designed for "missiles", space launch vehicles specified in 9A004 or sounding rockets specified in 9A104.
Technical Note:

Interstage connectors referred to in 9A121 also include electrical connectors installed between the "missil"e, space launch vehicle or sounding rocket and their payload.

Spraying or fogging systems, specially designed or modified for fitting to aircraft, "lighter-than-air vehicles" or unmanned aerial vehicles, and specially designed components therefor, as follows:

a. Complete spraying or fogging systems capable of delivering, from a liquid suspension, an initial droplet 'VMD' of less than 50 μm at a flow rate of greater than two litres per minute;

b. Spray booms or arrays of aerosol generating units capable of delivering, from a liquid suspension, an initial droplet 'VMD' of less than 50 μm at a flow rate of greater than two litres per minute;

c. Aerosol generating units specially designed for fitting to systems specified in 9A350.a. and.b.

Note: Aerosol generating units are devices specially designed or modified for fitting to aircraft such as nozzles, rotary drum atomizers and similar devices.

Note: 9A350 does not control spraying or fogging systems and components that are demonstrated not to be capable of delivering biological agents in the form of infectious aerosols.

Technical Notes:

1. Droplet size for spray equipment or nozzles specially designed for use on aircraft, "lighter-than-air vehicle"s or unmanned aerial vehicles should be measured using either of the following:

a. *Doppler laser method;*

b. *Forward laser diffraction method.*

2. In 9A350 'VMD' means Volume Median Diameter and for water-based systems this equates to Mass Median Diameter (MMD).

Test, Inspection and Production Equipment

Manufacturing equipment, tooling or fixtures, as follows:

NB: SEE ALSO 2B226

a. Directional solidification or single crystal casting equipment designed for "superalloys";

b. Casting tooling, specially designed for manufacturing gas turbine engine blades, vanes or "tip shrouds", manufactured from refractory metals or ceramics, as follows:

1. Cores;

2. Shells (moulds);

3. Combined core and shell (mould) units;

c. Directional-solidification or single-crystal additive-manufacturing equipment, specially designed for manufacturing gas turbine engine blades, vanes or "tip shrouds".

On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, having all of the following:

a. Specially designed for the "development" of gas turbine engines, assemblies or components; and

b. Incorporating any of the "technologies" specified in 9E003.h. or 9E003.i.

Equipment specially designed for the "production" or test of gas turbine brush seals designed to operate at tip speeds exceeding 335 m/s and temperatures in excess of 773 K (500 °C), and specially designed components or accessories therefor.

Tools, dies or fixtures, for the solid state joining of "superalloy", titanium or intermetallic airfoil-to-disk combinations described in 9E003.a.3. or 9E003.a.6. for gas turbines.

On-line (real time) control systems, instrumentation (including sensors) or automated data acquisition and processing equipment, specially designed for use with any of the following:

NB: SEE ALSO 9B105.

a. Wind tunnels designed for speeds of Mach 1,2 or more;

Note: 9B005.a. does not control wind tunnels specially designed for educational purposes and having a 'test section size' (measured laterally) of less than 250 mm.

Technical Note:

'Test section size' means the diameter of the circle, or the side of the square, or the longest side of the rectangle, at the largest test section location.

b. Devices for simulating flow-environments at speeds exceeding Mach 5, including hot-shot tunnels, plasma arc tunnels, shock tubes, shock tunnels, gas tunnels and light gas guns; or

c. Wind tunnels or devices, other than two-dimensional sections, capable of simulating Reynolds number flows exceeding 25×10^6.

Acoustic vibration test equipment capable of producing sound pressure levels of 160 dB or more (referenced to 20 μPa) with a rated output of 4 kW or more at a test cell temperature exceeding 1 273 K (1 000 °C), and specially designed quartz heaters therefor.

NB: SEE ALSO 9B106.

Equipment specially designed for inspecting the integrity of rocket motors and using Non-Destructive Test (NDT) techniques other than planar x-ray or basic physical or chemical analysis.

Direct measurement wall skin friction transducers specially designed to operate at a test flow total (stagnation) temperature exceeding 833 K (560 °C).

Tooling specially designed for producing gas turbine engine powder metallurgy rotor components having all of the following:

a. Designed to operate at stress levels of 60 % of Ultimate Tensile Strength (UTS) or more measured at a temperature of 873 K (600 °C); and

b. Designed to operate at 873 K (600 °C) or more.

Note: 9B009 does not control tooling for the production of powder.

Equipment specially designed for the production of items specified in 9A012.

'Aerodynamic test facilities' for speeds of Mach 0,9 or more, usable for 'missiles' and their subsystems.

NB: SEE ALSO 9B005.

Note: 9B105 does not control wind-tunnels for speeds of Mach 3 or less with dimension of the 'test cross section size' equal to or less than 250 mm.

Technical Notes:

1. In 9B105 'aerodynamic test facilities' includes wind tunnels and shock tunnels for the study of airflow over objects.

2. In Note to 9B105, 'test cross section size' means the diameter of the circle, or the side of the square, or the longest side of the rectangle, or the major axis of the ellipse at the largest 'test cross section' location. 'Test cross section' is the section perpendicular to the flow direction.

3. In 9B105 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

Environmental chambers and anechoic chambers, as follows:

a. Environmental chambers having all of the following:

1. Capable of simulating any of the following flight conditions:

a. Altitude equal to or greater than 15 km; or

b. Temperature range from below 223 K (– 50°C) to above 398 K (125°C); and

2. Incorporating, or 'designed or modified' to incorporate, a shaker unit or other vibration test equipment to produce vibration environments equal to or greater than 10 g rms, measured 'bare table', between 20 Hz and 2 kHz while imparting forces equal to or greater than 5 kN;

Technical Notes:

1. 9B106.a.2. describes systems that are capable of generating a vibration environment with a single wave (e.g., a sine wave) and systems capable of generating a broad band random vibration (i.e., power spectrum).

2. In 9B106.a.2., 'designed or modified' means the environmental chamber provides appropriate interfaces (e.g., sealing devices) to incorporate a shaker unit or other vibration test equipment as specified in 2B116.

3. In 9B106.a.2., 'bare table' means a flat table, or surface, with no fixture or fittings.

b. Environmental chambers capable of simulating the following flight conditions:

1. Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to 20 μPa) or with a total rated acoustic power output of 4 kW or greater; and

2. Altitude equal to or greater than 15 km; or

3. Temperature range from below 223 K (– 50°C) to above 398 K (125°C).

'Aerothermodynamic test facilities', usable for 'missiles', 'missile' rocket propulsion systems, and reentry vehicles and equipment specified in 9A116, having any of the following characteristics:

a. An electrical power supply equal to or greater than 5 MW; or

b. A gas supply total pressure equal to or greater than 3 MPa.

Technical Notes:

1. 'Aerothermodynamic test facilities' include plasma arc jet facilities and plasma wind tunnels for the study of thermal and mechanical effects of airflow on objects.

2. In 9B107 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

Specially designed "production equipment" for the systems, sub-systems and components specified in 9A005 to 9A009, 9A011, 9A101, 9A102, 9A105 to 9A109, 9A111, 9A116 to 9A120.

Specially designed "production facilities" for the space launch vehicles specified in 9A004, or systems, sub-systems, and components specified in 9A005 to 9A009, 9A011, 9A101, 9A102, 9A104 to 9A109, 9A111, 9A116 to 9A120 or 'missiles'.

Technical Note:

In 9B116 'missile' means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

Test benches or test stands for solid or liquid propellant rockets or rocket motors, having either of the following characteristics:

a. The capacity to handle more than 68 kN of thrust; or

b. Capable of simultaneously measuring the three axial thrust components.

Materials

"Insulation" material in bulk form and "interior lining", other than those specified in 9A008, for rocket motor cases usable in "missiles" or specially designed for solid propellant rocket engines specified in 9A007 or 9A107.

Resin impregnated fibre prepregs and metal coated fibre preforms therefor, for composite structures, laminates and manufactures specified in 9A110, made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a "specific tensile strength" greater than $7{,}62 \times 10^4$ m and a "specific modulus" greater than $3{,}18 \times 10^6$ m.

NB: SEE ALSO 1C010 AND 1C210.

Note: The only resin impregnated fibre prepregs specified in entry 9C110 are those using resins with a glass transition temperature (T_g), after cure, exceeding 418 K (145°C) as determined by ASTM D4065 or equivalent.

Software

"Software", not specified in 9D003 or 9D004, specially designed or modified for the "development" of equipment or "technology", specified in 9A001 to 9A119, 9B or 9E003.

"Software", not specified in 9D003 or 9D004, specially designed or modified for the "production" of equipment specified in 9A001 to 9A119 or 9B.

"Software" incorporating "technology" specified in 9E003.h. and used in "FADEC Systems" for systems specified in 9A or equipment specified in 9B.

Other "software" as follows:

a. 2D or 3D viscous "software", validated with wind tunnel or flight test data required for detailed engine flow modelling;

b. "Software" for testing aero gas turbine engines, assemblies or components, having all of the following:

1. Specially designed for testing any of the following:

a. Aero gas turbine engines, assemblies or components, incorporating "technology" specified in 9E003.a., 9E003.h. or 9E003.i.; or

b. Multi-stage compressors providing either bypass or core flow, specially designed for aero gas turbine engines incorporating "technology" specified in 9E003.a. or 9E003.h.; and

2. Specially designed for all of the following:

a. Acquisition and processing of data, in real time; and

b. Feedback control of the test article or test conditions (e.g. temperature, pressure, flow rate) while the test is in progress;

Note: 9D004.b. does not control software for operation of the test facility or operator safety (e.g. overspeed shutdown, fire detection and suppression), or production, repair or maintenance acceptance-testing limited to determining if the item has been properly assembled or repaired.

c. "Software" specially designed to control directional solidification or single crystal material growth in equipment specified in 9B001.a. or 9B001.c.;

d. Not used;

e. "Software" specially designed or modified for the operation of items specified in 9A012;

f. "Software" specially designed to design the internal cooling passages of aero gas turbine blades, vans and "tip shrouds";

g. "Software" having all of the following:

1. Specially designed to predict aero thermal, aeromechanical and combustion conditions in aero gas turbine engines; and

2. Theoretical modelling predictions of the aero thermal, aeromechanical and combustion conditions, which have been validated with actual aero gas turbine engine (experimental or production) performance data.

"Software" specially designed or modified for the operation of items specified in 9A004.e. or 9A004.f.

NB: For "softwar"e for items listed in 9A004.d. that are incorporated into "spacecrafts payload"s, see the appropriate Categories.

"Software" specially designed or modified for the "use" of goods specified in 9B105, 9B106, 9B116 or 9B117.

"Software" specially designed for modelling, simulation or design integration of the space launch vehicles specified in 9A004, sounding rockets specified in 9A104 or "missiles", or the subsystems specified in 9A005, 9A007, 9A105, 9A106.c., 9A107, 9A108.c., 9A116 or 9A119.

Note: "Softwar"e specified in 9D103 remains controlled when combined with specially designed hardware specified in 4A102.

"Software" as follows:

a. "Software" specially designed or modified for the "use" of goods specified in 9A001, 9A005, 9A006.d., 9A006.g., 9A007.a., 9A009.a., 9A010.d., 9A011, 9A101, 9A102, 9A105, 9A106.d., 9A107, 9A109, 9A111, 9A115.a., 9A117 or 9A118.

b. "Software" specially designed or modified for the operation or maintenance of subsystems or equipment specified in 9A008.d., 9A106.c., 9A108.c. or 9A116.d.

"Software" specially designed or modified to coordinate the function of more than one subsystem, other than that specified in 9D004.e., in space launch vehicles specified in 9A004 or sounding rockets specified in 9A104 or ‘missiles’

Note: 9D105 includes "softwar"e specially designed for a manned "aircraf"t converted to operate as "unmanned aerial vehicl"e, as follows:

a. *"Softwar"e specially designed or modified to integrate the conversion equipment with the "aircraf"t system functions; and*

b. *"Softwar"e specially designed or modified to operate the "aircraf"t as an "unmanned aerial vehicl"e.*

Technical Note:

In 9D105 ‘missile’ means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

Technology

Note: "Developmen"t or "productio""ntechnolog"y specified in 9E001 to 9E003 for gas turbine engines remains controlled when used for repair or overhaul. Excluded from control are: technical data, drawings or documentation for maintenance activities directly associated with calibration, removal or replacement of damaged or unserviceable line replaceable units, including replacement of whole engines or engine modules.

"Technology" according to the General Technology Note for the "development" of equipment or "software", specified in 9A001.b., 9A004 to 9A012, 9A350, 9B or 9D.

"Technology" according to the General Technology Note for the "production" of equipment specified in 9A001.b., 9A004 to 9A011, 9A350 or 9B.

NB: For "technolog"y for the repair of controlled structures, laminates or materials, see 1E002.f.

Other "technology" as follows:

a. "Technology""required" for the "development" or "production" of any of the following gas turbine engine components or systems:

1. Gas turbine blades, vanes or "tip shrouds", made from directionally solidified (DS) or single crystal (SC) alloys and having (in the 001 Miller Index Direction) a stress-rupture life exceeding 400 hours at 1 273 K (1 000 °C) at a stress of 200 MPa, based on the average property values;
Technical Note:

For the purposes of 9E003.a.1., stress-rupture life testing is typically conducted on a test specimen.

2. Combustors having any of the following:

a. ‘Thermally decoupled liners’ designed to operate at ‘combustor exit temperature’ exceeding 1 883K (1 610 °C);

b. Non-metallic liners;

c. Non-metallic shells; or

d. Liners designed to operate at ‘combustor exit temperature’ exceeding 1 883 K (1 610 °C) and having holes that meet the parameters specified in 9E003.c.;

Note: The "require""dtechnolog"y for holes in 9E003.a.2. is limited to the derivation of the geometry and location of the holes.

Technical Notes:

1. ‘Thermally decoupled liners’ are liners that feature at least a support structure designed to carry mechanical loads and a combustion facing structure designed to protect the support structure from the heat of combustion. The combustion facing structure and support structure have independent thermal displacement (mechanical displacement due to thermal load) with respect to one another, i.e. they are thermally decoupled.

2. ‘Combustor exit temperature’ is the bulk average gas path total (stagnation) temperature between the combustor exit plane and the leading edge of the turbine inlet guide vane (i.e., measured at engine station T40 as defined in SAE ARP 755A) when the engine is running in a "steady state mod"e of operation at the certificated maximum continuous operating temperature.

NB: See 9E003.c. for "technolog""yrequire"d for manufacturing cooling holes.

3. Components that are any of the following:

a. Manufactured from organic "composite" materials designed to operate above 588 K (315 °C);

b. Manufactured from any of the following:

1. Metal "matrix""composites" reinforced by any of the following:

a. Materials specified in 1C007;

b. "Fibrous or filamentary materials" specified in 1C010; or

c. Aluminides specified in 1C002.a.; or

2. Ceramic "matrix""composites" specified in 1C007.; or

c. Stators, vanes, blades, tip seals (shrouds), rotating blings, rotating blisks, or ‘splitter ducts’, that are all of the following:

1. Not specified in 9E003.a.3.a.;

2. Designed for compressors or fans; and

3. Manufactured from material specified in 1C010.e. with resins specified in 1C008;
Technical Note:

A 'splitter duct' performs the initial separation of the air-mass flow between the bypass and core sections of the engine.

4. Uncooled turbine blades, vanes or "tip-shrouds", designed to operate at a 'gas path temperature' of 1 373 K (1 100 °C) or more;

5. Cooled turbine blades, vanes, "tip-shrouds" other than those described in 9E003.a.1., designed to operate at a 'gas path temperature' of 1 693 K (1 420 °C) or more;
Technical Note:

'Gas path temperature' is the bulk average gas path total (stagnation) temperature at the leading edge plane of the turbine component when the engine is running in a "steady state mod"e of operation at the certificated or specified maximum continuous operating temperature.

6. Airfoil-to-disk blade combinations using solid state joining;

7. Not used;

8. 'Damage tolerant' gas turbine engine rotor components using powder metallurgy materials specified in 1C002.b.; or
Technical Note:

'Damage tolerant' components are designed using methodology and substantiation to predict and limit crack growth.

9. Not used;

10. Not used;

11. 'Fan blades' having all of the following:

a. 20 % or more of the total volume being one or more closed cavities containing vacuum or gas only; and

b. One or more closed cavities having a volume of 5 cm^3 or larger;
Technical Note:

For the purposes of 9E003.a.11., a 'fan blade' is the aerofoil portion of the rotating stage or stages, which provide both compressor and bypass flow in a gas turbine engine.

b. "Technology""required" for the "development" or "production" of any of the following:

1. Wind tunnel aero-models equipped with non-intrusive sensors capable of transmitting data from the sensors to the data acquisition system; or

2. "Composite" propeller blades or propfans, capable of absorbing more than 2 000 kW at flight speeds exceeding Mach 0,55;

c. "Technology""required" for manufacturing cooling holes, in gas turbine engine components incorporating any of the "technologies" specified in 9E003.a.1., 9E003.a.2. or 9E003.a.5., and having any of the following:

1. Having all of the following:

a. Minimum ‘cross-sectional area’ less than 0,45 mm^2;

b. ‘Hole shape ratio’ greater than 4,52; and

c. ‘Incidence angle’ equal to or less than 25^o; or

2. Having all of the following:

a. Minimum ‘cross-sectional area’ less than 0,12 mm^2;

b. ‘Hole shape ratio’ greater than 5,65; and

c. ‘Incidence angle’ more than 25^o;

Note: 9E003.c. does not control "technolog"y for manufacturing constant radius cylindrical holes that are straight through and enter and exit on the external surfaces of the component.

Technical Notes:

1. For the purposes of 9E003.c., the ‘cross-sectional area’ is the area of the hole in the plane perpendicular to the hole axis.

2. For the purposes of 9E003.c., ‘hole shape ratio’ is the nominal length of the axis of the hole divided by the square root of its minimum ‘cross-sectional area’.

3. For the purposes of 9E003.c., ‘incidence angle’ is the acute angle measured between the plane tangential to the aerofoil surface and the hole axis at the point where the hole axis enters the aerofoil surface.

4. Methods for manufacturing holes in 9E003.c. include "lase"r beam machining, water jet machining, Electro-Chemical Machining (ECM) or Electrical Discharge Machining (EDM).

d. "Technology""required" for the "development" or "production" of helicopter power transfer systems or tilt rotor or tilt wing "aircraft" power transfer systems;

e. "Technology" for the "development" or "production" of reciprocating diesel engine ground vehicle propulsion systems having all of the following:

1. ‘Box volume’ of 1,2 m^3 or less;

2. An overall power output of more than 750 kW based on 80/1269/EEC, ISO 2534 or national equivalents; and

3. Power density of more than 700 kW/m^3 of ‘box volume’;

Technical Note:

‘Box volume’ in 9E003.e. is the product of three perpendicular dimensions measured in the following way:

Length : *The length of the crankshaft from front flange to flywheel face;*

Width : *The widest of any of the following:*

a. *The outside dimension from valve cover to valve cover;*

b. *The dimensions of the outside edges of the cylinder heads; or*

c. *The diameter of the flywheel housing;*

Height : *The largest of any of the following:*

a. *The dimension of the crankshaft centre-line to the top plane of the valve cover (or cylinder head) plus twice the stroke; or*

b. *The diameter of the flywheel housing.*

f. "Technology""required" for the "production" of specially designed components for high output diesel engines, as follows:

1. "Technology""required" for the "production" of engine systems having all of the following components employing ceramics materials specified in 1C007:

a. Cylinder liners;

b. Pistons;

c. Cylinder heads; and

d. One or more other components (including exhaust ports, turbochargers, valve guides, valve assemblies or insulated fuel injectors);

2. "Technology""required" for the "production" of turbocharger systems with single-stage compressors and having all of the following:

a. Operating at pressure ratios of 4:1 or higher;

b. Mass flow in the range from 30 to 130 kg per minute; and

c. Variable flow area capability within the compressor or turbine sections;

3. "Technology""required" for the "production" of fuel injection systems with a specially designed multifuel (e.g., diesel or jet fuel) capability covering a viscosity range from diesel fuel (2,5 cSt at 310,8 K (37,8 °C)) down to gasoline fuel (0,5 cSt at 310,8 K (37,8 °C)) and having all of the following:

a. Injection amount in excess of 230 mm^3 per injection per cylinder; and

b. Electronic control features specially designed for switching governor characteristics automatically depending on fuel property to provide the same torque characteristics by using the appropriate sensors;

g. "Technology""required" for the "development" or "production" of 'high output diesel engines' for solid, gas phase or liquid film (or combinations thereof) cylinder wall lubrication and permitting operation to temperatures exceeding 723 K (450 °C), measured on the cylinder wall at the top limit of travel of the top ring of the piston;
Technical Note:

'High output diesel engines' are diesel engines with a specified brake mean effective pressure of 1,8 MPa or more at a speed of 2 300 r.p.m., provided the rated speed is 2 300 r.p.m. or more.

h. "Technology" for gas turbine engine "FADEC systems" as follows:

1. "Development""technology" for deriving the functional requirements for the components necessary for the "FADEC system" to regulate engine thrust or shaft power (e.g., feedback sensor time constants and accuracies, fuel valve slew rate);

2. "Development" or "production""technology" for control and diagnostic components unique to the "FADEC system" and used to regulate engine thrust or shaft power;

3. "Development""technology" for the control law algorithms, including "source code", unique to the "FADEC system" and used to regulate engine thrust or shaft power;

Note: 9E003.h. does not control technical data related to engine"-aircraf"t integration required by the civil aviation authorities of one or more EU Member States or Wassenaar Arrangement Participating States to be published for general airline use (e.g., installation manuals, operating instructions, instructions for continued airworthiness) or interface functions (e.g., input/output processing, airframe thrust or shaft power demand).

i. "Technology" for adjustable flow path systems designed to maintain engine stability for gas generator turbines, fan or power turbines, or propelling nozzles, as follows:

1. "Development""technology" for deriving the functional requirements for the components that maintain engine stability;

2. "Development" or "production""technology" for components unique to the adjustable flow path system and that maintain engine stability;

3. "Development""technology" for the control law algorithms, including "source code", unique to the adjustable flow path system and that maintain engine stability.

Note: 9E003.i. does not control "technolog"y for any of the following:

a. *Inlet guide vanes;*

b. *Variable pitch fans or prop-fans;*

c. *Variable compressor vanes;*

d. *Compressor bleed valves; or*

e. *Adjustable flow path geometry for reverse thrust.*

j. "Technology""required" for the "development" of wing-folding systems designed for fixed-wing "aircraft" powered by gas turbine engines.

NB: For "technolog""yrequire"d for the "developmen"t of wing-folding systems designed for fixed-wing "aircraf"t SEE ALSO MILITARY GOODS CONTROLS.

a. "Technology" according to the General Technology Note for the "development" of goods specified in 9A101, 9A102, 9A104 to 9A111, 9A112.a. or 9A115 to 9A121.

b. "Technology" according to the General Technology Note for the "production" of 'UAV's specified in 9A012 or goods specified in 9A101, 9A102, 9A104 to 9A111, 9A112.a. or 9A115 to 9A121.
Technical Note:

In 9E101.b. 'UAV' means unmanned aerial vehicle systems capable of a range exceeding 300 km.

"Technology" according to the General Technology Note for the "use" of space launch vehicles specified in 9A004, goods specified in 9A005 to 9A011, 'UAV's specified in 9A012 or goods specified in 9A101, 9A102, 9A104 to 9A111, 9A112.a., 9A115 to 9A121, 9B105, 9B106, 9B115, 9B116, 9B117, 9D101 or 9D103.
Technical Note:

In 9E102 'UAV' means unmanned aerial vehicle systems capable of a range exceeding 300 km.

Changes to legislation:
There are currently no known outstanding effects for the Commission Delegated Regulation (EU) 2020/1749, CATEGORY 9 – AEROSPACE AND PROPULSION.