SCHEDULE 1

PROHIBITED GOODS

PART III

GROUP 3

INDUSTRIAL GOODS

Interpretations, exclusions and definitions

1. Where notes are included in any entry of this Group they are to be treated as part of the entry.

2. This Group does not specify **software** which is either:

(a) generally available to the public or

(b) (1) sold from stock at retail selling points, without restriction, by means of:

(a) over-the-counter transactions;

(b) mail order transactions;

(c) telephone order transactions; and

(2) is designed for installation by the user without further substantial support by the supplier.

3. In this Group:

"3-D vector rate" means 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;

"accuracy", usually measured in terms of inaccuracy, means the maximum deviation, positive or negative, of an indicated value from an accepted standard or true value;

"active flight control systems" means systems whose function is to prevent undesirable **aircraft** motions, rocket motions or structural loads by autonomously processing outputs from multiple sensors and then providing necessary preventive commands to effect automatic control;

"active pixel" means a minimum (single) element of the solid state array which has a photoelectric transfer function when exposed to light;

"adaptive control" means a control system that adjusts the response from conditions detected during the operation;

"angular position deviation" means 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;

"ASTM" means the American Society for Testing and Materials;

"asynchronous transfer mode (ATM)" means a transfer mode in which the information is organised into cells; it is asynchronous in the sense that the recurrence of cells depends on the required or instantaneous bit rate;

"automatic target tracking" means 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, means designed to operate in one voice channel of 3,100 Hz, as defined in CCITT Recommendation G.151;

"basic gate propagation delay time" means the propagation delay time value corresponding to the basic gate used within a **family** of **monolithic integrated circuits;** this may be specified, for a given **family,** either as the propagation delay time per typical gate or as the typical propagation delay time per gate;

"beat length" means the distance over which two orthogonally polarised signals, initially in phase, must pass in order to achieve a 2 Pi radian(s) phase difference;

"bias" means an accelerometer output when no acceleration is applied;

"camming" (axial displacement) means 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;

"CCITT" means International Telegraph and Telephone Consultative Committee;

"CEP" (circle of equal probability) means a measure of accuracy defined as the radius of the circle centred at the target, at a specific range, in which 50% of the payloads impact;

"chemical laser" means a **laser** in which the excited species is produced by the output energy from a chemical reaction;

"circuit element" means a single active or passive functional part of an electronic circuit which may be a diode, a transistor, a resistor or a capacitor;

"circulation-controlled anti-torque or circulation-controlled directional control systems" means systems that use air blown over aerodynamic surfaces to increase or control the forces generated by the surfaces;

"commingled" means the filament to filament blending of thermoplastic fibres and reinforcement fibres in order to produce a fibre reinforcement **matrix** mix in total fibre form;

"comminution" means a process to reduce a material to particles by crushing or grinding;

"common channel signalling" means a signalling method in which a single channel between exchanges conveys, by means of labelled messages, signalling information relating to a multiplicity of circuits or calls and other information such as that used for network management;

"communications channel controller" means 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;

"composite" means a **matrix** and an additional phase or additional phases consisting of particles, whiskers, fibres or any combination thereof, present for a specific purpose or purposes;

"composite theoretical performance" (CTP) means a measure of computational performance given in millions of theoretical operations per second (Mtops), calculated using the aggregation of **computing elements** (CE);

Note to **composite theoretical performance** (CTP)

Abbreviations used in this Note

CE	**computing element** (typically an arithmetic logical unit)
FP	floating point

XP	fixed point
t	execution time
XOR	exclusive OR
CPU	central processing unit
TP	theoretical performance (of a single CE)
CTP	**composite theoretical performance** (multiple CEs)
Mtops	millions of theoretical operations per second
R	effective calculating rate
WL	word length
L	word length adjustment
*	multiply
	Execution time 't' is expressed in microseconds, TP and CTP are expressed in millions of theoretical operations per second (Mtops) and WL is expressed in bits.

Outline of the CTP calculation method

CTP is a measure of computational performance given in Mtops. In calculating the CTP of an aggregation of CEs the following three steps are required:

1. Calculate the effective calculating rate R for each CE;
2. Apply the word length adjustment (L) to the effective calculating rate (R), resulting in a Theoretical Performance (TP) for each CE.;
3. If there is more than one CE, combine the TPs resulting in a CTP for the aggregation.

Details for these steps are given in the following sections.

Note 1. For aggregations of multiple CEs which have both shared and unshared memory subsystems, the calculation of CTP is completed hierarchically, in two steps: first, aggregate the group of CEs sharing memory, second calculate the CTP of the groups using the calculation method for multiple CEs not sharing memory.

Note 2. CEs that are limited to input/output and peripheral functions (e.g. disk drive, communication and video display controllers) are not aggregated into the CTP calculation.

The following table shows the method of calculating the effective calculating rate (R) for each CE:

(Step 1) The effective calculating rate R

For CEs implementing Note: Every CE must be evaluated independently	*Effective calculating rate, R*
XP only (R_{xp})	$\frac{1}{3 * (t_{xp\ add})}$ if no add is implemented use:

For CEs implementing Note: Every CE must be evaluated independently	*Effective calculating rate, R*
	$\frac{1}{(t_{xp\ mult})}$ If neither add nor multiply is implemented use the fastest available arithmetic operation as follows: $\frac{1}{3 * t_{xp}}$ See Notes X & Y
FP only (R_{fp})	Max $\frac{1}{t_{fp\ add}}, \frac{1}{t_{fp\ mult}}$ See Notes X & Z
Both FP and XP (R)	Calculate both R_{xp}, R_{fp}
For simple logic processors not implementing any of the specified arithmetic operations.	$\frac{1}{3 * t_{log}}$ Where t_{log} is the execute time of the XOR, or for logic hardware not implementing the XOR, the fastest simple logic operation. See Notes X & Z
For special logic processors not using any of the specified arithmetic or logic operations.	$R = R' * WL/64$ Where R' is the number of results per second, WL is the number of bits upon which the logic operation occurs, and 64 is a factor to normalize to a 64 bit operation.

Note W: For a pipelined CE capable of executing up to one arithmetic or logic operation every clock cycle after the pipeline is full, a pipelined rate can be established. The effective calculating rate (R) for such a CE is the faster of the pipelined rate or non-pipelined execution rate.

Note X: For CEs which perform multiple operations of a specific type in a single cycle (e.g., two additions per cycle or two identical logic operations per cycle), the execution time t is given by:

$$t = \frac{\text{cycle time}}{\text{the number of identical arithmetic operations per machine cycle}}$$

CEs which perform different types of arithmetic or logic operations in a single machine cycle are to be treated as multiple separate CEs performing simultaneously (e.g., a CE performing an addition and a multiplication in one cycle is to be treated as two CEs, the first performing an addition in obne cycle and the second performing a multiplication in one cycle).

If a single CE has both scalar function and vector function, use the shorter execution time value.

Note Y: For the CE that does not implement FP add or FP multiply, but that performs FP divide:

$$R_{fp} = \frac{1}{t_{fpdivide}}$$

If the CE implements FP reciprocal but not FP add, FP multiply or FP divide, then

$$R_{fp} = \frac{1}{t_{fpreciprocal}}$$

If none of the specified instructions is implemented, the effective FP rate is 0.

Note Z: In simple logic operations, a single instruction performs a single logic manipulation of no more than two operands of given lengths. In complex logic operations, a single instruction performs multiple logic manipulations to produce one or more results from two or more operands.

Rates should be calculated for all supported operand lengths considering both pipelined operations (if supported), and non-pipelined operations using the fastest executing instruction for each operand length based on:

(1) Pipelined or register-to-register operations. Exclude extraordinarily short execution times generated for operations on a predetermined operand or operands (for example, multiplication by 0 or 1). If no register-to-register operations are implemented, continue with (2).

(2) The faster of register-to-memory or memory-to-register operations; if these also do not exist, then continue with (3).

(3) Memory-to-memory.

In each case above, use the shortest execution time certified by the manufacturer.

Step 2: TP for each supported operand length WL

Adjust the effective rate R (or R') by the word length adjustment L as follows:

TP = R * L,

where L = (1/3 + WL/96)

Note: The word length WL used in these calculations is the operand length in bits. (If an operation uses operands of different lengths, select the largest word length.)

The combination of a mantissa ALU and an exponent ALU of a floating point processor or unit is considered to be one CE with a Word Length (WL) equal to the number of bits in the data representation (typically 32 or 64) for purposes of the CTP calculation.

This adjustment is not applied to specialized logic processors which do not use XOR instructions. In this case TP = R.

Select the maximum resulting value of TP for:

Each XP-only CE (R_{xp});

Each FP-only CE (R_{fp});

Each combined FP and XP CE (R);

Each simple logic processor not implementing any of the specified arithmetic operations; and

Each special logic processor not using any of the specified arithmetic or logic operations.

(Step 3) CTP for aggregations of CEs, including CPUs

For a CPU with a single CE,

CTP = TP

(for CEs performing both fixed and floating point operations

$TP = \max (TP_{fp}, TP_{xp})$)

CTP for aggregations of multiple CEs operating simultaneously is calculated as follows:

Note 1: For aggregations that do not allow all of the CEs to run simultaneously, the possible combination of CEs that provides the largest CTP should be used. The TP of each contributing CE is to be calculated at its maximum value theoretically possible before the CTP of the combination is derived.

N.B. To determine the possible combinations of simultaneously operating CEs, generate an instruction sequence that initiates operations in multiple CEs, beginning with the slowest CE (the one needing the largest number of cycles to complete its operation) and ending with the fastest CE. At each cycle of the sequence, the combination of CEs that are in operation during that cycle is a possible combination. The instruction sequence must take into account all hardware and/or architectural constraints on overlapping operations.

Note 2: A single integrated circuit chip or board assembly may contain multiple CEs.

Note 3: Simultaneous operations are assumed to exist when the computer manufacturer claims concurrent, parallel or simultaneous operation or execution in a manual or brochure for the computer.

Note 4: CTP values are not to be aggregated for CE combinations (inter)connected by **local area networks,** Wide Area Networks, Input/Output shared connections/ devices, Input/Output controllers and any communication interconnection implemented by software.

Note 5: CTP values must be aggregated for multiple CEs specially designed to enhance performance by aggregation, operating simultaneously and sharing memory, — or multiple memory/CE — combinations operating simultaneously utilising specially designed hardware.

This aggregation does not apply to assemblies described by entry 4A003c

$CTP = TP_1 + C_2 * TP_2 + \ldots + C_n * TP_n$,

where the TPs are ordered by value, with TP_1 being the highest, TP_2 being the second highest,…, and TP_n being the lowest. C_i is a coefficient determined by the strength of the interconnection between CEs, as follows:

For multiple CEs operating simultaneously and sharing memory: $C_2 = C_3 = C_4 = \ldots = C_n = 0.75$

Note 1: When the CTP calculated by the above method does not exceed 194 Mtops, the following formula may be used to calculate C_i:

$$\frac{C_i = 0.75}{(m)^{i} \; (i = 2, \ldots, n)}$$

where

m = number of CEs or groups of CEs sharing access.

provided:

1. The TPi of each CE or group of CEs does not exceed 30 Mtops

2. The CEs or groups of CEs share access to main memory (excludingcache memory) over a single channel; and

3. Only one CE or group of CEs can have use of the channel at any given time.

N.B. This does not apply to items controlled under Category 3.

Note 2: CEs share memory if they access a common segment of solid state memory. This memory may include cache memory, main memory, or other internal memory. Peripheral memory devices such as disk drives, tape drives or RAM disks are not included.

For Multiple CEs or groups of CEs not sharing memory, interconnected by one or more data channels:

$C_i = 0.75 * k_i$ (i = 2,…,32) (see note below)

$= 0.60 * k_i$ (i = 33,…,64)

$= 0.45 * k_i$ (i = 65,…,256)

$= 0.30 * k_i$ (i > 256)

The value of C_i is based on the number of CEs, not the number of nodes.

where

$k_i = \min (S_i/K_r, 1)$, and

K_r = normalizing factor of 20 MByte/s

S_i = sum of the maximum data rates (in units of MByte/s) for all data channels connected to the i^{th} CE or group of CEs sharing memory.

When calculating a C_i for a group of CEs, the number of the first CE in a group determines the proper limits for C_i. For example, in an aggregation of groups consisting of 3 CEs each, the 22^{nd} group will contain CE_{64}, CE_{65} and CE_{66}. The proper limit for C_i for this group is 0.60.

Aggregation (of CEs or groups of CEs) should be from fastest-to-slowest; i.e.:

$TP_1 \geq TP_2 \geq \ldots \geq TP_n$, and

in the case of $TP_i + TP_{i+1}$ from the largest to smallest; i.e.:

$C_i \geq C_{i+1}$

Note: The k_i factor is not applied to CEs 2 to 12 if the TP_i of the CE or group of CEs is more than 50 Mtops; i.e., C_i for CEs 2 to 12 is 0.75;

“compound rotary table” means a table allowing the workpiece to rotate and tilt about two non-parallel axes, which can be coordinated simultaneously for **contouring control;**

“computing element” (CE) means the smallest computational unit that produces an arithmetic or logic result;

“contouring control” means 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;

“critical temperature” (sometimes referred to as the transition temperature) of a specific superconductive material means the temperature at which the specific material loses all resistance to the flow of direct electrical current;

“cryptography” means 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 or associated key management; for this purpose, "secret parameter" means a constant or key kept from the knowledge of others or shared only within a group;

"datagram" means a self-contained, independent entity of data carrying sufficient information to be routed from the source to the destination data terminal equipment without reliance on earlier exchanges between this source or destination data terminal equipment and the transporting network;

"data signalling rate" means the maximum one-way rate, i.e., the maximum rate in either transmission or reception, whichever is the greater, as defined in ITU Recommendation 53-36, taking into account that, for non-binary modulation, baud and bit per second are not equal; binary digits for coding, checking and synchronisation functions are included;

"deformable mirrors" (also known as adaptive optic mirrors) means mirrors having:

a. a single continuous optical reflecting surface which is dynamically deformed by the application of individual torques or forces to compensate for distortions in the optical waveform incident upon the mirror; or

b. multiple optical reflecting elements that can be individually and dynamically be repositioned by the application of torques or forces to compensate for distortions in the optical waveform incident upon the mirror;

"diffusion bonding" means a solid-state molecular joining of at least two separate metals into a single piece with a joint strength equivalent to that of the weakest material;

"digital computer" means equipment which can, in the form of one or more discrete variables:

a. accept data;

b. store data or instructions in fixed or alterable (writable) storage devices;

c. process data by means of a stored sequence of instructions which is modifiable (including by replacement of fixed storage devices, but not by a physical change in wiring or interconnections); and

d. provide output of data;

"digital transfer rate" means the total bit rate of the information that is directly transferred on any type of medium;

"direct-acting hydraulic pressing" means a deformation process which uses a fluid-filled flexible bladder in direct contact with the workpiece;

"discrete component" means a separately packaged **circuit element** with its own external connections;

"drift rate", as it relates to gyros, means 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" means automatic rerouting of traffic based on sensing and analysis of current actual network conditions;

"dynamic signal analysers" means **signal analysers** which use digital sampling and transformation techniques to form a Fourier spectrum display of the given waveform including amplitude and phase information;

"electronically steerable phased array antenna" means an antenna which forms a beam by means of phase coupling, where 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;

"electronic assemblies" mean a number of electronic components (including **circuit elements, discrete components** and integrated circuits) connected together to perform a specific function, which are replaceable as an entity and are normally capable of being disassembled;

"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; for this purpose, "active tooling unit" means a device for applying motive power, process energy or sensing to the workpiece;

"equivalent density" means the mass of an optic per unit optical area projected onto the optical surface;

"expert systems" means systems providing results by application of rules to data which are stored independently of the **programme** and capable of any of the following:

a. modifying automatically the **source code** introduced by the user;

b. providing knowledge linked to a class of problems in quasi-natural language; or

c. acquiring the knowledge required for their development (symbolic training);

"family" means a group of microprocessor or microcomputer microcircuits which have:

a. the same architecture;

b. the same basic instruction set; and

c. the same basic technology (e.g., only N-channel Metal Oxide Semiconductor (NMOS) or only Complementary Metal Oxide Semiconductor (CMOS));

"fast select" means a facility applicable to virtual calls which allows a data terminal equipment to expand the possibility of transmitting data in call set-up and clearing packets beyond the basic capabilities of a virtual call; for this purpose, "packet" means a group of binary digits (including call control signals and data) which is switched as a composite whole, the call control signals, data and if present error control information being arranged in a specified format;

"fault tolerance" means the ability 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 or filamentary materials" include:

a. continuous monofilaments;

b. continuous yarns and rovings;

c. tapes, fabrics, random mats and braids;

d. chopped fibres, staple fibres and coherent fibre blankets;

e. whiskers, either monocrystalline or polycrystalline, of any length;

f. aromatic polyamide pulp;

"film type integrated circuit" means an array of **circuit elements** and metallic interconnections formed by deposition of a thick or thin film on an insulating **substrate;**

"fixed", as it relates to **information security,** means that the coding or compression algorithm cannot accept externally supplied parameters (e.g., cryptographic or key variables) and cannot be modified by the user;

"flexible manufacturing unit" (FMU), (sometimes also referred to as flexible manufacturing system (FMS) or flexible manufacturing cell (FMC)) means a combination of at least:

a. a **digital computer** including its own **main storage** and its own related equipment; and

b. two or more of the following:

1. a machine tool specified in head c. of entry 2B001;
2. a dimensional inspection machine or another digitally controlled measuring machine specified in Category 2;
3. a **robot** specified in Categories 2 or 8;
4. digitally controlled equipment specified in entries 1B003, 2B003 or 9B001;
5. **Stored programme controlled** equipment specified in head a. of entry 3B001;
6. digitally controlled equipment specified in entry 1B001;
7. digitally controlled electronic equipment specified in head c. of entry 3A002;

"fluoride fibres" means fibres manufactured from bulk fluoride compounds;

"focal plane array" means a linear or two-dimensional planar layer, or combination of planar layers, of individual detector elements, with or without readout electronics, which work in the focal plane; this is not intended to include a stack of single detector elements or any two, three or four element detectors provided time delay and integration is not performed within the element;

"frequency agility" means a system in which the transmission frequency of a single communication channel is made to change by discrete steps (sometimes known as frequency hopping);

"frequency switching time" means 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. a frequency within 100 Hz of the final frequency; or

b. an output level within 1 dB of the final output level;

"frequency synthesiser" means 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 atomisation" means a process to reduce a molten stream of metal alloy to droplets of 500 micrometre diameter or less by a high pressure gas stream;

"gateway" means the function, realised by any combination of equipment and **software,** to carry out the conversion of conventions for representing, processing or communicating information used in one system into the corresponding but different conventions used in another system;

"generic software" means a set of instructions for a **stored programme controlled** switching system that is the same for all switches using that type of switching system, the database portion is not considered to be part of the **generic software;**

"geographically dispersed" means where each sensor location is distant from any other by more than 1,500m in any direction; mobile sensors are always considered **geographically dispersed;**

"global interrupt latency time" means the time taken by a computer system to recognize an interrupt due to an event, service the interrupt and perform a context switch to an alternate memory-resident task waiting on the interrupt;

"guidance set" means systems that integrate the process of measuring and computing a vehicles position and velocity (i.e. navigation) with that of computing and sending commands to the vehicles flight control systems to correct the trajectory;

"hot isostatic densification" means the process of pressurising a casting at temperatures exceeding 375 K (102°C) in a closed cavity through various media (including gas, liquid or

solid particles) to create equal force in all directions to reduce or eliminate internal voids in the casting;

"hybrid computer" means equipment which can:

a. accept data;

b. process data, in both analogue and digital representations; and

c. provide output of data;

"hybrid integrated circuit" means any combination of integrated circuit(s), integrated circuits with **circuit elements** or **discrete components** connected together to perform a specific function and having all the following characteristics:

a. containing at least one unencapsulated device;

b. connected together using typical integrated circuit production methods

c. replaceable as an entity; and

d. not normally capable of being disassembled;

"image enhancement" means 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;

"improvised explosive devices" means devices placed or fabricated in an improvised manner incorporating destructive, lethal, noxious, pyrotechnic or incendiary chemicals, designed to destroy, disfigure or harass; they may incorporate military stores, but are normally devised from non-military components;

"information security" means 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; for this purpose, "cryptanalysis" is the analysis of a cryptographic system or its inputs and outputs to derive confidential variables or sensitive data, including clear text;

"instantaneous bandwidth" means the bandwidth over which output power remains constant within 3 dB without adjustment of other operating parameters;

"instrumented range" means the specified unambiguous display range of a radar;

"insulation" means material intended to provide protection from the effects of heat during the operation of rocket motors. The material includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It is applied to the components of a rocket motor, i.e. the case, nozzle, inlets, case closures.

"Integrated Services Digital Network" (ISDN) means 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" means two or more radar sensors which mutually exchange data in real time;

"intrinsic magnetic gradiometer" means a single magnetic field gradient sensing element and associated electronics, the output of which is a measure of magnetic field gradient;

"ISO" means the International Standards Organisation;

"isostatic presses" means equipment capable of pressurising a closed cavity through various media (including gas, liquid and solid particles) to create equal pressure in all directions within the cavity upon a workpiece or material;

"ITU" means International Telecommunications Union;

"laser" means an assembly of components which produce both spatially and temporally coherent light which is amplified by stimulated emission of radiation;

"linearity" (usually measured in terms of non-linearity) means the maximum deviation of the actual characteristic (average of upscale and downscale readings), positive or negative, from a straight line so positioned as to equalise and minimise the maximum deviations;

"local area network" means a data communication system which:

a. allows any number of independent data devices to communicate directly with each other; and

b. is confined to a geographical area of moderate size (e.g., office building, plant, campus, warehouse);

"magnetic gradiometers" means instruments designed to detect the spatial variation of magnetic fields from external sources; they consist of multiple **magnetometers** and associated electronics, the output of which is a measure of magnetic field gradient;

"magnetometers" means instruments designed to detect magnetic fields from external sources; 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" means 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;

"matrix" means a substantially continuous phase that fills the space between particles, whiskers or fibres;

"maximum bit transfer rate" of:

a. solid state storage equipment means the number of data bits per second transferred between the equipment and its controller;

b. a disk drive means the internal data transfer rate calculated as B×R×T (bits per second)

where:

B=maximum number of data bits per track available to read or write in a single revolution;

R=revolutions per second;

T=number of tracks which can be read or written simultaneously;

"mechanical alloying" means 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 addition of the appropriate powders;

"media access unit" means 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;

"melt extraction" means 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 metal alloy;

"melt spinning" means 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" means a **monolithic integrated circuit** or **multichip integrated** circuit containing an arithmetic logic unit (ALU) capable of executing general purpose instructions from an internal storage (or on an internal storage augmented by an external storage), on data contained in the internal storage;

"microprocessor microcircuit" means a **monolithic integrated circuit** or **multichip integrated circuit** containing an arithmetic logic unit (ALU) capable of executing a series of general purpose instructions from an external storage: this includes chip sets which are designed to operate together to provide the function of a **microprocessor microcircuit;**

"missiles" means complete rocket systems and unmanned air vehicle systems, capable of a range of at least 300 km;

"monolithic integrated circuit" means a combination of passive or active **circuit elements** or both which:

a. are formed by means of diffusion processes, implantation processes or deposition processes in or on a single semiconducting piece of material;

b. can be considered as indivisibly associated; and

c. performs the function of a circuit;

"motion control board" means an **electronic assembly** 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" means two or more **monolithic integrated circuits** bonded to a common substrate;

"multi-data-stream processing" means the **microprogramme** 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:

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

b. Multiple Single Instruction Multiple Data (MSIMD) architectures;

c. Multiple Instruction Multiple Data (MIMD) architectures, including those which are tightly coupled, closely coupled or loosely coupled; or

d. Structured arrays of processing elements, including systolic arrays;

"multilevel security" means a class of system containing information with different sensitivities that simultaneously permits access by users with different security clearances, but prevents users from obtaining access to information for which they lack authorization;

"multispectral imaging sensors" means sensors capable of simultaneous or serial acquisition of imaging data from two or more discrete spectral bands; sensors having more than twenty discrete spectral bands are sometimes referred to as hyperspectral imaging sensors;

"network access controller" means a physical interface to a distributed switching network which:

a. uses a common medium operating throughout at the same **digital transfer rate;**

b. uses arbitration (e.g., token or carrier sense) for transmission control;

c. independently from any other, selects data packets or data groups addressed to it; and

d. is an assembly that can be integrated into computer or telecommunications equipment to provide communications access;

"neural computer" means a computational device designed or modified to mimic the behaviour 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;

"noise level" means an electrical signal given in terms of power spectral density; the relation between noise level expressed in peak-to-peak is given by $S^2_{pp} = 8N_0(f_2-f_1)$, where S_{pp} is the peak-to-peak value of the signal (e.g., nanoteslas), N_0 is the power spectral density (e.g., $(\text{nanotesla})^2/\text{Hz}$) and (f_2-f_1) defines the bandwidth of interest;

"numerical control" means the automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress;

"object code" (sometimes referred to as object language) means an equipment executable form of a convenient expression of one or more processes **(source code)** which has been converted by a programming system;

"operate autonomously" means operating fully submerged, without snorkel, all systems working and cruising at the minimum speed at which the submersible can safely control its depth dynamically by using its depth planes only, with no need for a support vessel or support base on the surface, sea-bed or shore, and containing a propulsion system for submerged or surface use;

"optical amplification", in optical communications, means an amplification technique that introduces a gain of optical signals that have been generated by a separate optical source, without conversion to electrical signals, using semiconductor optical amplifiers or optical fibre luminescent amplifiers;

"optical computer" means a computer designed or modified to use light to represent data and whose computational logic elements are based on directly coupled optical devices;

"optical fibre preforms" means bars, ingots, or rods of glass, plastic or other materials which have been specially processed for use in fabricating optical fibres; the characteristics of an **optical fibre preform** determine the basic parameters of the resultant drawn optical fibres;

"optical integrated circuit" means 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;

"optical switching" means the routing of, or switching of, signals in optical form without conversion to electrical signals;

"overall current density" means 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.);

"peak power", as it relates to **lasers,** means energy per pulse in joules divided by the pulse duration in seconds;

"personalized smart card" means a smart card containing a microcircuit, in accordance with ISO/IEC 7816, which has been programmed by the issuer and cannot be changed by the user;

"power management" means 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;

"principal element" means an element whoose replacement value is more than 35% of the total value of the system of which it is an element; element value is the cost of the element for 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;

"production equipment" means tooling, templates, jigs, mandrels, moulds, dies, fixtures, alignment mechanisms, test equipment, other machinery and components therefor, limited

to those specially designed or modified for **development** or for one or more phases of **production;**

"production facilities" means equipment and specially designed software therefor integrated into installations for **development** or for one or more phases of **production**;

"pulse compression" means 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" means the duration of a **laser** pulse measured at Full Width Half Intensity (FWHI) levels;

"Q-switched laser" means 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" means 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" means any modulation technique for spreading energy originating from a signal with a relatively narrow frequency band, over a much wider band of frequencies, by using random or pseudo-random coding;

"range" means half the maximum distance a submersible vehicle can cover;

"real time bandwidth" for **dynamic signal analysers** means the widest frequency range which the analyser can output to display or mass storage without causing any discontinuity in the analysis of the input data; for analysers with more than one channel, the channel configuration yielding the widest **real-time bandwidth** shall be used to make the calculation;

"real time processing" means processing of data by an electronic computer in response to an external event according to time requirements imposed by the external event;

"required", as applied to **technology** or **software,** means only that portion of **technology** or **software** which is peculiarly responsible for achieving or exceeding the specified performance levels, characteristics or functions; such **required technology** or **software** may be shared by different products;

"resolution" means the least increment of a measuring device; on digital instruments, the least significant bit;

"robot" means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use sensors, and which:

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;

except:

a. manipulation mechanisms which are only manually/teleoperator controllable;

b. fixed sequence manipulation mechanisms, which are automated moving devices, operating according to programmes where the motions are limited by fixed stops, such as pins or cams and the sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;

c. mechanically controlled variable sequence manipulation mechanisms, which are automated moving devices, operating according to programmes where the motions are limited by fixed, but adjustable stops, such as pins or cams and the sequence of motions and the selection of paths or angles are variable within the fixed programme pattern; variations or modifications of the programme pattern (e.g., changes of pins or exchanges of cams) in one or more motion axes are accomplished only through mechanical operations;

d. non-servo-controlled variable sequence manipulation mechanisms, which are automated moving devices, operating according to mechanically fixed programmed motions; the programme is variable but the sequence proceeds only by the binary signal from mechanically fixed electrical binary devices or adjustable stops;

e. 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;

"rotary atomisation" means a process to reduce a stream or pool of molten metal to droplets to a diameter of 500 micrometre or less by centrifugal force;

"run out" (out-of-true running) means 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;

"scale factor" means 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;

"settling time" means the time required for the output to come within one-half bit of the final value when switching between any two levels of the converter;

"signal analysers" means apparatus capable of measuring and displaying basic properties of the single-frequency components of multi-frequency signals;

"signal processing" means the processing of externally derived information-bearing signals by algorithms such as time compression, filtering, extraction, selection, correlation, convolution or transformations between domains (e.g., fast Fourier transform or Walsh transform);

"simple educational devices" means devices designed for use in teaching basic scientific principles and demonstrating the operation of those principles in educational institutions;

"solidify rapidly" means solidification of molten material at cooling rates exceeding 1,000 K/ sec;

"source code" (sometimes referred to as source language) means a convenient expression of one or more processes which may be turned by a programming system into equipment executable form **(object code);**

"spacecraft" means active and passive satellites and space probes;

"space qualified" means products which are stated by the manufacturer as designed and tested to meet the special electrical, mechanical or environmental requirements for use in rockets, satellites or high-altitude flight systems operating at altitudes of 100 km or more;

"specific modulus" means Young's modulus in Pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%;

"specific tensile strength" means ultimate tensile strength in pascals, equivalent to N/m^2 divided by specific weight in N/m^3, measured at a temperature of (296 ± 2) K ((23 ± 2)°C) and a relative humidity of (50 ± 5)%;

"spectral efficiency" means a figure of merit which characterizes the efficiency of transmission systems which use complex modulation schemes including QAM (quadrature amplitude modulation), Trellis coding and QPSK (Q-phased shift key); it is calculated as follows:

$$\text{spectral efficiency} = \frac{\textbf{digital transfer rate (bit/second)}}{\text{6 dB spectrum bandwidth (Hz)}}$$

"splat quenching" means a process to **solidify rapidly** a molten metal stream impinging upon a chilled block, forming a flake-like product;

"spread spectrum" means the technique whereby energy in a relatively narrow-band communication channel is spread over a much wider energy spectrum;

"sputtering" means 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; triode, magnetron or radio frequency sputtering to increase adhesion of coating and rate of deposition are ordinary modifications of the process;

"stability" means the 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;

"stored programme controlled" means controlled by using instructions stored in an electronic storage which a processor can execute in order to direct the performance of predetermined functions;

"substrate" means 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" means monolithic compounds with dimensions suitable for the production of optical elements such as mirrors or optical windows;

"superalloys" means nickel-, cobalt- or iron-base alloys having strengths superior to any alloys in the American Iron and Steel Society (AISI) 300 series at temperatures over 922 K (649°C) under severe environmental and operating conditions;

"superconductive" refers to 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); the superconductive state of a material is individually characterized by a **critical temperature**, a critical magnetic field, which is a function of temperature, and a critical current density which is a function of both magnetic field and temperature;

"Super High Power Laser" (SHPL) means a **laser** capable of delivering (the total or any portion of) an output energy exceeding 1 kJ within 50 ms or having an average or CW power exceeding 20 kW;

"superplastic forming" means a deformation process using heat for metals that are normally characterised by low values of elongation (less than 20%) 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 2 times those values;

"swept frequency network analysers" means analysers which involve 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" means that hardware and associated **software** which provides the physical or virtual connection path for in-transit message traffic being switched;

"Synchronous Digital Hierarchy (SDH)" means 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.707, G.708, G.709; the first level rate of SDH is 155.52 Mbit/s;

"Synchronous Optical Network (SONET)" means a network providing a means to manage, multiplex and access various forms of digital traffic using a synchronous transmission format on fibre 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" means processed, correlated (fusion of radar target data to flight plan position) and updated aircraft flight position reports available to the Air Traffic Control centre controllers;

"systolic array computer" means a computer where the flow and modification of the data is dynamically controllable at the logic gate level by the user;

"terminal interface equipment" means equipment at which information enters or leaves the telecommunication system, including telephone, data device, computer and facsimile device;

"tilting spindle" means a tool-holding spindle which alters, during the machining process, the angular position of its centre line with respect to any other axis;

"time constant" means the time taken from the application of a light stimulus for the current increment to reach a value of 1-1/e times the final value (i.e., 63% of the final value);

"total digital transfer rate" means the number of bits, including line coding, overhead and so forth per unit time passing between corresponding equipment in a digital transmission system;

"transfer laser" means a **laser** in which the lasing species is excited through the transfer of energy by collision of a non-lasing atom or molecule with a lasing atom or molecule species;

"tunable" means 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**;

"user-accessible programmability" means the facility allowing a user to insert, modify or replace **programmes** by means other than:

a. a physical change in wiring or interconnections; or

b. the setting of function controls including entry of parameters;

"vacuum atomisation" means a process to reduce a molten stream of metal to droplets of a diameter of 500 micrometre or less by the rapid evolution of a dissolved gas upon exposure to a vacuum;

"variable geometry airfoils" means the use of trailing edge flaps or tabs, or leading edge slats or pivoted nose droop, the position of which can be controlled in flight.

Category 1—Materials, Chemicals, Microorganisms & Toxins

Equipment, Assemblies and Components

1A.—(1A001) Components made from fluorinated compounds, as follows:

(a) Seals, gaskets, sealants or fuel bladders specially designed for aircraft or aerospace use made from more than 50% of any of the materials specified in heads b. or c. of entry 1C009;

(b) Piezoelectric polymers and copolymers made from vinylidene fluoride:

(1) In sheet or film form; and

(2) With a thickness exceeding 200 micrometre;

(c) Seals, gaskets, valve seats, bladders or diaphragms made from fluoroelastomers containing at least one vinylether monomer, specially designed for aircraft, aerospace or missile use.

In this sub-head, "missile" means complete rocket systems and unmanned air vehicle systems.

(1A002) **Composite** structures or laminates, as follows(**1**):

(a) Having an organic **matrix** and made from materials specified in heads c., d. or e. of entry 1C010; or

(b) Having a metal or carbon **matrix** and made from:

(1) Carbon **fibrous or filamentary materials** with:

(a) A **specific modulus** exceeding 10.15×10^6m; and

(b) A **specific tensile strength** exceeding 17.7×10^4m; or

(2) Materials specified in head c. of entry 1C010.

Note: This entry does not specify composite structures or laminates made from epoxy resin impregnated carbon **fibrous or filamentary materials** for the repair of aircraft structures or laminates, provided the size does not exceed 1 m^2.

(1A003) Manufactures of non-fluorinated polymeric substances specified in head a. of entry 1C008, in film, sheet, tape or ribbon form:

(a) With a thickness exceeding 0.254 mm; or

(b) Coated or laminated with carbon, graphite, metals or magnetic substances.

(1A102) Resaturated pyrolized carbon-carbon materials designed for systems specified in entries 9A004 or 9A104.

(1A202) Composite structures, other than those specified in entry 1A002, in the form of tubes with an inside diameter of between 75 mm and 400 mm made with **fibrous or filamentary materials** specified in heads a. or b. of entry 1C010 or entry 1C210(**2**).

(1A225) Platinized catalysts specially designed or prepared for promoting the hydrogen isotope exchange reaction between hydrogen and water for the recovery of tritium from heavy water or for the production of heavy water.

(1A226) Specialized packings for use in separating heavy water from ordinary water and made of phosphor bronze mesh or copper (both chemically treated to improve wettability) and designed for use in vacuum distillation towers.

(1A227) High-density (lead glass or other) radiation shielding windows greater than 0.3 m on a side and with a density greater than 3 g/cm^3 and a thickness of 100 mm or greater and specially designed frames therefor.

1B Test, Inspection and Production Equipment

(1B001) Equipment for the production of fibres, prepregs, preforms or **composites** specified in entries 1A002 or 1C010, as follows, and specially designed components and accessories therefor(**3**):

(a) Filament winding machines of which the motions for positioning, wrapping and winding fibres are coordinated and programmed in three or more axes, specially designed for the manufacture of **composite** structures or laminates from **fibrous or filamentary materials**;

(**1**) See also entries 1A202, 9A010 and 9A110.
(**2**) See also entry 9A110.
(**3**) See also entries 1B101 and 1B201.

(b) Tape-laying or tow-placement machines of which the motions for positioning and laying tape, tows or sheets are coordinated and programmed in two or more axes, specially designed for the manufacture of **composite** airframe or missile structures;

(c) Multidirectional, multidimensional weaving machines or interlacing machines, including adapters and modification kits, for weaving, interlacing or braiding fibres to manufacture **composite** structures;

except:

Textile machinery not modified for the above end-uses;

(d) Equipment specially designed or adapted for the production of reinforcement fibres, as follows:

(1) Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon, pitch or polycarbosilane) into carbon fibres or silicon carbide fibres, including special equipment to strain the fibre during heating;

(2) Equipment for the chemical vapour deposition of elements or compounds on heated filamentary substrates to manufacture silicon carbide fibres;

(3) Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);

(4) Equipment for converting aluminium containing precursor fibres into alumina fibres by heat treatment;

(e) Equipment for producing prepregs specified in head e. of entry 1C010 by the hot melt method;

(f) Non-destructive inspection equipment capable of inspecting defects three dimensionally, using ultrasonic or X-ray tomography and specially designed for **composite** materials.

In this entry, "missile" means complete rocket systems and unmanned air vehicle systems.

(1B002) Systems and components therefor specially designed for producing metal alloys, metal alloy powder or alloyed materials specified in sub-head a.2. of entry 1C002, head b. of entry 1C002 or head c. of entry 1C002.

(1B003) Tools, dies, moulds or fixtures, for **superplastic forming** or **diffusion bonding** titanium or aluminium or their alloys, specially designed for the manufacture of:

(a) Airframe or aerospace structures;

(b) Aircraft or aerospace engines; or

(c) Specially designed components for those structures or engines.

(1B101) Equipment, other than that specified in entry 1B001, for the production of structural composites as follows; and specially designed components and accessories therefor(**4**):

Note: Components and accessories specified in this entry include moulds, mandrels, dies, fixtures and tooling for the preform pressing, curing, casting, sintering or bonding of composite structures, laminates and manufactures thereof.

(a) Filament winding machines of which the motions for positioning, wrapping and winding fibres can be coordinated and programmed in three or more axes, designed to fabricate composite structures or laminates from fibrous or filamentary materials, and coordinating and programming controls;

(b) Tape-laying machines of which the motions for positioning and laying tape and sheets can be coordinated and programmed in two or more axes, designed for the manufacture of composite airframe and **missile** structures;

(**4**) See also entry 1B201.

(c) Multi-directional, multi-dimensional weaving machines or interlacing machines, including adapters and modification kits for weaving, interlacing or braiding fibres to manufacture composite structures;

except:

Textile machinery which has not been modified for the above end uses;

(d) Equipment designed or modified for the production of fibrous or filamentary materials as follows:

(1) Equipment for converting polymeric fibres (such as polyacrylonitrile, rayon or polycarbosilane) including special provision to strain the fibre during heating;

(2) Equipment for the vapour deposition of elements or compounds on heated filament substrates; and

(3) Equipment for the wet-spinning of refractory ceramics (such as aluminium oxide);

(e) Equipment designed or modified for special fibre surface treatment or for producing prepregs and preforms specified in entry 9A110.

Note: Equipment covered by this sub-head includes rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.

(1B115) Equipment for the production, handling and acceptance testing of **goods** specified in entry 1C115, and specially designed components therefor.

Note: The only mixers specified in this entry are those which have provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber:

(a) Batch mixers having a total volumetric capacity of 110 litres or more and at least one mixing/kneading shaft mounted off centre;

(b) Continuous mixers having two or more mixing/kneading shafts and capability to open the mixing chamber.

(1B116) Specially designed nozzles for producing pyrolitically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1573 K (1300°C) to 3173 K (2900°C) temperature range at pressures of 130 Pa to 20 kPa.

(1B201) Filament winding machines, other than those specified in entries 1B001 or 1B101, in which the motions for positioning, wrapping, and winding fibres are coordinated and programmed in two or more axes, specially designed to fabricate composite structures or laminates from **fibrous or filamentary materials** and capable of winding cylindrical rotors of diameter between 75 mm and 400 mm and lengths of 600 mm or greater and coordinating and programming controls and precision mandrels therefor.

(1B225) Electrolytic cells for fluorine production with a production capacity greater than 250g of fluorine per hour.

(1B226) Electromagnetic isotope separators, designed for or equipped with, single or multiple ion sources capable of providing a total ion beam current of 50 mA or greater.

Note: This entry includes separators:

(a) Capable of enriching stable isotopes;

(b) With the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.

(1B227) Ammonia synthesis converters, ammonia synthesis units in which the synthesis gas (nitrogen and hydrogen) is withdrawn from an ammonia/hydrogen high-pressure exchange column and the synthesized ammonia is returned to that column.

(1B228) Hydrogen-cryogenic distillation columns having all of the following characteristics:

(a) Designed to operate with internal temperatures of 35 K (-238°C) or less;

(b) Designed to operate at an internal pressure of 0.5 to 5 MPa (5 to 50 atmospheres);

(c) Constructed of fine-grain stainless steels of the 300 series with low sulphur content or equivalent cryogenic and H_2-compatible materials; and

(d) With internal diameters of 1 m or greater and effective lengths of 5 m or greater.

(1B229) Water-hydrogen sulphide exchange tray columns constructed from fine carbon steel with a diameter of 1.8 m or greater to operate at a nominal pressure of 2 MPa or greater.

Notes:

(1) For columns which are specially designed or prepared for the production of heavy water see entry B40 of Group 2 of Part III of this Schedule.

(2) This entry includes internal contactors of the columns, which are segmented trays with an effective assembled diameter of 1.8 m or greater, such as sieve trays, valve trays, bubble cap trays, and turbogrid trays designed to facilitate countercurrent contacting and constructed of materials resistant to corrosion by hydrogen sulphide/water mixtures, such as 304L or 316 stainless steel.

(3) Fine Carbon steels include steels such as specified by ASTM A516.

(1B230) Pumps circulating solutions of diluted or concentrated potassium amide catalyst in liquid ammonia (KNH_2/NH_3), with all of the following characteristics:

(a) Airtight (i.e., hermetically sealed);

(b) For concentrated potassium amide solutions (1% or greater), operating pressure of 1.5-60 MPa (15-600 atmospheres); for dilute potassium amide solutions (less than 1%), operating pressure of 20-60 MPa (200-600 atmospheres); and

(c) A capacity greater than 8.5 m^3/hr.

(1B231) Facilities or plants for the production, recovery, extraction, concentration, or handling of tritium, and equipment as follows:

(a) Hydrogen or helium refrigeration units capable of cooling to 23 K (-250°C) or less, with heat removal capacity greater than 150 Watts; or

(b) Hydrogen isotope storage and purification systems using metal hydrides as the storage, or purification medium.

1C Materials

(1C001) Materials specially designed for use as absorbers of electromagnetic waves, or intrinsically conductive polymers, as follows(**5**):

(a) Materials for absorbing frequencies exceeding 2×10^8 Hz but less than 3×10^{12} Hz; except:

Materials as follows:

Note: Nothing in head a. of this entry releases magnetic materials to provide absorption when contained in paint.

1. Hair type absorbers, constructed of natural or synthetic fibres, with non-magnetic loading to provide absorption;

2. Absorbers having no magnetic loss and whose incident surface is non-planar in shape, including pyramids, cones, wedges and convoluted surfaces;

3. Planar absorbers:

a. Made from:

(**5**) See also entry 1C101.

1. Plastic foam materials (flexible or non-flexible) with carbon-loading, or organic materials, including binders, providing more than 5% echo compared with metal over a bandwidth exceeding ±15% of the centre frequency of the incident energy, and not capable of withstanding temperatures exceeding 450 K (177°C); or
2. Ceramic materials providing more than 20% echo compared with metal over a bandwidth exceeding ±15% of the centre frequency of the incident energy, and not capable of withstanding temperatures exceeding 800 K (527°C);

Note: Absorption test samples for sub-head a.3.a. of this entry should be a square of side of length at least 5 wavelengths of the centre frequency, and should be positioned in the far field of the radiating element.

b. Tensile strength less than 7×10^6 N/m^2; and

c. Compressive strength less than 14×10^6 N/m^2;

4. Planar absorbers made of sintered ferrite, with:
   a. A specific gravity exceeding 4.4; and
   b. A maximum operating temperature of 548 K (275°C);

(b) Materials for absorbing frequencies exceeding 1.5×10^{14} Hz but less than 3.7×10^{14} Hz and not transparent to visible light;

(c) Intrinsically conductive polymeric materials with a bulk electrical conductivity exceeding 10,000 S/m (Siemens per metre) or a sheet (surface) resistivity of less than 100 ohms/square, based on any of the following polymers:

(1) Polyaniline;

(2) Polypyrrole;

(3) Polythiophene;

(4) Poly phenylene-vinylene; or

(5) Poly thienylene-vinylene.

Note: Bulk electrical conductivity and sheet (surface) resistivity should be determined using ASTM D-257.

(1C002) Metal alloys, metal alloy powder or alloyed materials, as follows(**6**):

Note: Entry 1C002 does not specify metal alloys, metal alloy powder or alloyed materials for coating substrates.

(a) Metal alloys, as follows:

(1) Nickel or titanium-based alloys in the form of aluminides, as follows, in crude or semi-fabricated forms:

(a) Nickel aluminides containing 10 weight per cent or more aluminium;

(b) Titanium aluminides containing 12 weight per cent or more aluminium;

(2) Metal alloys, as follows, made from metal alloy powder or particulate material specified in head b. of this entry:

(a) Nickel alloys with:

(1) A stress-rupture life of 10,000 hours or longer at 923 K (650°C) at a stress of 550 MPa; or

(**6**) See also entry 1C202.

(2) A low cycle fatigue life of 10,000 cycles or more at 823 K (550°C) at a maximum stress of 700 MPa;

(b) Niobium alloys with:

(1) A stress-rupture life of 10,000 hours or longer at 1,073 K (800°C) at a stress of 400 MPa; or

(2) A low cycle fatigue life of 10,000 cycles or more at 973 K (700°C) at a maximum stress of 700 MPa;

(c) Titanium alloys with:

(1) A stress-rupture life of 10,000 hours or longer at 723 K (450°C) at a stress of 200 MPa; or

(2) A low cycle fatigue life of 10,000 cycles or more at 723 K (450°C) at a maximum stress of 400 MPa;

(d) Aluminium alloys with a tensile strength of:

(1) 240 MPa or more at 473 K (200°C); or

(2) 415 MPa or more at 298 K (25°C);

(e) Magnesium alloys with a tensile strength of 345 MPa or more and a corrosion rate of less than 1 mm/year in 3% sodium chloride aqueous solution measured in accordance with ASTM standard G-31;

Notes:

(1) The metal alloys specified in head a. of this entry are those containing a higher percentage by weight of the stated metal than of any other element.

(2) Stress-rupture life should be measured in accordance with ASTM standard E-139.

(3) Low cycle fatigue life should be measured in accordance with ASTM Standard E-606 'Recommended Practice for Constant-Amplitude Low-Cycle Fatigue Testing'. Testing should be axial with an average stress ratio equal to 1 and a stress-concentration factor (Kt) equal to 1. The average stress is defined as maximum stress minus minimum stress divided by maximum stress.

(b) Metal alloy powder or particulate material for materials specified in head a. of this entry, as follows:

(1) Made from any of the following composition systems:

Note: X in the following equals one or more alloying elements.

(a) Nickel alloys (Ni-Al-X, Ni-X-Al) qualified for turbine engine parts or components, i.e. with less than 3 non-metallic particles (introduced during the manufacturing process) larger than 100 micrometre in 10^9 alloy 15 particles;

(b) Niobium alloys (Nb-Al-X or Nb-X-Al, Nb-Si-X or Nb-X-Si, Nb-Ti-X or Nb-X-Ti);

(c) Titanium alloys (Ti-Al-X or Ti-X-Al);

(d) Aluminium alloys (Al-Mg-X or Al-X-Mg, Al-Zn-X or Al-X-Zn, Al-Fe-X or Al-X-Fe); or

(e) Magnesium alloys (Mg-Al-X or Mg-X-Al); and

(2) Made in a controlled environment by any of the following processes:

(a) **Vacuum atomisation;**

(b) **Gas atomisation;**

(c) **Rotary atomisation;**

(d) **Splat quenching;**

(e) **Melt spinning** and **comminution;**

(f) **Melt extraction** and **comminution;** or

(g) **Mechanical alloying;**

(c) Alloyed materials, in the form of uncomminuted flakes, ribbons or thin rods produced in a controlled environment by **splat quenching, melt spinning** or **melt extraction,** used in the manufacture of metal alloy powder or particulate material specified in head b. of this entry.

(1C003) Magnetic metals, of all types and of whatever form, having any of the following characteristics:

(a) Initial relative permeability of 120,000 or more and a thickness of 0.05 mm or less;

Note: Measurement of initial permeability must be performed on fully annealed materials.

(b) Magnetostrictive alloys with:

(1) A saturation magnetostriction of more than 5×10^{-4} or

(2) A magnetomechanical coupling factor (k) of more than 0.8; or

(c) Amorphous alloy strips having both of the following characteristics:

(1) A composition having a minimum of 75 weight percent of iron, cobalt or nickel; and

(2) A saturation magnetic induction (B_s) of 1.6 T or more, and:

(a) A strip thickness of 0.02 mm or less; or

(b) An electrical resistivity of 2×10^{-4} ohm cm or more.

(1C004) Uranium titanium alloys or tungsten alloys with a **matrix** based on iron, nickel or copper, with:

(a) A density exceeding 17.5 g/cm^3;

(b) An elastic limit exceeding 1,250 MPa;

(c) An ultimate tensile strength exceeding 1,270 MPa; and

(d) An elongation exceeding 8%.

(1C005) **Superconductive composite** conductors in lengths exceeding 100 m or with a mass exceeding 100 g, as follows:

(a) Multifilamentary **superconductive composite** conductors containing one or more niobium-titanium filaments:

(1) Embedded in a **matrix** other than a copper or copper-based mixed **matrix**; or

(2) With a cross-section area less than 0.28×10^{-4} mm^2 (6 micrometre in diameter for circular filaments);

(b) **Superconductive composite** conductors consisting of one or more **superconductive** filaments other than niobium-titanium:

(1) With a **critical temperature** at zero magnetic induction exceeding 9.85 K (-263.31°C) but less than 24 K (-249.16°C);

(2) With a cross-section area less than 0.28×10^{-4} mm^2; and

(3) Which remain in the **superconductive** state at a temperature of 4.2 K (-268.96°C) when exposed to a magnetic field corresponding to a magnetic induction of 12 T.

(1C006) Fluids and lubricating materials, as follows:

(a) Hydraulic fluids containing, as their principal ingredients, any of the following compounds or materials:

(1) Synthetic hydrocarbon oils or silahydrocarbon oils with:

(a) A flash point exceeding 477 K (204°C);

(b) A pour point at 239 K (-34°C) or less;

(c) A viscosity index of 75 or more; and

(d) A thermal stability at 616 K (343°C); or

Note: For the purpose of this sub-head, silahydrocarbon oils contain exclusively silicon, hydrogen and carbon.

(2) Chlorofluorocarbons with:

(a) No flash point;

(b) An autogenous ignition temperature exceeding 977 K (704°C);

(c) A pour point at 219 K (-54°C) or less;

(d) A viscosity index of 80 or more; and

(e) A boiling point at 473 K (200°C) or higher;

Note: For the purpose of this sub-head, chlorofluorocarbons contain exclusively carbon, fluorine and chlorine.

(b) Lubricating materials containing, as their principal ingredients, any of the following compounds or materials:

(1) Phenylene or alkylphenylene ethers or thio-ethers, or their mixtures, containing more than two ether or thio-ether functions or mixtures thereof; or

(2) Fluorinated silicone fluids with a kinematic viscosity of less than 5,000 mm^2/s (5,000 centistokes) measured at 298 K (25°C);

(c) Damping or flotation fluids with a purity exceeding 99.8%, containing less than 25 particles of 200 micrometre or larger in size per 100 ml and made from at least 85% of any of the following compounds or materials:

(1) Dibromotetrafluoroethane;

(2) Polychlorotrifluoroethylene (oily and waxy modifications only); or

(3) Polybromotrifluoroethylene.

Notes:

(1) Flash point is determined using the Cleveland Open Cup Methoddescribed in ASTM D-92.

(2) Pour point is determined using the method described in ASTM D-97.

(3) Viscosity index is determined using the method described in ASTM D-2270.

(4) Thermal stability is determined by the following test procedure: Twenty ml of the fluid under test is placed in a 46 ml type 317 stainless steel chamber containing one each of 12.5 mm (nominal) diameter balls of M-10 tool steel, 52100 steel and naval bronze (60% Cu, 39% Zn, 0.75% Sn). The chamber is purged with nitrogen, sealed at atmospheric pressure and the

temperature raised to and maintained at 644 ± 6 K (371 ± 6C) for six hours. The specimen will be considered thermally stable if, on completion of the above procedure, all of the following conditions are met:

(a) The loss in weight of each ball is less than 10 mg/mm^2 of ball surface;

(b) The change in original viscosity as determined at 311 K (38°C) is less than 25%; and

(c) The total acid or base number is less than 0.40.

(5) Autogenous ignition temperature is determined using the methoddescribed in ASTM E-659.

(1C007) Ceramic base materials, non-**composite** ceramic materials, ceramic-**matrix** composite materials and precursor materials, as follows(**7**):

(a) Base materials of single or complex borides of titanium having total metallic impurities, excluding intentional additions, of less than 5,000 ppm, an average particle size equal to or less than 5 micrometre and no more than 10% of the particles larger than 10 micrometre;

(b) Non-**composite** ceramic materials in crude or semi-fabricated form composed of borides of titanium with a density of 98% or more of the theoretical density; except: Abrasives;

(c) Ceramic-ceramic **composite** materials with a glass or oxide-**matrix** and reinforced with fibres from any of the following systems:

(1) Si-N;

(2) Si-C;

(3) Si-Al-O-N; or

(4) Si-O-N;

(d) Ceramic-ceramic **composite** materials, with or without a continuous metallic phase, containing finely dispersed particles or phases of any fibrous or whisker-like material, where carbides or nitrides of silicon, zirconium or boron form the **matrix;**

(e) Precursor materials (i.e., special purpose polymeric or metallo-organic materials) for producing any phase or phases of the materials specified in head c. of this entry, as follows:

(1) Polydiorganosilanes (for producing silicon carbide);

(2) Polysilazanes (for producing silicon nitride);

(3) Polycarbosilazanes (for producing ceramics with silicon, carbon and nitrogen components).

(1C008) Non-fluorinated polymeric substances, as follows:

(a) (1) Bismaleimides;

(2) Aromatic polyamide-imides;

(3) Aromatic polyimides;

(4) Aromatic polyetherimides having a glass transition temperature (T_g) exceeding 503 K (230°C) as measured by the wet method;

Note: This head does not specify non-fusible compression moulding powders or moulded forms.

(b) Thermoplastic liquid crystal copolymers having a heat distortion temperature exceeding 523 K (250°C) measured according to ASTM D-648, method A, with a load of 1.82 N/mm^2 and composed of:

(**7**) See also entry 1C107.

(1) Either of the following:

(a) Phenylene, biphenylene or naphthalene; or

(b) Methyl, tertiary-butyl or phenyl substituted phenylene, biphenylene or naphthalene; and

(2) Any of the following acids:

(a) Terephthalic acid;

(b) 6-hydroxy-2 naphthoic acid; or

(c) 4-hydroxybenzoic acid;

(c) Polyarylene ether ketones, as follows:

(1) Polyether ether ketone (PEEK);

(2) Polyether ketone ketone (PEKK);

(3) Polyether ketone (PEK);

(4) Polyether ketone ether ketone ketone (PEKEKK);

(d) Polyarylene ketones;

(e) Polyarylene sulphides, where the arylene group is biphenylene, triphenylene or combinations thereof;

(f) Polybiphenylenethersulphone.

(1C009) Unprocessed fluorinated compounds, as follows:

(a) Copolymers of vinylidene fluoride having 75% or more beta crystalline structure without stretching;

(b) Fluorinated polyimides containing 30% or more of combined fluorine;

(c) Fluorinated phosphazene elastomers containing 30% or more of combined fluorine.

(1C010) **Fibrous or filamentary materials** which may be used in organic **matrix,** metallic **matrix** or carbon **matrix composite** structures or laminates, as follows(**8**):

(a) Organic **fibrous or filamentary materials** (except polyethylene) with:

(1) A **specific modulus** exceeding 12.7×10^6m; and

(2) A **specific tensile strength** exceeding 23.5×10^4m;

(b) Carbon **fibrous or filamentary materials** with:

(1) A **specific modulus** exceeding 12.7×10^6m; and

(2) A **specific tensile strength** exceeding 23.5×10^4m;

Notes:

(1) Properties for materials described in this head should be determined using Suppliers of Advance Composite Materials Association (SACMA) recommended methods SRM 12 to 17 or Japanese Industrial Standard JIS-R-7601, Paragraph 6.6.2., and based on lot average.

(2) This head does not specify fabric made from **fibrous or filamentary materials** for the repair of aircraft structures or laminates in which the size of individual sheets does not exceed 50 cm × 90 cm.

(c) Inorganic **fibrous or filamentary materials** with:

(**8**) See also entry 1C210.

(1) A **specific modulus** exceeding 2.54×10^6m; and

(2) A melting, decomposition or sublimation point exceeding 1,922 K (1,649°C) in an inert environment;

Note: This head does not specify:

(a) Discontinuous, multiphase, polycrystalline alumina fibres in chopped fibre or random mat form, containing 3 weight percent or more silica, with a **specific modulus** of less than 10×10^6m;

(b) Molybdenum and molybdenum alloy fibres;

(c) Boron fibres;

(d) Discontinuous ceramic fibres with a melting, decomposition or sublimation point lower than 2,043 K (1,770°C) in an inert environment.

(d) **Fibrous or filamentary materials:**

(1) Composed of any of the following:

(a) Polyetherimides specified in head a. of entry 1C008; or

(b) Materials specified in heads b., c., d., e. or f. of entry 1C008; or

(2) Composed of materials specified in sub-head d.1. of this entry and **commingled** with other fibres specified in heads a., b. or c. of this entry;

(e) Resin- or pitch-impregnated fibres (prepregs), metal or carbon-coated fibres (preforms) or carbon fibre preforms, as follows:

(1) Made from **fibrous or filamentary materials** specified in heads a., b. or c. of this entry;

(2) Made from organic or carbon **fibrous or filamentary materials:**

(a) With a **specific tensile strength** exceeding 17.7×10^4 m;

(b) With a **specific modulus** exceeding 10.15×10^6m;

(c) Not specified in heads a. or b. of this entry; and

(d) When impregnated with materials specified in entry 1C008 or head b. of entry 1C009, or with phenolic or epoxy resins, having a glass transition temperature (T_g) exceeding 383 K (110°C).

Note: This head does not specify epoxy resin matrix impregnated carbon **fibrous or filamentary materials** (prepregs) for the repair of aircraft structures or laminates, in which the size of individual sheets of prepreg does not exceed 50 cm × 90 cm.

(1C101) Materials and devices for reduced observables such as radar reflectivity, ultraviolet/ infrared signatures and acoustic signatures (i.e. stealth technology), other than those specified in entry 1C001, usable in **missiles** and their subsystems.

Notes:

(1) This entry includes:

(a) Structural materials and coatings specially designed for reduced radar reflectivity;

(b) Coatings, including paints, specially designed for reduced or tailored reflectivity or emissivity in the microwave, infra red or ultra violet regions of the electromagnetic spectrum.

(2) This entry does not include coatings when specially used for the thermal control of satellites.

(1C107) Graphite and ceramic materials, as follows:

(a) Fine grain recrystallised bulk graphites, having a bulk density of 1.72 g/cm^3 or greater, measured at 288 K (15°C), and having a particle size of 100 micrometres or less, pyrolytic or fibrous reinforced graphites, usable for rocket nozzles and reentry vehicle nose tips;

(b) Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10,000 MHz), usable for radomes, and bulk machinable silicon-carbide reinforced unfired ceramic, usable for nose tips.

(1C115) Propellants and constituent chemicals for propellants, as follows:

(a) Propulsive substances:

(1) Spherical aluminium powder, other than that specified in ML8 of Group 1 of Part III of this Schedule, with particles of uniform diameter of less than 500 micrometre and an aluminium content of 97% by weight or greater;

(2) Metal fuels, other than that specified in ML8 of Group 1 of Part III of this Schedule, in particle sizes less than 500 micrometres, whether spherical, atomized, spheroidal, flaked or ground, consisting of 97% by weight or more of any of the following:

(a) Zirconium;

(b) Beryllium;

(c) Boron;

(d) Magnesium;

(e) Zinc;

(f) Alloys of the metals specified by a. to e. above; or

(g) Misch metal;

(3) Liquid oxidisers, the following:

(a) Dinitrogen trioxide;

(b) Nitrogen dioxide/dinitrogen tetroxide;

(c) Dinitrogen pentoxide;

(b) Polymeric substances:

(1) Carboxy-terminated polybutadiene (CTPB);

(2) Hydroxy-terminated polybutadiene (HTPB), other than that specified in ML8 of Group 1 of Part III of this Schedule;

(3) Polybutadiene-acrylic acid (PBAA);

(4) Polybutadiene-acrylic acid-acrylonitrile (PBAN);

(c) Other propellant additives and agents:

(1) Butacene;

(2) Triethylene glycol dinitrate (TEGDN);

(3) 2-Nitrodiphenylamine.

Note: For propellants and constituent chemicals for propellants not specified here, see ML8 of Group 1 of Part III of this Schedule.

(1C116) Maraging steels (steels generally characterised by high nickel, very low carbon content and the use of substitutional elements or precipitates to produce age-hardening) having an ultimate

tensile strength of 1500 MPa or greater, measured at 293 K (20°C), in the form of sheet, plate or tubing with a wall or plate thickness equal to or less than 5 mm(**9**).

(1C117) Tungsten, molybdenum and alloys of these metals in the form of uniform spherical or atomized particles of 500 micrometre diameter or less with a purity of 97% or greater for fabrication of rocket motor components i.e. heat shields, nozzle substrates, nozzle throats and thrust vector control surfaces.

(1C202) Alloys, other than those specified in sub-head a.2.c. or head d. of entry 1C002, as follows:

(a) Aluminium alloys capable of an ultimate tensile strength of 460 MPa or more at 293 K (20°C), in the form of tubes or solid forms (including forgings) with an outside diameter of more than 75 mm;

(b) Titanium alloys capable of an ultimate tensile strength of 900 MPa or more at 293 K (20°C) in the form of tubes or solid forms (including forgings) with an outside diameter of more than 75 mm.

In this entry, "alloys capable of" means alloys before or after heat treatment.

(1C210) **Fibrous or filamentary materials,** other than those specified in heads a. or b. of entry 1C010, as follows:

(a) Carbon or aramid **fibrous or filamentary materials** having a **specific modulus** of 12.7 $\times 10^6$ m or greater or a **specific tensile strength** of 23.5 $\times 10^4$ m or greater; or

(b) Glass **fibrous or filamentary materials** having a **specific modulus** of 3.18 $\times 10^6$ m or greater and a **specific tensile strength** of 7.62 $\times 10^4$ m or greater.

(1C216) Maraging steel, other than that specified in entry 1C116, capable of an ultimate tensile strength of 2,050 MPa or more, at 293 K (20°C);

except:

Forms in which no linear dimension exceeds 75 mm.

In this entry, "maraging steel capable of" means maraging steel before or after heat treatment.

(1C225) Boron and boron compounds, mixtures and loaded materials in which the boron-10 isotope is more than 20% by weight of the total boron content.

(1C226) Tungsten, as follows: parts made of tungsten, tungsten carbide, or tungsten alloys (greater than 90% tungsten) having a mass greater than 20 kg and a hollow cylindrical symmetry (including cylinder segments) with an inside diameter greater than 100 mm but less than 300 mm;

except:

Parts specially designed for use as weights or gamma-ray collimators.

(1C227) Calcium (high purity) containing both less than 1,000 parts per million by weight of metallic impurities other than magnesium and less than 10 parts per million of boron.

(1C228) Magnesium (high purity) containing both less than 200 parts per million by weight of metallic impurities other than calcium and less than 10 parts per million of boron.

(1C229) High purity (99.99% or greater) bismuth with very low silver content (less than 10 parts per million).

(1C230) Beryllium metal, alloys containing more than 50% of beryllium by weight, compounds containing beryllium, and manufactures thereof; except:

(a) Metal Windows for X-ray machines;

(**9**) See also entry 1C216.

(b) Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits.

Note: This entry includes waste and scrap containing beryllium as defined here.

(1C231) Hafnium metal, alloys and compounds of hafnium containing more than 60% hafnium by weight and manufactures thereof.

(1C232) Helium in any form isotopically enriched in the helium-3 isotope, whether or not mixed with any other materials or contained in any equipment or device;except:

Products or devices containing less than 1 g of helium-3.

(1C233) Lithium, as follows:

(a) Metal, hydrides or alloys containing lithium enriched in the 6 isotope (^{6}Li) to a concentration higher than the one existing in nature (7.5 % weight percent);

(b) Any other materials containing lithium enriched in the 6 isotope (including compounds, mixtures and concentrates);

except:

^{6}Li incorporated in thermoluminescent dosimeters.

(1C234) Zirconium as follows: metal, alloys containing more than 50% zirconium by weight, and compounds in which the ratio of hafnium content to zirconium content is less than 1 part to 500 parts by weight, and manufactures wholly thereof;

except:

Zirconium in the form of foil having a thickness not exceeding 0.10 mm.

Notes

1. This entry includes waste and scrap containing zirconium as defined here.
2. For zirconium pressure tubes specially designed or prepared for a nuclear reactor see entry B50 of Group 2 of Part III of this Schedule.

(1C235) Tritium, tritium compounds, and mixtures containing tritium in which the ratio of tritium to hydrogen by atoms exceeds 1 part in 1000;

except:

A product or device containing not more than 40 Ci of tritium in any chemical or physical form.

(1C236) Alpha-emitting radionuclides having an alpha half-life of 10 days or greater but less than 200 years, including equipment, compounds and mixtures containing these radionuclides with a total alpha activity of 1 curie per kilogram (37 GBq/kg) or greater;

except:

Devices containing less than 100 millicuries (3.7 GBq) of alpha activity per device.

(1C237) Radium-226;

except:

Radium contained in medical applicators.

(1C238) Chlorine trifluoride (ClF_3).

(1C239) High explosives(**10**), other than those specified in ML8 of Group 1 of Part III of this Schedule, or substances or mixtures containing more than 2% thereof, with a crystal density greater than 1.8 gm/cm^3 and having a detonation velocity greater than 8,000 m/s.

(**10**) See also entry 1C991.

(1C350) Chemicals, which may be used as precursors for toxic chemical agents, as follows, and preparations thereof(**11**):

(a) (1) Ammonium hydrogen fluoride;
(2) Arsenic trichloride;
(3) Benzilic acid;
(4) 2-Chloroethanol;
(5) Diethylaminoethanol;
(6) Diethyl ethylphosphonate;
(7) Diethyl methylphosphonite;
(8) Diethyl-N,N-dimethylphosphoramidate;
(9) Diethyl phosphite;
(10) Diisopropylamine;
(11) N,N-Diisopropyl-(beta)-aminoethane thiol;
(12) N,N-Diisopropyl-(beta)-amino ethanol;
(13) N,N-Diisopropyl-(beta)-aminoethyl chloride;
(14) N,N-Diisopropyl-(beta)-aminoethyl chloride hydrochloride;
(15) Dimethyl ethylphosphonate;
(16) Dimethyl methylphosphonate;
(17) Dimethyl phosphite;
(18) Dimethylamine;
(19) Dimethylamine hydrochloride;
(20) Ethyl phosphinyl dichloride;
(21) Ethyl phosphinyl difluoride;
(22) Ethyl phosphonyl dichloride;
(23) Ethyl phosphonyl difluoride;
(24) Hydrogen fluoride;
(25) 3-Hydroxy-1-methylpiperidine;
(26) Methyl benzilate;
(27) Methyl phosphinyl dichloride;
(28) Methyl phosphinyl difluoride;
(29) Methyl phosphonyl dichloride;
(30) Phosphorus oxychloride;
(31) Phosphorus pentachloride;
(32) Phosphorus pentasulphide;
(33) Phosphorus trichloride;
(34) Pinacolone;
(35) Pinacolyl alcohol;
(36) Potassium fluoride;
(37) Potassium cyanide;

(**11**) See also ML7 of Group 1 of Part III of this Schedule.

(38) Potassium hydrogen fluoride;

(39) 3-Quinuclidinol;

(40) 3-Quinuclidone;

(41) Sodium bifluoride;

(42) Sodium cyanide;

(43) Sodium fluoride;

(44) Sodium sulphide;

(45) Sulphur dichloride;

(46) Sulphur monochloride;

(47) Thiodiglycol;

(48) Thionyl chloride;

(49) Triethanolamine;

(50) Triethanolamine hydrochloride;

(51) Triethyl phosphite;

(52) Trimethyl phosphite;

except:

Preparations which include any of the above chemicals, which;

1. Are put up for retail sale and intended for individual personal use or consumption; or
2. Contain the chemical in such a way that it cannot be easily recovered by standard processes.

(1C351) Human pathogens, zoonoses and toxins (**12**):

(a) Viruses, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Chikungunya virus;

(2) Congo-Crimean haemorrhagic fever virus;

(3) Dengue fever virus;

(4) Eastern equine encephalitis virus;

(5) Ebola virus;

(6) Hantaan virus;

(7) Junin virus;

(8) Lassa fever virus;

(9) Lymphocytic choriomeningitis virus;

(10) Machupo virus;

(11) Marburg virus;

(12) Monkey pox virus;

(13) Rift Valley fever virus;

(14) Russian Spring-Summer encephalitis virus;

(**12**) See also ML7 of Group 1 of Part III of this Schedule.

(15) Variola virus;

(16) Venezuelan equine encephalitis virus;

(17) Western equine encephalitis virus;

(18) White pox;

(19) Yellow fever virus;

(20) Japanese encephalitis virus;

(b) Rickettsiae, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Coxiella burnetii;

(2) Rickettsia quintana;

(3) Rickettsia prowasecki;

(4) Rickettsia rickettsii;

(c) Bacteria, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Bacillus anthracis;

(2) Brucella abortus;

(3) Brucella melitensis;

(4) Brucella suis;

(5) Chlamydia psittaci;

(6) Clostridium botulinum;

(7) Francisella tularensis;

(8) Pseudomonas mallei (Burkholderia mallei);

(9) Pseudomonas pseudomallei (Burkholderia pseudomallei;

(10) Salmonella typhi;

(11) Shigella dysenteriae;

(12) Vibrio cholerae;

(13) Pasteurella pseudotuberculosis var pestis (Yersinia pestis);

(d) **Toxins,** as follows;

(1) Botulinum toxins;

(2) Clostridium perfringens toxins;

(3) Conotoxin;

(4) Ricin;

(5) Saxitoxin;

(6) Shiga toxin;

(7) Staphylococcus aureus toxins;

(8) Tetrodotoxin;

(9) Verotoxin;

(10) Microcystins (Cyanginosins);

except:

Any **goods** specified in this entry in the form of a vaccine(**13**).

(1C352) Animal Pathogens, as follows(**14**):

(a) Viruses, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) African swine fever virus;

(2) Avian influenza virus, which are:

(a) Uncharacterised; or

(b) Those defined in Council Directive 92/40/EEC(**15**), as having high pathogenicity, as follows:

(1) Type A viruses with an IVPI (intravenous pathogenicity index) in 6 week old chickens of greater than 1.2; or

(2) Type A viruses H5 or H7 subtype for which nucletide sequencing has demonstrated multiple basic amino acids at the cleavage site of haemagglutinin;

(3) Bluetongue virus;

(4) Foot and mouth disease virus;

(5) Goat pox virus;

(6) Porcine herpes virus (Aujeszky's disease);

(7) Swine fever virus (Hog cholera virus);

(8) Lyssa virus;

(9) Newcastle disease virus;

(10) Peste des petits ruminants virus;

(11) Swine vesicular disease (porcine enterovirus type 9);

(12) Rinderpest virus;

(13) Sheep pox virus;

(14) Teschen disease virus;

(15) Vesicular stomatitis virus;

(b) Bacteria, whether natural, enhanced or modified, either in the form of isolated live cultures or as material including living material which has been deliberately inoculated or contaminated with Mycoplasma mycoides;

except:

Any **goods** specified in this entry in the form of a vaccine.

(1C353) Genetically-modified **microorganisms,** as follows(**16**):

(a) Genetically modified **microorganisms** or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms specified in heads a. to c. of entry 1C351 or entries 1C352 or 1C354;

(**13**) See also entry 1C992.
(**14**) See also ML7 of Group 1 of Part III of this Schedule.
(**15**) O.J. No. L167, 22.6.92 p.1.
(**16**) See also ML7 of Group 1 of Part III of this Schedule.

(b) Genetically modified **microorganisms** or genetic elements that contain nucleic acid sequences coding for any of the **toxins** specified in head d. of entry 1C351.

(1C354) Plant pathogens, as follows:

(a) Bacteria, whether natural, enhanced or modified, either in the form of **isolated live cultures** or as material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Xanthomonas albilineans;

(2) Xanthomonas campestris pv. citri including strains referred to as Xanthomonas campestris pv. citri types A,B,C,D,E or otherwise classified as Xanthomonas citri, Xanthomonas campestris pv. aurantifolia or Xanthomonas campestris pv. citrumelo;

(b) Fungi, whether natural, enhanced or modified, either in the form of **isolated live cultures** or as material which has been deliberately inoculated or contaminated with such cultures, as follows:

(1) Colletotrichum coffeanum var. virulans;

(2) Cochlibolus miyabeanus (Helminthosporium oryzae);

(3) Microcyclus ulei(syn. Dothidella ulei);

(4) Puccinia graminis (syn. Puccinia graminis f. sp. tritici);

(5) Puccinia striiformis (syn. Puccinia glumarum);

(6) Magnaporthe grisea (Pyricularia grisea/Pyricularia oryzae).

(1C991) Other explosives and propellants and related substances as follows(**17**):

(a) Amatol;

(b) Nitrocellulose (containing more than 12.5% nitrogen);

(c) Nitroglycol;

(d) Pentaerythritol tetranitrate (PETN);

(e) Picryl chloride;

(f) Trinitrophenylmethylnitramine (tetryl);

(g) 2,4,6-Trinitrotoluene (TNT).

(1C992) Vaccines for protection against either of the following:

(a) Bacillus anthracis; or

(b) Botulinum toxin.

1D Software

(1D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 1B001 to 1B003.

(1D002) **Software** for the **development** of organic **matrix,** metal **matrix** or carbon **matrix** laminates or **composites.**

(1D101) **Software** specially designed for the **use** of **goods** specified in entry 1B101.

(1D103) **Software** specially designed for analysis of reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures.

(1D201) **Software** specially designed for the **use** of **goods** specified in entry 1B201.

1E Technology

(**17**) See also entries 1C115, 1C239 and ML8 of Group 1 of Part III of this Schedule.

(1E001) **Technology required** for the **development** or **production** of **goods** specified in heads b. or c. of entry 1A001, or entries 1A002, 1A003, or sub-categories 1B or 1C.

(1E002) Other **technology:**

(a) **Technology** for the **development** or **production** of polybenzothiazoles or polybenzoxazoles;

(b) **Technology** for the **development** or **production** of fluoroelastomer compounds containing at least one vinylether monomer;

(c) **Technology** for the design or **production** of the following base materials or non-**composite** ceramic materials:

(1) Base materials having all of the following characteristics:

(a) Any of the following compositions:

(1) Single or complex oxides of zirconium and complex oxides of silicon or aluminium;

(2) Single nitrides of boron (cubic crystalline forms);

(3) Single or complex carbides of silicon or boron; or

(4) Single or complex nitrides of silicon;

(b) Total metallic impurities, excluding intentional additions, of less than:

(1) 1,000 ppm for single oxides or carbides; or

(2) 5,000 ppm for complex compounds or single nitrides; and

(c) 1. Average particle size equal to or less than 5 micrometre and no more than 10% of the particles larger than 10 micrometre; or

Note: For zirconia, these limits are 1 micrometre and 5 micrometre respectively.

2. a. Platelets with a length to thickness ratio exceeding 5;

b. Whiskers with a length to diameter ratio exceeding 10 for diameters less than 2 micrometre; and

c. Continuous or chopped fibres less than 10 micrometre in diameter;

(2) Non-**composite** ceramic materials (except abrasives) composed of the materials described in sub-head c.1. of this entry;

(d) **Technology** for the **production** of aromatic polyamide fibres;

(e) **Technology** for the installation, maintenance or repair of materials specified in entry 1C001;

(f) **Technology** for the repair of **composite** structures, laminates or materials specified in entry 1A002 and heads c. or d. of entry 1C007.

Note: Head f. of this entry does not specify **technology** for the repair of civil **aircraft** structures using carbon **fibrous or filamentary materials** and epoxy resins, contained in manufacturers' manuals.

(1E101) **Technology required** for the **use** of **goods** specified in entries 1A102, 1B001, 1B101, 1B115, 1B116, 1C001, 1C101, 1C107, 1C115 to 1C117, 1D101 or 1D103.

(1E102) **Technology required** for the **development** of **software** specified in entries 1D001, 1D101 or 1D103.

(1E103) **Technology** for the regulation of temperature, pressure or atmosphere in autoclaves or hydroclaves, when used for the production of composites or partially processed composites.

(1E104) **Technology** relating to the **production** of pyrolitically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1,573 K (1,300°C) to 3,173 K (2,900°C) temperature range at pressures of 130 Pa to 20 kPa.*Note:* This entry includes **technology** for the composition of precursor gases, flowrates and process control schedules and parameters.

(1E201) **Technology required** for the **use** of **goods** specified in entries 1A002, 1A202, 1A225 to 1A227, 1B201, 1B225 to 1B231, sub-heads a.2.c. and a.2.d. of entry 1C002, head b. of entry 1C010, or entries 1C202, 1C210, 1C216, 1C225 to 1C239 or 1D201.

(1E202) **Technology required** for the **development** or **production** of **goods** specified in entries 1A202, 1A225 to 1A227.

(1E203) **Technology required** for the **development** of **software** specified in entry 1D201.

Category 2—Materials Processing

Equipment, Assemblies and Components

2A Notes to 2A001 to 2A006:

(1) DN is the product of the bearing bore diameter in mm and the bearing rotational velocity in rpm.

(2) Operating temperatures include those temperatures obtained when a gas turbine engine has stopped after operation.

(2A001) Ball bearings or solid roller bearings (except tapered roller bearings) having tolerances specified by the manufacturer in accordance with ISO Standard Class 4 (Annular Bearing Engineers Committee (ABEC) 7, ABEC 7P, ABEC 7T) or better, and having any of the following characteristics:

(a) Rings, balls or rollers made from monel or beryllium;

(b) Manufactured for use at operating temperatures above 573 K (300°C) either by using special materials or by special heat treatment; or

(c) With lubricating elements or component modifications that, according to the manufacturer's specifications, are specially designed to enable the bearings to operate at speeds exceeding 2.3 million DN.

(2A002) Other ball bearings or solid roller bearings (except tapered roller bearings) having tolerances specified by the manufacturer in accordance with ISO Standard Class 2 (Annular Bearing Engineers Committee (ABEC) 9, ABEC 9P or better).

(2A003) Solid tapered roller bearings, having tolerances specified by the manufacturer in accordance with American National Standards Institute (ANSI)/Anti-Friction Bearing Manufacturers Association (AFBMA) Class 00 (inch) or Class A (metric) or better and having either of the following characteristics:

(a) With lubricating elements or component modifications that, according to the manufacturer's specifications, are specially designed to enable the bearings to operate at speeds exceeding 2.3 million DN; or

(b) Manufactured for use at operating temperatures below 219 K (-54°C) or above 423 K (150°C).

(2A004) Gas-lubricated foil bearings manufactured for use at operating temperatures of 561 K (288°C) or higher and with a unit load capacity exceeding 1 MPa.

(2A005) Active magnetic bearing systems.

(2A006) Fabric-lined self-aligning or fabric-lined journal sliding bearings manufactured for use at operating temperatures below 219 K (-54°C) or above 423 K (150°C).

(2A225) Crucibles made of materials resistant to liquid actinide metals, as follows:

(a) Crucibles with a volume of between 150 ml and 8 litres and made of or coated with any of the following materials having a purity of 98% or greater:

(1) Calcium fluoride (CaF_2);

(2) Calcium zirconate (metazirconate) (Ca_2ZrO_3);

(3) Cerium sulphide (Ce_2S_3);

(4) Erbium oxide (erbia) (Er_20_3);

(5) Hafnium oxide (hafnia) (HfO_2);

(6) Magnesium oxide (MgO);

(7) Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20%W);

(8) Yttrium oxide (yttria) (Y_2O_3); or

(9) Zirconium oxide (zirconia) (ZrO_2);

(b) Crucibles with a volume of between 50 ml and 2 litres and made of or lined with tantalum, having a purity of 99.9% or greater;

(c) Crucibles with a volume of between 50 ml and 2 litres and made of or lined with tantalum (having a purity of 98% or greater) coated with tantalum carbide, nitride or boride (or any combination of these).

(2A226) Valves 5 mm or greater in diameter, with a bellows seal, wholly made of or lined with aluminium, aluminium alloy, nickel or alloy containing 60% or more nickel, either manually or automatically operated.

(2B) **Test, Inspection and Production Equipment**

Note: Entries 2B001 to 2B009 do not specify measuring interferometer systems, without closed or open loop feedback, containing a **laser** to measure slide movement errors of machine-tools, dimensional inspection machines or similar equipment.

(2B001) **Numerical control** units, **motion control boards** specially designed for **numerical control** applications on machine tools, machine tools, and specially designed components therefor, as follows:

Notes:

(1) Secondary parallel contouring axes, e.g., the w-axis on horizontal boring mills or a secondary rotary axis the centre line of which is parallel to the primary rotary axis, are not counted in the total number of contouring axes.

N.B.: Rotary axes need not rotate over 360°. A rotary axis can be driven by a linear device, e.g., a screw or a rack-and-pinion.

(2) Axis nomenclature shall be in accordance with International Standard ISO 841, 'Numerical Control Machines – Axis and Motion Nomenclature'.

(a) **Numerical control** units for machine tools, as follows, and specially designed components therefor:

Note: Head a. of this entry does not specify **numerical control** units:

(a) Modified for and incorporated in machines not specified in this entry; or

(b) Specially designed for machines not specified in this entry.

(1) Having more than four interpolating axes which can be coordinated simultaneously for **contouring control**;

(2) Having two, three or four interpolating axes which can be coordinated simultaneously for **contouring control** and:

(a) Capable of **real time processing** of data to modify, during the machining operation, tool path, feed rate and spindle data by either:

(1) Automatic calculation and modification of part programme data for machining in two or more axes by means of measuring cycles and access to source data; or

(2) **Adaptive control** with more than one physical variable measured and processing by means of a computing model (strategy) to change one or more machining instructions to optimize the process;

(b) Capable of receiving directly (on-line) and processing computer aided design (CAD) data for internal preparation of machine instructions; or

(c) Capable, without modification, according to the manufacturer's technical specifications, of accepting additional boards which would permit an increase above the levels specified in this entry, in the number of interpolating axes which can be coordinated simultaneously for **contouring control,** even if they do not contain these additional boards;

(b) **Motion control boards** specially designed for machine tools and having any of the following characteristics:

(1) Interpolation in more than four axes;

(2) Capable of **real time processing** as described in sub-head a.2.a. of this entry; or

(3) Capable of receiving and processing CAD data as described in sub-head a.2.b. of this entry;

(c) Machine tools, as follows, for removing or cutting metals, ceramics or composites, which, according to the manufacturer's technical specifications, can be equipped with electronic devices for simultaneous **contouring control** in two or more axes:

(1) Machine tools for turning, grinding, milling or any combination thereof which:

(a) Have two or more axes which can be coordinated simultaneously for **contouring control**; and

(b) Have any of the following characteristics:

(1) Two or more contouring rotary axes;

Note: The c axis on jig grinders used to maintain grinding wheels normal to the work surface is not considered a contouring rotary axis.

(2) One or more contouring **tilting spindles**;

Note: Sub-head c.1.b.2. of this entry applies to machine tools for grinding or milling only.

(3) **Camming** (axial displacement) in one revolution of the spindle less (better) than 0.0006 mm total indicator reading (TIR);

Note: Sub-head c.1.b.3. of this entry applies to machine tools for turning only.

(4) **Run out** (out-of-true running) in one revolution of the spindle less (better) than 0.0006 mm TIR;

(5) The positioning accuracies, with all compensations available, are less (better) than:

(a) 0.001° on any rotary axis; or

(b)

(1) 0.004 mm along any linear axis (overall positioning) for grinding machines;

(2) 0.006 mm along any linear axis (overall positioning) for turning or milling machines; or

Notes:

(1) Sub-head c.1.b.5. of this entry does not specify milling or turning machine tools with a positioning accuracy along one axis, with all compensations available, equal to or more (worse) than 0.005 mm.

(2) The positioning accuracy of **numerically controlled** machine tools is to be determined and presented in accordance with ISO 230/2 paragraph 2.13, in conjunction with the requirements below:

(a) Test conditions (paragraph 3):

(1) For 12 hours before and during measurements, the machine tool 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;

(2) The machine shall be equipped with any mechanical, electronic, or software compensation to be exported with the machine;

(3) Accuracy of measuring equipment for the measurements shall be at least four times more accurate than the expected machine tool accuracy;

(4) Power supply for slide drives shall be as follows:

(a) Line voltage variation shall not exceed ± 10% of nominal rated voltage;

(b) Frequency variation shall not exceed ±2 Hz of normal frequency;

(c) Lineouts or interrupted service are not permitted;

(b) Test programme (paragraph 4):

(1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate, except in the case of machine tools which generate optical quality surfaces, the feed rate shall be equal to or less than 50 mm per minute;

(2) 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;

(3) Axes not being measured shall be retained at mid travel during test of an axis;

(c) Presentation of test results (paragraph 2): The results of the measurements must include:

(1) Positioning accuracy (A); and

(2) The mean reversal error (B).

End of Notes

(6)

(a) A positioning accuracy less (better) than 0.007 mm; and

(b) A slide motion from rest for all slides within 20% of a motion command input for inputs of less than 0.5 micrometre;

Notes:

(1) Minimum increment of motion test (slide motion from rest): The test is conducted only if the machine tool is equipped with a control unit the minimum increment of which is less (better) than 0.5 micrometre. Prepare the machine for testing in accordance with ISO 230/2 paragraphs 3.1, 3.2, 3.3.Conduct the test on each axis (slide) of the machine tool as follows:

(a) Move the axis over at least 50% of the maximum travel in plus and minus directions twice at maximum feed rate, rapid traverse rate or jog control;

(b) Wait at least 10 seconds;

(c) With manual data input, input the minimum programmable increment of the control unit;

(d) Measure the axis movement;

(e) Clear the control unit with the servo null, reset or whatever clears any signal (voltage) in the servo loop;

(f) Repeat steps b. to e. above five times, twice in the same direction of the axis travel and three times in the opposite direction of travel for a total of six test points;

(g) If the axis movement is between 80% and 120% of the minimum programmable input for four of the six test points, the machine is controlled.

For rotary axes, the measurement is taken 200 mm from the centre of rotation.

(2) Sub-head c.1. of this entry does not specify cylindrical external, internal and external-internal grinding machines having all of the following characteristics:

(a) Not centreless (shoe-type) grinding machines;

(b) Limited to cylindrical grinding;

(c) A maximum workpiece capacity of 150 mm outside diameter or length;

(d) Only two axes which can be coordinated simultaneously for **contouring control**; and

(e) No contouring c axis.

(3) Sub-head c.1. of this entry does not specify machines designed specifically as jig grinders having both of the following characteristics:

(a) Axes limited to x, y, c and a, where the c axis is used to maintain the grinding wheel normal to the work surface and the a axis is configured to grind barrel cams; and

(b) A spindle **run out** not less (not better) than 0.0006 mm.

(4) Sub-head c.1. of this entry does not specify tool or cutter grinding machines having all of the following characteristics:

(a) Shipped as a complete system with **software** specially designed for the production of tools or cutters;

(b) No more than two rotary axes which can be coordinated simultaneously for **contouring control**;

(c) **Run out** (out-of-true running) in one revolution of the spindle not less (not better) than 0.0006 mm TIR; and

(d) The positioning accuracies, with all compensations available, are not less (not better) than:

(1) 0.004 mm along any linear axis for overall positioning; or

(2) 0.001° on any rotary axis.

End of Notes

(2) Electrical discharge machines (EDM) of the wire feed type which have five or more axes which can be coordinated simultaneously for **contouring control**;

(3) Electrical discharge machines (EDM) of the non-wire type which have two or more rotary axes which can be coordinated simultaneously for **contouring control**;

(4) Machine tools for removing metals, ceramics or composites:

(a) By means of:

(1) Water or other liquid jets, including those employing abrasive additives;

(2) Electron beam; or

(3) **Laser** beam; and

(b) Having two or more rotary axes which:

(1) Can be coordinated simultaneously for **contouring control**; and

(2) Have a positioning accuracy of less (better) than 0.003°.

Note: Machines capable of being simultaneously coordinated for contouring control, in two or more rotary axes or one or more tilting spindles, are specified in this entry regardless of the number of simultaneously coordinated contouring axes that can be controlled by the **numerical control** unit attached to the machine.

(2B002) Non-**numerically controlled** machine tools for generating optical quality surfaces, as follows:

(a) Turning machines using a single point cutting tool and having all of the following characteristics:

(1) Slide positioning accuracy less (better) than 0.0005 mm per 300 mm of travel;

(2) Bidirectional slide positioning repeatability less (better) than 0.00025 mm per 300 mm of travel;

(3) Spindle **run out** and **camming** less (better) than 0.0004 mm TIR;

(4) Angular deviation of the slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR, over full travel; and

(5) Slide perpendicularity less (better) than 0.001 mm per 300 mm of travel;

Note: The bidirectional slide positioning repeatability (R) of an axis is the maximum value of the repeatability of positioning at any position along or around the axis determined using the procedure and under the conditions specified in part 2.11 of ISO 230/2: 1988.

(b) Fly cutting machines having both of the following characteristics:

(1) Spindle **run out** and **camming** less (better) than 0.0004 mm TIR; and

(2) Angular deviation of slide movement (yaw, pitch and roll) less (better) than 2 seconds of arc, TIR, over full travel.

(2B003) **Numerically controlled** or manual machine tools specially designed for cutting, finishing, grinding or honing either of the following classes of bevel or parallel axis hardened (R_c = 40 or more) gears, and specially designed components, controls and accessories therefor:

(a) Hardened bevel gears finished to a quality of better than ISO 1328 class 4; or

(b) Hardened spur, helical and double-helical gears with a pitch diameter exceeding 1,250 mm and a face width of 15% of pitch diameter or larger finished to a quality of ISO 1328 class 3 or better.

(2B004) Hot **isostatic presses**, as follows, and specially designed dies, moulds, components, accessories and controls therefor(**18**):

(a) Having a controlled thermal environment within the closed cavity and possessing a chamber cavity with an inside diameter of 406 mm or more; and

(b) Having:

(1) A maximum working pressure exceeding 207 MPa;

(2) A controlled thermal environment exceeding 1,773 K (1,500°C); or

(3) A facility for hydrocarbon impregnation and removal of resultant gaseous degradation products.

Note: The inside chamber dimension is that of the chamber in which both the working temperature and the working pressure are achieved and does not include fixtures. That dimension will be the smaller of either the inside diameter of the pressure chamber or the inside diameter of the insulated furnace chamber, depending on which of the two chambers is located inside the other.

(2B005) Equipment specially designed for the deposition, processing and in-process control of inorganic overlays, coatings and surface modifications, as follows, for non-electronic substrates, by processes shown in the Table and associated Notes following head d. of entry 2E003, and specially designed automated handling, positioning, manipulation and control components therefor:

(a) **Stored programme controlled** chemical vapour deposition (CVD) production equipment with both of the following:

(1) Process modified for one of the following:

(a) Pulsating CVD;

(b) Controlled nucleation thermal decomposition (CNTD); or

(c) Plasma enhanced or plasma assisted CVD; and

(2) Either of the following:

(a) Incorporating high vacuum (equal to or less than 0.01 Pa) rotating seals; or

(b) Incorporating in situ coating thickness control;

(b) **Stored programme controlled** ion implantation production equipment having beam currents of 5 mA or more;

(c) **Stored programme controlled** electron beam physical vapour deposition (EBPVD) production equipment incorporating:

(1) Power systems rated for over 80 kW;

(2) A liquid pool level **laser** control system which regulates precisely the ingots feed rate; and

(3) A computer controlled rate monitor operating on the principle of photoluminescence of the ionised atoms in the evaporant stream to control the deposition rate of a coating containing two or more elements;

(d) **Stored programme controlled** plasma spraying production equipment having either of the following characteristics:

(**18**) See also Entries 2B104 and 2B204.

(1) Operating at reduced pressure controlled atmosphere (equal to or less than 10 kPa measured above and within 300 mm of the gun nozzle exit) in a vacuum chamber capable of evacuation down to 0.01 Pa prior to the spraying process; or

(2) Incorporating in situ coating thickness control;

(e) **Stored programme controlled** sputter deposition production equipment capable of current densities of 0.1 mA/mm^2 or higher at a deposition rate of 15 micrometre/hr or more;

(f) **Stored programme controlled** cathodic arc deposition production equipment incorporating a grid of electromagnets for steering control of the arc spot on the cathode;

(g) **Stored programme controlled** ion plating production equipment allowing for the in situ measurement of either:

(1) Coating thickness on the substrate and rate control; or

(2) Optical characteristics.

Note: Head g. of this entry does not specify standard ion plating coating equipment for cutting or machining tools.

(2B006) Dimensional inspection or measuring systems or equipment, as follows:

(a) Computer controlled, **numerically controlled** or **stored programme controlled** dimensional inspection machines, having both of the following characteristics:

(1) Two or more axes; and

(2) A one dimensional length **measurement uncertainty** equal to or less (better) than (1.25 + L/1,000) micrometre tested with a probe with an **accuracy** of less (better) than 0.2 micrometre (L is the measured length in mm);

(b) Linear and angular displacement measuring instruments, as follows:

(1) Linear measuring instruments having any of the following characteristics:

(a) Non-contact type measuring systems with a **resolution** equal to or less (better) than 0.2 micrometre within a measuring range up to 0.2 mm;

(b) Linear voltage differential transformer systems with both of the following characteristics:

(1) **Linearity** equal to or less (better) than 0.1% within a measuring range up to 5 mm; and

(2) Drift equal to or less (better) than 0.1% per day at a standard ambient test room temperature ±1 K; or

(c) Measuring systems having both of the following characteristics:

(1) Containing a **laser**; and

(2) Maintaining, for at least 12 hours, over a temperature range of ± 1 K around a standard temperature and at a standard pressure:

(a) A **resolution** over their full scale of 0.1 micrometre or less (better); and

(b) A **measurement uncertainty** equal to or less (better) than (0.2 +L/2,000) micrometre (L is the measured length in mm);

(2) Angular measuring instruments having an **angular position deviation** equal to or less (better) than 0.00025°;

Note: Sub-head b.2. of this entry does not specify optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.

(c) Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:

(1) **Measurement uncertainty** along any linear axis equal to or less (better) than 3.5 micrometre per 5 mm; and

(2) **Angular position deviation** equal to or less (better) than 0.02°;

(d) Equipment for measuring surface irregularities, by measuring optical scatter as a function of angle, with a sensitivity of 0.5 nm or less (better).

Notes:

(1) The probe used in determining the **measurement uncertainty** of a dimensional inspection system shall be as described in Verein Deutscher Ingenieure (VDI) / Verband Deutscher Elektrotechniker (VDE) 2617 Parts 2, 3 and 4.

(2) All measurement values in this entry represent permissible positive and negative deviations from the target value, i.e., not total band.

(3) Machine tools which can be used as measuring machines are specified if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.

(4) A machine described in this entry is specified if it exceeds the threshold anywhere within its operating range.

(5) In this entry **measurement uncertainty** means the characteristic parameter which specifies in what range around the output value the correct value of the measurable variable lies with a confidence level of 95%. It includes the uncorrected systematic deviations, the uncorrected backlash and the random deviations (Reference: VDI/VDE 2617).

(2B007) **Robots,** as follows, and specially designed controllers and **end-effectors** therefor(**19**):

(a) Capable in real time of full three-dimensional image processing or full three-dimensional scene analysis to generate or modify **programmes** or to generate or modify numerical **programme** data;

Note: The scene analysis limitation does not include approximation of the third dimension by viewing at a given angle, or limited grey scale interpretation for the perception of depth or texture for the approved tasks (2 1/2 D).

(b) Specially designed to comply with national safety standards applicable to explosive munitions environments; or

(c) Specially designed or rated as radiation-hardened beyond that necessary to withstand normal industrial (i.e., non-nuclear industry) ionizing radiation.

(2B008) Assemblies, units or inserts specially designed for machine tools, or for equipment specified in entries 2B006 or 2B007, as follows:

(a) Spindle assemblies, consisting of spindles and bearings as a minimal assembly, with radial **(run out)** or axial **(camming)** axis motion in one revolution of the spindle less (better) than 0.0006 mm TIR;

(b) Linear position feedback units (e.g., inductive type devices, graduated scales, infrared systems or **laser** systems) having an overall **accuracy** less (better) than $(800 + (600 \times L \times 10^{-3}))$ nm (L equals the effective length in mm);

(c) Rotary position feedback units, e.g., inductive type devices, graduated scales, infrared systems or **laser** systems, having an accuracy less (better) than 0.00025°;

(**19**) See also entry 2B207.

(d) Slide way assemblies consisting of a minimal assembly of ways, bed and slide having all of the following characteristics:

(1) A yaw, pitch or roll of less (better) than 2 seconds of arc TIR over full travel;

(2) A horizontal straightness of less (better) than 2 micrometre per 300 mm length; and

(3) A vertical straightness of less (better) than 2 micrometre per 300 mm length;

(e) Single point diamond cutting tool inserts, having all of the following characteristics:

(1) Flawless and chip-free cutting edge when magnified 400 times in any direction;

(2) Cutting radius from 0.1 to 5 mm inclusive; and

(3) Cutting radius out-of-roundness less (better) than 0.002 mm TIR.

(2B009) Specially designed printed circuit boards with mounted components and **software** therefor, or **compound rotary tables** or **tilting** spindles, capable of upgrading, according to the manufacturer's specifications, **numerical control** units, machine tools or feed-back devices to or above the levels specified in entries 2B001 to 2B008.

(2B104) Equipment and process controls designed or modified for densification and pyrolysis of structural composite rocket nozzles and reentry vehicle nose tips.

Note: The only **isostatic presses** and furnaces specified in this entry are as follows:

a. **Isostatic presses**, other than those specified in entry 2B004, having all the following characteristics:

1. Maximum working pressure of 69 MPa or greater;

2. Designed to achieve and maintain a controlled thermal environment of 873 K (600°C) or greater; and

3. Possessing a chamber cavity with an inside diameter of 254 mm or greater;

b. CVD furnaces designed or modified for the densification of carbon-carbon composites.

(2B115) Flow-forming machines, and specially designed components therefor(**20**), which:

(a) According to the manufacturer's technical specification, can be equipped with **numerical control** units or a computer control, even when not equipped with such units; and

(b) With more than two axes which can be coordinated simultaneously for **contouring control**.

Note: Machines combining the function of spin-forming and flow-forming are for the purpose of this entry regarded as flow-forming machines.

(2B116) Vibration test equipment and components therefor, the following:

(a) Vibration test systems employing feedback or closed loop techniques and incorporating a digital controller, capable of vibrating a system at 10 g rms or more over the entire range 20 Hz to 2000 Hz and imparting forces of 50 kN (11,250 lbs), measured bare table, or greater;

(b) Digital controllers, combined with specially designed vibration test software, with a real-time bandwidth greater than 5 kHz and designed for use with vibration test systems in head a. of this entry;

(c) Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN (11,250 lbs), measured bare table, or greater and usable in vibration test systems in head a. of this entry;

(d) Test piece support structures and electronic units designed to combine multiple shaker units in a system capable of providing an effective combined force of 50 kN, measured bare table, or greater, and usable in vibration systems in head a. of this entry.

(**20**) See also entry 2B215.

In this entry, "bare table" means a flat table, or surface, with no fixtures or fittings.

(2B204) **Isostatic presses**, other than those specified in entries 2B004 or 2B104, capable of achieving a maximum working pressure of 69 MPa or greater and having a chamber cavity with an inside diameter in excess of 152 mm and specially designed dies, moulds and controls therefor.

(2B207) **Robots** and **end-effectors**, other than those specified in entry 2B007, specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives) and specially designed controllers therefor.

(2B215) Spin-forming and flow-forming machines, other than those specified in entry 2B115, and precision rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 mm and 400 mm therefor, which:

(a) According to the manufacturer's technical specification, can be equipped with **numerical control** units or a computer control; and

(b) With two or more axes that can be coordinated simultaneously for **contouring control**.

Note: The only spin-forming machines specified in this entry are those combining the function of spin-forming and flow-forming.

(2B225) Remote manipulators that provide mechanical translation of human operator actions by electrical, hydraulic or mechanical means to an operating arm and terminal fixture that can be used to provide remote actions in radiochemical separation operations and hot cells, as follows:

(a) Having a capability of penetrating 0.6 m or more of cell wall; or

(b) Having a capability to bridge over the top of a cell wall with a thickness of 0.6 m or more.

(2B226) Vacuum or controlled environment (inert gas) induction furnaces capable of operating above 1,123 K (850°C) and having induction coils 600 mm or less in diameter and specially designed power supplies therefor with an output rating of 5 kW or more(**21**).

Note: This entry does not specify furnaces designed for the processing of semiconductor wafers.

(2B227) Vacuum and controlled atmosphere metallurgical melting and casting furnaces as follows; and specially configured computer control and monitoring systems therefor:

(a) Arc remelt and casting furnaces with consumable electrode capacities between 1000 cm^3 and 20,000 cm^3, capable of operating with melting temperatures above 1973 K (1700°C);

(b) Electron beam melting and plasma atomization and melting furnaces, with a power of 50 kW or greater, capable of operating with melting temperatures above 1473 K (1200°C).

(2B228) Rotor fabrication and assembly equipment and bellows-forming mandrels and dies, as follows:

(a) Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles and end caps, including associated precision mandrels, clamps and shrink fit machines;

(b) Rotor straightening equipment for alignment of gas centrifuge rotor tube sections to a common axis;

Note: Normally such equipment will consist of precision measuring probes linked to a computer that subsequently controls the action of, for example, pneumatic rams used for aligning the rotor tube sections.

(c) Bellows-forming mandrels and dies for producing single-convolution bellows (bellows made of high-strength aluminium alloys, maraging steel or high strength filamentary materials). The bellows have all of the following dimensions:

(**21**) See also sub-category 3B.

(1) 75 mm to 400 mm inside diameter;

(2) 12.7 mm or more in length; and

(3) Single convolution depth more than 2 mm.

(2B229) Centrifugal multiplane balancing machines, fixed or portable, horizontal or vertical, as follows:

(a) Centrifugal balancing machines designed for balancing flexible rotors having a length of 600 mm or more and having all of the following characteristics:

(1) A swing or journal diameter of 75 mm or more;

(2) Mass capability of from 0.9 to 23 kg; and

(3) Capable of balancing speed of revolution more than 5000 rpm;

(b) Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:

(1) A journal diameter of 75 mm or more;

(2) Mass capability of from 0.9 to 23 kg;

(3) Capable of balancing to a residual imbalance of 0.01 kg mm/kg per plane or better; and

(4) Belt drive type.

(2B230) Instruments capable of measuring pressures up to 13 kPa to an accuracy of better than 1% (full-scale), with corrosion-resistant pressure-sensing elements constructed of nickel, nickel alloys, phosphor bronze, stainless steel, aluminium or aluminium alloys.

(2B231) Vacuum pumps with an input throat size of 380 mm or greater with a pumping speed of 15,000 litres/s or greater and capable of producing an ultimate vacuum better than 13 mPa.

Note: The ultimate vacuum is determined at the input of the pump with the input of the pump blocked off.

(2B232) Multistage light gas gun or other high-velocity gun systems (coil, electromagnetic, electrothermal or other advanced systems) capable of accelerating projectiles to 2 km/s or greater.

(2B350) Chemical manufacturing facilities and equipment, as follows:

(a) Reaction vessels or reactors, with or without agitators, with total internal (geometric) volume greater than 0.1 m^3 (100 litres) and less than 20 m^3 (20,000 litres), where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coating or glass lining);

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

(b) Agitators for use in reaction vessels or reactors where all surfaces of the agitator that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coating or glass lining);

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

(c) Storage tanks, containers or receivers with a total internal (geometric) volume greater than 0.1 m^3 (100 litres) where all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coatings or glass lining);

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

(d) Heat exchangers or condensers with a heat transfer surface area of less than 20 m^2, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coatings or glass lining);

(4) Graphite;

(5) Nickel or alloys with more than 40% nickel by weight;

(6) Tantalum or tantalum alloys;

(7) Titanium or titanium alloys; or

(8) Zirconium or zirconium alloys;

(e) Distillation or absorption columns of internal diameter greater than 0.1 m, where all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coatings or glass lining);

(4) Graphite;

(5) Nickel or alloys with more than 40% nickel by weight;

(6) Tantalum or tantalum alloys;

(7) Titanium or titanium alloys; or

(8) Zirconium or zirconium alloys;

(f) Remotely operated filling equipment in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight; or

(2) Nickel or alloys with more than 40% nickel by weight;

(g) Multiple seal valves incorporating a leak detection port, bellows-seal valves, non-return (check) valves or diaphragm valves, in which all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coatings or glass lining);

(4) Nickel or alloys with more than 40% nickel by weight;

(5) Tantalum or tantalum alloys;

(6) Titanium or titanium alloys; or

(7) Zirconium or zirconium alloys;

(h) Multi-walled piping incorporating a leak detection port, in which all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Fluoropolymers;

(3) Glass (including vitrified or enamelled coatings or glass lining);

(4) Graphite;

(5) Nickel or alloys with more than 40% nickel by weight;

(6) Tantalum or tantalum alloys;

(7) Titanium or titanium alloys; or

(8) Zirconium or zirconium alloys;

(i) Multiple-seal, canned drive, magnetic drive, bellows or diaphragm pumps, with manufacturer's specified maximum flow-rate greater than 0.6 m^3/hour, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m^3/hour (under standard temperature (273 K (0°C)) and pressure (101.3 kPa) conditions), in which all surfaces that come in direct contact with the chemical(s) being processed are made from any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Ceramics;

(3) Ferrosilicon;

(4) Fluoropolymers;

(5) Glass (including vitrified or enamelled coatings or glass lining);

(6) Graphite;

(7) Nickel or alloys with more than 40% nickel by weight;

(8) Tantalum or tantalum alloys;

(9) Titanium or titanium alloys; or

(10) Zirconium or zirconium alloys;

(j) Incinerators designed to destroy chemicals specified in entry 1C350, having specially designed waste supply systems, special handling facilities and an average combustion chamber temperature greater than 1273 K (1000°C), in which all surfaces in the waste supply system that come into direct contact with the waste products are made from or lined with any of the following materials:

(1) Alloys with more than 25% nickel and 20% chromium by weight;

(2) Ceramics; or

(3) Nickel or alloys with more than 40% nickel by weight.

(2B351) Toxic gas monitoring systems, as follows, and dedicated detectors therefor:

(a) Designed for continuous operation and usable for the detection of chemical warfare agents, chemicals specified in entry 1C350 or organic compounds containing phosphorus, sulphur, fluorine or chlorine, at concentrations of less than 0.3 mg/m^3; or

(b) Designed for the detection of cholinesterase-inhibiting activity.

(2B352) Equipment capable of use in biological manufacturing, as follows;

(a) Containment facilities at Containment Level (ACDP) 3 or 4, and related equipment, as follows:

(1) Facilities that meet the criteria for Containment Level 3 or 4 as specified in guidance from the Advisory Committee on Dangerous Pathogens approved by the Health and Safety Commission (published by HMSO, Second Edition 1990);

Note: The criteria for Containment Level 3 or 4 in head a. of this entry are equivalent to the criteria for P3 or P4, BL3 or BL4, L3 or L4 containment as specified in the WHO Laboratory Biosafety manual (Geneva, 1983).

(2) Independently ventilated protective full or half suits;

(3) Biological safety cabinets or isolators, which allow manual operations to be performed within, whilst providing an environment equivalent to Class III biological protection;

Note: In this sub-head, "isolators" include flexible isolators, dry boxes, anaerobic chambers and glove boxes.

(b) Fermenters, bioreactors, chemostats and continuous-flow systems, capable of operation without the propagation of aerosols, having all the following characteristics:

(1) Capacity of 300 litres or more;

(2) Double or multiple sealing joints within the steam containment area; and

(3) Capable of in-situ sterilisation in a closed state;

(c) Centrifugal separators or decanters, capable of continuous separation without the propagation of aerosols, having all the following characteristics:

(1) Flow rate exceeding 100 litres per hour;

(2) Components of polished stainless steel or titanium;

(3) Double or multiple sealing joints within the steam containment area; and

(4) Capable of in-situ sterilisation in a closed state;

(d) Cross-flow filtration equipment, designed for continuous separation without the propagation of aerosols, having both of the following characteristics:

(1) Equal to or greater than 5 square metres; and

(2) Capable of in-situ sterilization;

(e) Steam sterilisable freeze drying equipment with a condenser capacity exceeding 50 kg of ice in 24 hours and less than 1,000 kg of ice in 24 hours;

(f) Chambers designed for aerosol challenge testing with pathogenic **microorganisms** or **toxins** and having a capacity of 1 m^3 or greater.

2C Materials

None

2D Software

(2D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 2A001 to 2A006 or 2B001 to 2B009.

(2D002) Specific **software**, as follows:

(a) **Software** to provide **adaptive control** and having both of the following characteristics:

(1) For **flexible manufacturing units** (FMUs) which consist at least of equipment described in sub-heads b.1. and b.2. of the definition of **flexible manufacturing unit**; and

(2) Capable of generating or modifying, in **real time processing, programmes** or data by using the signals obtained simultaneously by means of at least two detection techniques, such as:

(a) Machine vision (optical ranging);

(b) Infrared imaging;

(c) Acoustical imaging (acoustical ranging);

(d) Tactile measurement;

(e) Inertial positioning;

(f) Force measurement;

(g) Torque measurement;

Note: Head a. of this entry does not specify **software** which only provides rescheduling of functionally identical equipment within **flexible manufacturing units** using pre-stored part programmes and a pre-stored strategy for the distribution of the part programmes.

(b) **Software** for electronic devices other than those described in heads a. or b. of entry 2B001, which provides the **numerical control** capability of the **goods** specified in entry 2B001.

Note: Entry 2B001 and this entry specify any combination of electronic devices or systems that collectively contain software enabling such devices or systems to function as a **numerical control** unit capable of coordinating simultaneously more than 4 axes for **contouring control**.

(2D101) **Software** specially designed for the **use** of **goods** specified in entries 2B104, 2B115 or 2B116(**22**).

(2D201) **Software** specially designed for the **use** of **goods** specified in entries 2B204, 2B207, 2B215, 2B227 or 2B229.

Technology

2E.—(2E001) **Technology required** for the **development** of **goods** specified in sub-categories 2A, 2B or 2D.

(2E002) **Technology required** for the **production** of **goods** specified in sub-categories 2A or 2B.

(2E003) Other **technology**, as follows:

(a) **Technology:**

(1) For the **development** of interactive graphics as an integrated part in **numerical control** units for preparation or modification of part programmes;

(**22**) See also entry 9D004.a.

(2) For the **development** of generators of machine tool instructions (e.g., part programmes) from design data residing inside **numerical control** units;

(3) For the **development** of integration **software** for incorporation of expert systems for advanced decision support of shop floor operations into **numerical control** units;

(b) **Technology** for metal-working manufacturing processes, as follows:

(1) **Technology** for the design of tools, dies or fixtures specially designed for the following processes:

(a) **Superplastic forming**;

(b) **Diffusion bonding**;

(c) **Direct-acting hydraulic pressing**;

(2) Technical data consisting of process methods or parameters as listed below used to control:

(a) **Superplastic forming** of aluminium alloys, titanium alloys or **superalloys**:

(1) Surface preparation;

(2) Strain rate;

(3) Temperature;

(4) Pressure;

(b) **Diffusion bonding** of **superalloys** or titanium alloys:

(1) Surface preparation;

(2) Temperature;

(3) Pressure;

(c) **Direct-acting hydraulic pressing** of aluminium alloys or titanium alloys:

(1) Pressure;

(2) Cycle time;

(d) **Hot isostatic densification** of titanium alloys, aluminium alloys or **superalloys**:

(1) Temperature;

(2) Pressure;

(3) Cycle time;

(c) **Technology** for the **development** or **production** of hydraulic stretch-forming machines and dies therefor, for the manufacture of airframe structures;

(d) **Technology** for:

The application of inorganic overlay coatings or inorganic surface modification coatings, specified in column 3 of the following Table;

To non-elecronic substrates, specified in column 2 of the following Table; By processes specified in column 1 of the following Table and defined in the Note.

TABLE—

DEPOSITION TECHNIQUES

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
(A) Chemical Vapour Deposition (CVD)	**Superalloys**	Aluminides for internal passages
	Ceramics and low-expansion glasses(14)	Silicides
		Carbides
		Dielectric layers (15)
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Refractory metals
		Mixtures thereof (4)
		Dielectric layers (15)
		Aluminides
		Alloyed aluminides (2)
	Cemented tungsten carbide (16), silicon carbide	Carbides
		Tungsten
		Mixtures thereof (4)
		Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15)
(B) Thermal-Evaporation Physical Vapour Deposition (TE-PVD)		
(1) (1) Physical Vapour Deposition (PVD): Electron-Beam (EB-PVD)	**Superalloys**	Alloyed silicides
		Alloyed aluminides (2)

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
		MCrA1X (5)
		Modified zirconia (12)
		Silicides
		Aluminides
		Mixtures thereof (4)
	Ceramics and low-expansion glasses (14)	Dielectric layers (15)
	Corrosion resistant steel (7)	MCrA1X (5)
		Modified zirconia (12)
		Mixtures thereof (4)
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Refractory metals
		Mixtures thereof (4)
		Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Carbides
		Tungsten
		Mixtures thereof (4)
		Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
		Borides
	Sensor window materials (9)	Dielectric layers (15)
	Titanium alloys (13)	Borides
		Nitrides
(B.2) (B.2) Ion assisted resistive heating Physical Vapour Deposition (Ion Plating)	Ceramics and low-expansion glasses (14)	Dielectric layers (15)

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
	Carbon-carbon, ceramic and metal **matrix composites**	Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15)
(B.3) (B.3) Physical Vapour Deposition: **laser** evaporation	Ceramics and low-expansion glasses (14)	Silicides
		Dielectric layers (15)
	Carbon-carbon, ceramic and metal **matrix composites**	Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
	Beryllium and beryllium alloys	Dielectric layers (15)
	Sensor window materials (9)	Dielectric layers (15)
		Diamond-like carbon
(B.4) (B.4) Physical Vapour Deposition: cathodic arc discharge	**Superalloys**	Alloyed silicides
		Alloyed aluminides (2)
		MCrA1X (5)
	Polymers (11) and organic **matrix composites**	Borides
		Carbides
		Nitrides
(C) (C) Pack cementation (see A above for out-of-	Carbon-carbon, ceramic and metal **matrix composites**	Silicides

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
pack cementation) (10)		
		Carbides
		Mixtures thereof (4)
	Titanium alloys (13)	Silicides
		Aluminides
		Alloyed aluminides (2)
	Refractory metals and alloys (8)	Silicides
		Oxides
D. Plasma spraying	**Superalloys**	MCrA1X (5)
		Modified zirconia (12)
		Mixtures thereof (4)
		Abradable Nickel-Graphite
		Abradable Ni-Cr-Al-Bentonite
		Abradable Al-Si-Polyester
		Alloyed aluminides (2)
	Aluminium alloys (6)	MCrA1X (5)
		Modified zirconia (12)
		Silicides
		Mixtures thereof (4)
	Refractory metals and alloys (8)	Aluminides
		Silicides
		Carbides
	Corrosion resistant steel (7)	Modified zirconia (12)
		Mixtures thereof (4)
	Titanium alloys (13)	Carbides
		Aluminides
		Silicides
		Alloyed aluminides (2)
		Abradable Nickel-Graphite

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
		Abradable Ni-Cr-Al-Bentonite
		Abradable Al-Si-Polyester
E. Slurry Deposition	Refractory metals and alloys (8)	Fused silicides
		Fused aluminides except for resistance heating elements
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides
		Mixtures thereof (4)
F. Sputter Deposition	**Superalloys**	Alloyed silicides
		Alloyed aluminides (2)
		Noble metal modified aluminides (3)
		MCrA1X (5)
		Modified zirconia (12)
		Platinum
		Mixtures thereof (4)
	Ceramics and low-expansion glasses (14)	Silicides
		Platinum
		Mixtures thereof (4)
		Dielectric layers (15)
	Titanium alloys (13)	Borides
		Nitrides
		Oxides
		Silicides
		Aluminides
		Alloyed aluminides (2)
		Carbides
	Carbon-carbon, ceramic and metal **matrix composites**	Silicides
		Carbides

a (The numbers in parenthesis refer to the Notes following this Table.)

1	*2*	*3*
Coating Process (1)	*Substrate*	*Resultant Coating*
		Refractory metals
		Mixtures thereof (4)
		Dielectric layers (15)
	Cemented tungsten carbide (16), silicon carbide	Carbides
		Tungsten
		Mixtures thereof (4)
		Dielectric layers (15)
	Molybdenum and molybdenum alloys	Dielectric layers (15)
Beryllium and beryllium alloys	Borides	
Sensor window materials (9)	Dielectric layers (15)	
		Dielectric layers (15)
	Refractory metals and alloys (8)	Aluminides
		Silicides
		Oxides
		Carbides
G. Ion Implantation	High temperature bearing steels	Additions of chromium, tantalum or niobium (columbium)
	Titanium alloys (13)	Borides
		Nitrides
	Beryllium and beryllium alloys	Borides
	Cemented tungsten carbide(16)	Carbides
		Nitrides

a (The numbers in parenthesis refer to the Notes following this Table.)

Table—Deposition Techniques—Notes

1. The term "coating process" includes coating repair and refurbishing as well as original coating.

2. The term "alloyed aluminide coating" includes single or multiple-step coatings in which an element or elements are deposited prior to or during application of the aluminide coating, even if these elements are deposited by another coating process. It does not, however, include the multiple use of single-step pack cementation processes to achieve alloyed aluminides.

3. The term "noble metal modified aluminide" coating includes multiple-step coatings in which the noble metal or noble metals are laid down by some other coating process prior to application of the aluminide coating.

4. Mixtures consist of infiltrated material, graded compositions, co-deposits and multilayer deposits and are obtained by one or more of the coating processes specified in the Table.

5. MCrA1X refers to a coating alloy where M equals cobalt, iron, nickel or combinations thereof and X equals hafnium, yttrium, silicon, tantalum in any amount or other intentional additions over 0.01 weight percent in various proportions and combinations;

except:

(a) CoCrAlY coatings which contain less than 22 weight percent of chromium, less than 7 weight percent of aluminium and less than 2 weight percent of yttrium;

(b) CoCrAlY coatings which contain 22 to 24 weight percent of chromium, 10 to 12 weight percent of aluminium and 0.5 to 0.7 weight percent of yttrium; or

(c) NiCrAlY coatings which contain 21 to 23 weight percent of chromium, 10 to 12 weight percent of aluminium and 0.9 to 1.1 weight percent of yttrium.

6. The term "aluminium alloys" means alloys having an ultimate tensile strength of 190 MPa or more measured at 293 K (20°C).

7. The term "corrosion resistant steel" means AISI (American Iron and Steel Institute) 300 series or equivalent national standard steels.

8. Refractory metals consist of the following metals and their alloys: niobium (columbium), molybdenum, tungsten and tantalum.

9. Sensor window materials, as follows: alumina, silicon, germanium, zinc sulphide, zinc selenide, gallium arsenide and the following metal halides: potassium iodide, potassium fluoride, or sensor window materials of more than 40 mm diameter for thallium bromide and thallium chlorobromide.

10. **Technology** for single-step pack cementation of solid airfoils is not specified in Category 2.

11. Polymers, as follows: polyimide, polyester, polysulphide, polycarbonates and polyurethanes.

12. Modified zirconia refers to additions of other metal oxides, e.g., calcia, magnesia, yttria, hafnia, rare earth oxides, etc., to zirconia in order to stabilise certain crystallographic phases and phase compositions. Thermal barrier coatings made of zirconia, modified with calcia or magnesia by mixing or fusion, are not controlled.

13. Titanium alloys refers to aerospace alloys having an ultimate tensile strength of 900 MPa or more measured at 293 K (20°C).

14. Low-expansion glasses refers to glasses which have a coefficient of thermal expansion of $1 \times 10_{-7}\ K_{-1}$ or less measured at 293 K (20°C).

15. Dielectric layers are coatings constructed of multi-layers of insulator materials in which the interference properties of a design composed of materials of various refractive indices are used to reflect, transmit or absorb various wavelength bands. Dielectric layers refers to more than four dielectric layers or dielectric/metal **composite** layers.

16. Cemented tungsten carbide does not include cutting and forming tool materials consisting of tungsten carbide/(cobalt, nickel), titanium carbide/(cobalt, nickel), chromium carbide/nickel-chromium and chromium carbide/nickel.

17. Processes specified in Column 1 of the Table are defined as follows:

(a) Chemical Vapour Deposition (CVD) is 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.

Notes:

(1) CVD includes the following processes: directed gas flow out-of-pack deposition, pulsating CVD, controlled nucleation thermal decomposition (CNTD), plasma enhanced or plasma assisted CVD processes.

(2) Pack denotes a substrate immersed in a powder mixture.

(3) The gaseous reactants used in the out-of-pack process are produced using the same basic reactions and parameters as the pack cementation process, except: that the substrate to be coated is not in contact with the powder mixture.

(b) Thermal Evaporation-Physical Vapour Deposition (TE-PVD) is 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;

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.

   Note:

   Cathodic arc deposition does not include random cathodic arcdeposition with non-biased substrates.

(c) Ion plating is 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 in order 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.

(d) Pack cementation is a 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 aluminium, 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 is contained within a retort which is heated to between 1,030 K (757°C) and 1,375 K (1,102°C) for sufficient time to deposit the coating.

(e) Plasma spraying is an 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. Plasma spraying constitutes either low pressure plasma spraying or high velocity plasma spraying carried out underwater.

Notes:

(1) Low pressure means less than ambient atmospheric pressure.

(2) High velocity refers to nozzle-exit gas velocity exceeding750 m/s calculated at 293 K (20°C) at 0.1 MPa.

(f) Slurry deposition is 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, subsequent air or oven drying, and heat treatment to obtain the desired coating.

(g) Sputter deposition is 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.

Notes:

(1) The Table refers only to triode, magnetron or reactive sputter deposition which is used to increase adhesion of the coating and rate of deposition and to radio frequency (RF) augmented sputter deposition used to permit vaporization of non-metallic coating materials.

(2) Low-energy ion beams (less than 5 keV) can be used to activatethe deposition.

(h) Ion implantation is 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 vapour deposition or sputter deposition.

(2E101) **Technology required** for the **use** of equipment or **software** specified in entries 2B004, 2B104, 2B115, 2B116 or 2D101.

(2E201) **Technology required** for the **use** of equipment or **software** specified in entries 2A225, 2A226, 2B001,2B006, head b. of entry 2B007, head c. of entry 2B007, or entries 2B008, 2B009, 2B204, 2B207, 2B215, 2B225 to 2B232 or 2D201.

(2E301) **Technology required** for the **use** of **goods** specified in entries 2B350 to 2B352.

Category 3—Electronics

Equipment, Assemblies and Components

3A.—(3A) *Notes:*

(1) The control on export of equipment, devices and components described in entries 3A001 or 3A002, other than those described in sub-heads a.3. to a.10. or sub-head a.12. of entry 3A001, which are specially designed for, or which have the same functional characteristics as other equipment, is determined by the export control requirements applying to that other equipment.

(2) The control on export of integrated circuits described in sub-heads a.3. to a.9. or sub-head a.12. of entry 3A001, which are unalterably programmed or designed for a specific function in a piece of equipment, is determined by the export control requirements applying to that other equipment.

N.B.:

(1) When the export control requirements applying to the equipment cannot be determined, the integrated circuits are evaluated against the parameters in entry 3A001.

(2) For silicon based **microcomputer microcircuits** or micro-controller microcircuits, having an operand (data) word length of 8 bits or less, the export control requirements thereof are determined only in sub-head a.3. of entry 3A001.

Electronic devices and components:

(a) General purpose integrated circuits, as follows:

Notes:

(1) Wafers (finished or unfinished), in which the function has been determined, are evaluated against the parameters of this head.

(2) Integrated circuits include the following types:

Monolithic integrated circuits;

Hybrid integrated circuits;

Multichip integrated circuits;

Film type integrated circuits, including silicon-on-sapphire integrated circuits;

Optical integrated circuits.

(1) Integrated circuits, designed or rated as radiation hardened to withstand either of the following:

(a) a total dose of 5×10^5 rads(Si), or higher; or

(b) a dose rate upset of 5×10^8 rads(Si)/s or higher;

Note:

For integrated circuits designed or rated against neutron or transient ionising radiation, see Group 1 of Part III of this Schedule.

(2) **Microprocessor microcircuits, microcomputer microcircuits,** microcontroller microcircuits, electrical erasable programmable read-only memories (EEPROMs), static random-access memories (SRAMs), storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or **optical integrated circuits** for **signal processing,** field programmable gate arrays, field programmable logic arrays, neural network integrated circuits, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, or Fast Fourier Transform (FFT) processors, as follows:

(a) Rated for operation at an ambient temperature above 398 K (125°C);

(b) Rated for operation at an ambient temperature below 218 K (-55°C); or

(c) Rated for operation over the entire ambient temperature range from 218 K (-55°C) to 398 K (125°C);

Note:

This sub-head does not apply to integrated circuits for civil automobiles or railway train applications.

(3) **Microprocessor microcircuits, microcomputer microcircuits** and microcontroller microcircuits, having any of the following:*Note:* Sub-head a.3. of this entry includes digital signal processors, digital array processors and digital coprocessors.

(a) An arithmetic logic unit with an access width of 32 bit or more and a **composite theoretical performance** (CTP) of 80 million theoretical operations per second (Mtops) or more;

(b) Manufactured from a compound semiconductor and operating at a clock frequency exceeding 40 MHz; or

(c) More than one data or instruction bus or serial communication port for external interconnection in a parallel processor with a transfer rate exceeding 2.5 Mbyte/s;

(4) Electrically erasable programmable read-only memories (EEPROMs) static random-access memories (SRAMs) and storage integrated circuits manufactured from a compound semiconductor, as follows:

(a) EEPROMs with a storage capacity:

(1) Exceeding 16 Mbit per package for flash memory types; or

(2) Exceeding either of the following limits for all other EEPROMtypes:

(a) 4 Mbit per package; or

(b) 1 Mbit per package and having a maximum access time of lessthan 80 ns;

(b) SRAMs with a storage capacity:

(1) Exceeding 4 Mbit per package; or

(2) Exceeding 1 Mbit per package and having a maximum access time of less than 20 ns;

(c) Storage integrated circuits manufactured from a compoundsemiconductor;

(5) Analogue-to-digital and digital-to-analogue converter integrated circuits, as follows:

(a) Analogue-to-digital converters having any of the following:

(1) A resolution of 8 bit or more, but less than 12 bit, with a total conversion time to maximum resolution of less than 10 ns;

(2) A resolution of 12 bit with a total conversion time to maximumresolution of less than 200 ns; or

(3) A resolution of more than 12 bit with a total conversion time to maximum resolution of less than 2 microseconds;

(b) Digital-to-analogue converters with a resolution of 12 bit or more, and a **settling time** of less than 10 ns;

(6) Electro-optical or **optical integrated circuits** for **signal processing** having all of the following:

(a) One or more internal **laser** diodes;

(b) One or more internal light detecting elements; and

(c) Optical waveguides;

(7) Field programmable gate arrays having either of the following:

(a) An equivalent usable gate count of more than 30,000 (2 input gates); or

(b) A typical **basic gate propagation delay time** of less than 0.4 ns;

(8) Field programmable logic arrays having either of the following:

(a) An equivalent usable gate count of more than 30,000 (2 input gates); or

(b) A toggle frequency exceeding 133 MHz;

(9) Neural network integrated circuits;

(10) Custom integrated circuits, for which either the function is unknown, or the control status of the equipment in which the integrated circuit will be used is unknown, having any of the following:

(a) More than 144 terminals;

(b) A typical **basic gate propagation delay time** of less than 0.4 ns; or

(c) An operating frequency exceeding 3 GHz;

(11) Digital integrated circuits based upon any compound semiconductor and having either of the following:

(a) An equivalent gate count of more than 300 (2 input gates); or

(b) A toggle frequency exceeding 1.2 GHz;

Note: This sub-head does not apply to **microprocessor microcircuits, microcomputer microcircuits,** microcontroller microcircuits, electrical erasable programmable read-only memories (EEPROMs), static random-access memories (SRAMs), storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, digital-to-analogue converters, electro-optical or **optical integrated circuits** for **signal processing,** field programmable gate arrays, field programmable logic arrays, neural network integrated circuits, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, or Fast Fourier Transform (FFT) processors.

(12) Fast Fourier Transform (FFT) processors having any of the following:

(a) A rated execution time for a 1,024 point complex FFT of less than 1 ms;

(b) A rated execution time for an N-point complex FFT of other than 1,024 points of less than $N \log_2 N/10{,}240$ ms, where N is the number of points; or

(c) A butterfly throughput of more than 5.12 MHz;

(b) Microwave or millimetre wave devices:

(1) Electronic vacuum tubes and cathodes, as follows:

Notes:

1. For frequency agile magnetron tubes, see entry ML11 in Group 1 of Part III of this Schedule.

2. Sub-head b.1. of this entry does not specify tubes designed or rated to operate in the Standard Civil Telecommunications Bands at frequencies not exceeding 31 GHz.

a. Travelling wave tubes, pulsed or continuous wave, as follows:

1. Operating at frequencies higher than 31 GHz;

2. Having a cathode heater element with a turn on time to rated RF power of less than 3 seconds;
3. Coupled cavity tubes, or derivatives thereof with an **instantaneous bandwidth** of more than 7% or a peak power exceeding 2.5 kW;
4. Helix tubes, or derivatives thereof, with any of the following characteristics:
    a. An **instantaneous bandwidth** of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0.5;
    b. An **instantaneous bandwidth** of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1; or
    c. **Space qualified;**

b. Crossed-field amplifier tubes with a gain of more than 17 dB;
c. Impregnated cathodes for electronic tubes, with either of the following:
    1. Having a turn on time to rated emission of less than 3 seconds; or
    2. Producing a continuous emission current density at rated operating conditions exceeding 5 A/cm^2;

(2) Microwave integrated circuits or modules containing **monolithic integrated circuits** operating at frequencies exceeding 3 GHz;

Note: Sub-head b.2. of this entry does not specify circuits or modules for equipment designed or rated to operate in the Standard Civil Telecommunications Bands at frequencies not exceeding 31 GHz.

(3) Microwave transistors rated for operation at frequencies exceeding 31 GHz;

(4) Microwave solid state amplifiers, as follows:

(a) Operating at frequencies exceeding 10.5 GHz and having an **instantaneous bandwidth** of more than half an octave;

(b) Operating at frequencies exceeding 31 GHz;

(5) Electronically or magnetically tunable band-pass or band-stop filters having more than 5 tunable resonators capable of tuning across a 1.5:1 frequency band (f_{max}/f_{min}) in less than 10 microseconds with either:

(a) A band-pass bandwidth of more than 0.5% of centre frequency; or

(b) A band-stop bandwidth of less than 0.5% of centre frequency;

(6) Microwave assemblies capable of operating at frequencies exceeding 31 GHz;

(7) Mixers and converters designed to extend the frequency range of equipment described in heads c., e. or f. of entry 3A002 beyond the limits stated therein;

(c) Acoustic wave devices, as follows, and specially designed components therefor:

(1) Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices (i.e., **signal processing** devices employing elastic waves in materials), having any of the following:

(a) A carrier frequency exceeding 2.5 GHz;

(b) A carrier frequency of 2.5 GHz or less, and:

(1) A frequency side-lobe rejection exceeding 55 dB;

(2) A product of the maximum delay time and the bandwidth (time in microseconds and bandwidth in MHz) of more than 100; or

(3) A dispersive delay of more than 10 microseconds; or

(c) A carrier frequency exceeding 1 GHz and a bandwidth of 250 MHz or more;

(2) Bulk (volume) acoustic wave devices (i.e., **signal processing** devices employing elastic waves) which permit direct processing of signals at frequencies exceeding 1 GHz;

(3) Acoustic-optic **signal processing** devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves which permit the direct processing of signals or images, including spectral analysis, correlation or convolution;

(d) Electronic devices or circuits containing components, manufactured from **superconductive** materials specially designed for operation at temperatures below the **critical temperature** of at least one of the **superconductive** constituents, with any of the following:

(1) Electromagnetic amplification:

(a) At frequencies equal to or less than 31 GHz with a noise figure of less than 0.5 dB; or

(b) At frequencies exceeding 31 GHz;

(2) Current switching for digital circuits using **superconductive** gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than 10^{-14} J; or

(3) Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

(e) High energy devices, as follows:

(1) Batteries, as follows:

Note: Sub-head e.1. of this entry does not specify batteries with volumes equal to or less than 27 cm^3 (e.g., standard C-cells or R14 batteries).

(a) Primary cells and batteries having an energy density exceeding 480 Wh/kg and rated for operation in the temperature range from below 243 K (-30°C) to above 343 K (70°C);

(b) Rechargeable cells and batteries having an energy density exceeding 150 Wh/kg after 75 charge/discharge cycles at a discharge current equal to C/5 hours (C being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K (-20°C) to above 333 K (60°C);

Note: Energy density is obtained by multiplying the average power in watts (average voltage in volts times average current in amperes) by the duration of the discharge in hours to 75% of the open circuit voltage divided by the total mass of the cell (or battery) in kg.

(c) **Space qualified** and radiation hardened photovoltaic arrays with a specific power exceeding 160 W/m^2 at an operating temperature of 301 K (28°C) under a tungsten illumination of 1 kW/m^2 at 2,800 K (2,527°C);

(2) High energy storage capacitors, as follows(**23**):

(**23**) See also entry 3A201.a.

(a) Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) having all of the following:

(1) A voltage rating equal to or more than 5 kV;

(2) An energy density equal to or more than 250 J/kg; and

(3) A total energy equal to or more than 25 kJ;

(b) Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) having all of the following:

(1) A voltage rating equal to or more than 5 kV;

(2) An energy density equal to or more than 50 J/kg;

(3) A total energy equal to or more than 100 J; and

(4) A charge/discharge cycle life equal to or more than 10,000;

(3) **Superconductive** electromagnets or solenoids specially designed to be fully charged or discharged in less than one second, having all of the following(**24**):

(a) Energy delivered during the discharge exceeding 10 kJ in the first second;

(b) Inner diameter of the current carrying windings of more than 250 mm; and

(c) Rated for a magnetic induction of more than 8 T or **overall current density** in the winding of more than 300 A/mm^2;

Note: Sub-head e.3. of this entry does not specify **superconductive** electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

(4) Circuits or systems for electromagnetic energy storage, containing components manufactured from **superconductive** materials specially designed for operation at temperatures below the **critical temperature** of at least one of their **superconductive** constituents, having all of the following:

(a) Resonant operating frequencies exceeding 1 MHz;

(b) A stored energy density of 1 MJ/m^3 or more; and

(c) A discharge time of less than 1 ms;

(5) Flash discharge type X-ray systems, and tubes therefor, having all of the following(**25**):

(a) A peak power exceeding 500 MW;

(b) An output voltage exceeding 500 kV; and

(c) A pulse width of less than 0.2 microsecond;

(f) Rotary input type shaft absolute position encoders having either of the following:

(1) A resolution of better than 1 part in 265,000 (18 bit resolution) of full scale; or

(2) An accuracy better than ± 2.5 seconds of arc.

(3A002) General purpose electronic equipment:

(a) Recording equipment, as follows, and specially designed test tape therefor:

(1) Analogue instrumentation magnetic tape recorders, including those permitting the recording of digital signals (e.g., using a high density digital recording (HDDR) module), having any of the following:

(**24**) See also entry 3A201.b.
(**25**) See also entry 3A101.b. and 3A201.c.

(a) A bandwidth exceeding 4 MHz per electronic channel or track;

(b) A bandwidth exceeding 2 MHz per electronic channel or track and having more than 42 tracks; or

(c) A time displacement (base) error, measured in accordance with applicable Inter Range Instrumentation Group (IRIG) or Electronic Industries Association (EIA) documents, of less than ± 0.1 microsecond;

(2) Digital video magnetic tape recorders having a maximum digital interface transfer rate exceeding 180 Mbit/s, except: those specially designed for television recording using a signal format standardized or recommended by the International Radio Consultative Committee (CCIR) or the International Technical Commission (IEC) for civil television applications;

(3) Digital instrumentation magnetic tape data recorders employing helical scan techniques or fixed head techniques, having either of the following:

(a) A maximum digital interface transfer rate exceeding 175 Mbit/s; or

(b) **Space qualified;**

Note: Sub-head a.3. of this entry does not specify analogue magnetic tape recorders equipped with HDDR conversion electronics and configured to record only digital data.

(4) Equipment, with a maximum digital interface transfer rate exceeding 175 Mbit/s, designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;

(5) Waveform digitisers and transient recorders with both of the following(**26**):

(a) Digitising rates equal to or more than 200 million samples per second and a resolution of 10 bits or more; and

(b) A continuous throughput of 2 Gbits/s or more;

Note: For those instruments with a parallel bus architecture, the continuous throughput rate is the highest word rate multiplied by the number of bits in a word. In this entry, "continuous throughput" means the fastest data rate the instrument can output to mass storage without the loss of any information whilst sustaining the sample rate and analogue-to-digital conversion.

(b) **Frequency synthesiser electronic assemblies** having a **frequency switching time** from one selected frequency to another of less than 1 ms;

(c) **Signal analysers,** as follows:

(1) Capable of analysing frequencies exceeding 31 GHz;

(2) **Dynamic signal analysers** with a **real-time bandwidth** exceeding 25.6 kHz; except:

Those using only constant percentage bandwidth filters (also known as octave or fractional octave filters);

(d) Frequency synthesised signal generators producing output frequencies, the accuracy and short term and long term stability of which are controlled, derived from or disciplined by the internal master frequency, and having any of the following:

(1) A maximum synthesised frequency exceeding 31 GHz;

(**26**) See also entry 3A202.

(2) A **frequency switching time** from one selected frequency to another of less than 1 ms; or

(3) A single sideband (SSB) phase noise better than -(126 + 20 $\log_{10}$F − 20 $\log_{10}$f) in dBc/Hz, where F is the off-set from the operating frequency in Hz and f is the operating frequency in MHz;

Note: Head d. of this entry does not specify equipment in which the output frequency is either produced by the addition or subtraction of two or more crystal oscillator frequencies, or by an addition or subtraction followed by a multiplication of the result.

(e) Network analysers with a maximum operating frequency exceeding 31 GHz;

Note: Head e. of this entry does not specify **swept frequency network analysers** with a maximum operating frequency not exceeding 40 GHz and which do not contain a data bus for remote control interfacing.

(f) Microwave test receivers with both of the following:

(1) A maximum operating frequency exceeding 31 GHz; and

(2) Capable of measuring amplitude and phase simultaneously;

(g) Atomic frequency standards having either of the following characteristics:

(1) Long term stability (aging) less (better) than 1×10^{-11}/month; or

Note: Sub-head g.1. of this entry does not specify non-**space qualified** rubidium standards.

(2) **Space qualified;**

(h) Emulators for microcircuits specified in sub-heads a.3. or a.9. of entry 3A001.

Note: Head h. of this entry does not specify emulators designed for a **family** which contains at least one device not specified in sub-heads a.3. or a.9. of entry 3A001.

(3A101) Electronic devices and components, other than those specified in entry 3A001, as follows:

(a) Analogue-to-digital converters, usable in **missiles,** designed to meet military specifications for ruggedized equipment;

(b) Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and systems containing those accelerators.

Note: Head b of this entry does not specify goods specially designed for medical purposes.

(3A201) Electronic devices and components, other than those specified in entry 3A001, as follows:

(a) Capacitors with the following characteristics:

(1) Voltage rating greater than 1.4 kV, energy storage greater than 10J, capacitance greater than 500 nF and series inductance less than 50 nH; or

(2) Voltage rating greater than 750 V, capacitance greater than 250 nF and series inductance less than 10 nH;

(b) Superconducting solenoidal electromagnets with all of the following characteristics:

(1) Capable of creating magnetic fields of more than 2 Teslas (20 kilogauss);

(2) With an L/D ratio (length divided by inner diameter) greater than 2;

(3) With an inner diameter of more than 300 mm; and

(4) With a magnetic field uniform to better than 1% over the central 50% of the inner volume.

Note: Head b. of this entry does not specify magnets specially designed for and exported as parts of medical nuclear magnetic resonance (NMR) imaging systems. In this entry, "as part of" does not necessarily mean physical part in the same shipment; separate shipments from different sources are allowed, provided the related export documents clearly specify that the shipments are dispatched "as part of" the same imaging systems.

(c) Flash X-ray generators or pulsed electron accelerators with peak energy of 500 keV or greater, as follows;

except:

Accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) and those designed for medical purposes:

1. Having an accelerator peak electron energy of 500 keV or greater but less than 25 MeV and with a figure of merit (K) of 0.25 or greater, where K is defined as:

$K = 1.7 \times 10^3 V^{2.65} Q$;

where

V is the peak electron energy in million electron volts and Q is the total accelerated charge in coulombs if the accelerator beam pulse duration is less than or equal to 1 microsecond; if the accelerator beam pulse duration is greater than 1 microsecond, Q is the maximum accelerated charge in 1 microsecond [Q equals the integral of i with respect to t, over the lesser of 1 microsecond or the time duration of the beam pulse (Q = [integral] idt), where i is beam current in amperes and t is time in seconds]; or

2. Having an accelerator peak electron energy of 25 MeV or greater and a peak power greater than 50 MW. [Peak power = (peak potential in volts) × (peak beam current in amperes)].

Notes:

1. Time duration of the beam pulse—In machines, based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 microsecond or the duration of the bunched beam packet resulting from one microwave modulator pulse.
2. Peak beam current—In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.

(3A202) Oscilloscopes and transient recorders other than those specified in sub-head a.5. of entry 3A002, as follows; and specially designed components therefor:

(a) Non-modular analogue oscilloscopes having a bandwidth of 1 GHz or greater;

(b) Modular analogue oscilloscope systems having either of the following characteristics:

(1) A mainframe with a bandwidth of 1 GHz or greater; or

(2) Plug-in modules with an individual bandwidth of 4 GHz or greater;

(c) Analogue sampling oscilloscopes for the analysis of recurring phenomena with an effective bandwidth greater than 4 GHz;

(d) Digital oscilloscopes and transient recorders, using analogue-to-digital conversion techniques, capable of storing transients by sequentially sampling single-shot inputs at

successive intervals of less than 1 ns (greater than 1 giga-sample per second), digitizing to 8 bits or greater resolution and storing 256 or more samples.

Notes:

(1) Specially designed components specified in this entry are the following, for analogue oscilloscopes:

(a) Plug-in units;

(b) External amplifiers;

(c) Pre-amplifiers;

(d) Sampling devices;

(e) Cathode ray tubes.

(2) In this entry, the term "bandwidth" means the band of frequencies over which the deflection on the cathode ray tube does not fall below 70.7% of that at the maximum point measured with a constant input voltage to the oscilloscope amplifier.

(3A225) Frequency changers (also known as converters or inverters) or generators, other than those specified in entry B10b.2.k. of Group 2 of Part III of this Schedule, having all of the following characteristics:

(a) A multiphase output capable of providing a power of 40 W or more;

(b) Capable of operating in the frequency range between 600 and 2000 Hz;

(c) Total harmonic distortion below 10%; and

(d) Frequency control better than 0.1%.

(3A226) Direct current high-power supplies capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater and with current or voltage regulation better than 0.1%.

(3A227) High-voltage direct current power supplies capable of continuously producing, over a time period of 8 hours, 20,000 V or greater with current output of 1 A or greater and with current or voltage regulation better than 0.1%.

(3A228) Switching devices, as follows:

(a) Cold-cathode tubes (including gas krytron tubes and vacuum sprytron tubes), whether gas filled or not, operating similarly to a spark gap, containing three or more electrodes, and having all of the following characteristics:

(1) Anode peak voltage rating of 2,500 V or more;

(2) Anode peak current rating of 100 A or more; and

(3) Anode delay time of 10 microsecond or less;

(b) Triggered spark-gaps having an anode delay time of 15 microsecond or less and rated for a peak current of 500 A or more;

(c) Modules or assemblies with a fast switching function having all of the following characteristics:

(1) Anode peak voltage rating greater than 2,000 V;

(2) Anode peak current rating of 500 A or more; and

(3) Turn-on time of 1 microsecond or less.

(3A229) Firing sets and equivalent high-current pulse generators (for controlled detonators), as follows(**27**):

(**27**) See also Group 1 of Part III of this Schedule.

(a) Explosive detonator firing sets designed to drive multiple controlled detonators specified in entry 3A232;

(b) Modular electrical pulse generators (pulsers) designed for portable, mobile or ruggedized use (including xenon flash-lamp drivers) having all the following characteristics:

(1) Capable of delivering their energy in less than 15 microsecond;

(2) Having an output greater than 100 A;

(3) Having a rise time of less than 10 microsecond into loads of less than 40 ohms (rise time is the time interval from 10% to 90% current amplitude when driving a resistive load);

(4) Enclosed in a dust-tight enclosure;

(5) No dimension greater than 254 mm;

(6) Weight less than 25 kg; and

(7) Specified for use over an extended temperature range (223 K [-50°C] to 373 K [100°C]) or specified as suitable for aerospace use.

(3A230) High-speed pulse generators with output voltages greater than 6 volts into a less than 55 ohm resistive load, and with pulse transition times less than 500 picoseconds.

In this entry, "pulse transition time" means the time interval between 10% and 90% voltage amplitude.

(3A231) Neutron generator systems, including tubes, designed for operation without an external vacuum system and utilizing electrostatic acceleration to induce a tritium-deu-terium nuclear reaction.

(3A232) Detonators and multipoint initiation systems, as follows(**28**):

(a) Electrically driven explosive detonators, the following:

(1) Exploding bridge (EB);

(2) Exploding bridge wire (EBW);

(3) Slapper;

(4) Exploding foil initiators (EFI);

(b) Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface (over greater than 5000 mm^2) from a single firing signal (with an initiation timing spread over the surface of less than 2.5 microseconds).

Notes:

(1) This entry does not specify detonators using only primary explosives, such as lead azide.

(2) The detonators in this entry all utilise a small electrical conductor (bridge, bridge wire or foil) that explosively vaporizes when a fast, high-current electrical pulse is passed through it. In nonslapper types, the exploding conductor starts a chemical detonation in a contacting high-explosive material such as PETN (Pentaerythritoltetranitrate). In slapper detonators, the explosive vaporization of the electrical conductor drives a flyer or slapper across a gap and the impact of the slapper on an explosive starts a chemical detonation. The slapper in some designs is driven by a magnetic force. The term 'exploding foil' detonator may refer to either an EB or a slapper-type detonator.

(**28**) See also Group 1 of Part III of this Schedule.

(3A233) Mass spectrometers, other than those specified in entry B20g. of Group 2 of Part III of this Schedule, capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, as follows; and ion sources therefor:

(a) Inductively coupled plasma mass spectrometers (ICP/MS);

(b) Glow discharge mass spectrometers (GDMS);

(c) Thermal ionization mass spectrometers (TIMS);

(d) Electron bombardment mass spectrometers which have a source chamber constructed from, lined with or plated with materials resistant to UF_6;

(e) Molecular beam mass spectrometers as follows:

(1) Which have a source chamber constructed from, lined with or plated with stainless steel or molybdenum and have a cold trap capable of cooling to 193 K (-80°C) or less; or

(2) Which have a source chamber constructed from, lined with or plated with materials resistant to UF_6; or

(f) Mass spectrometers equipped with a microfluorination ion source designed for use with actinides or actinide fluorides.

(3A990) Apparatus or devices, other than those specified in entry PL5006 of Group 1 of Part III of this Schedule or entries 3A229 to 3A232 of this Group, designed for the handling, control, discharging, decoying, jamming, detonation, disruption or detection of explosive devices or **improvised explosive devices**;

except:

1. Inspection devices not employing electronic management;

2. X-ray apparatus or devices, not specified elsewhere in this Group.

3B Test, Inspection and Production Equipment

(3B) Equipment for the manufacture or testing of semiconductor devices or materials, as follows, and specially designed components and accessories therefor:

(3B001) **Stored programme controlled** equipment for epitaxial growth, as follows:

(a) Capable of producing a layer thickness uniform to less than ± 2.5% across a distance of 75 mm or more;

(b) Metal organic chemical vapour deposition (MOCVD) reactors specially designed for compound semiconductor crystal growth by the chemical reaction between materials specified in entries 3C003 or 3C004;

(c) Molecular beam epitaxial growth equipment using gas sources.

(3B002) **Stored programme controlled** equipment designed for ion implantation, having any of the following:

(a) An accelerating voltage exceeding 200 keV;

(b) Specially designed and optimized to operate at an accelerating voltage of less than 10 keV;

(c) Direct write capability; or

(d) Capable of high energy oxygen implant into a heated semiconductor material **substrate**.

(3B003) **Stored programme controlled** anisotropic plasma dry etching equipment, as follows:

(a) With cassette-to-cassette operation and load-locks, and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR);

(b) Specially designed for equipment specified in entry 3B005 and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR).

(3B004) **Stored programme controlled** plasma enhanced CVD equipment, as follows:

(a) With cassette-to-cassette operation and load-locks, and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR);

(b) Specially designed for equipment specified in entry 3B005 and having either of the following:

(1) Magnetic confinement; or

(2) Electron cyclotron resonance (ECR).

(3B005) **Stored programme controlled** automatic loading multi-chamber central wafer handling systems, having interfaces for wafer input and output, to which more than two pieces of semiconductor processing equipment are to be connected, to form an integrated system in a vacuum environment for sequential multiple wafer processing.

Note: This entry does not specify automatic robotic wafer handling systems not designed to operate in a vacuum environment.

(3B006) **Stored programme controlled** lithography equipment, as follows:

(a) Align and expose step and repeat equipment for wafer processing using photo-optical or X-ray methods, having either of the following:

(1) A light source wavelength shorter than 400 nm; or

(2) Capable of producing a pattern with a minimum resolvable feature size of 0.7 micrometre or less when calculated by the following formula:

$$\text{MRF} = \frac{(\text{wavelength in micrometre}) \times (\text{K factor})}{\text{numerical aperture}}$$

where:

"MRF" means the minimum resolvable feature size;

the "K factor" = 0.7; and

"wavelength" means the exposure light source wavelength;

(b) Equipment specially designed for mask making or semiconductor device processing using deflected focussed electron beam, ion beam or **laser** beam, with any of the following:

(1) A spot size smaller than 0.2 micrometre;

(2) Capable of producing a pattern with a feature size of less than 1 micrometre; or

(3) An overlay accuracy of better than ± 0.20 micrometre (3 sigma).

(3B007) Masks or reticles, as follows:

(a) For integrated circuits specified in entry 3A001;

(b) Multi-layer masks with a phase shift layer.

(3B008) **Stored programme controlled** test equipment, specially designed for testing semiconductor devices and unencapsulated dice, as follows:

(a) For testing S-parameters of transistor devices at frequencies exceeding 31 GHz;

(b) For testing integrated circuits, and capable of performing functional (truth table) testing at a pattern rate of more than 40 MHz;

Note: Head b. of this entry does not specify test equipment specially designed for testing:

(1) **Electronic assemblies** or a class of **electronic assemblies** for home or entertainment applications;

(2) Electronic components, **electronic assemblies** or integrated circuits not specified in this Group.

(c) For testing microwave integrated circuits at frequencies exceeding 3 GHz;

Note: Head c. of this entry does not specify test equipment specially designed for testing microwave integrated circuits for equipment designed or rated to operate in the Standard Civil Telecommunication Bands at frequencies not exceeding 31 GHz.

(d) Electron beam systems designed for operation at or below 3 keV, or **laser** beam systems, for the non-contactive probing of powered-up semiconductor devices, with both of the following:

(1) Stroboscopic capability with either beam-blanking or detector strobing; and

(2) An electron spectrometer for voltage measurement with a resolution of less than 0.5 V.

Note: Head d. of this entry does not specify scanning electron microscopes; except: when specially designed and instrumented for the non-contactive probing of powered-up semiconductor devices.

3C Materials

(3C001) Hetero-epitaxial materials consisting of a **substrate** with stacked epitaxially grown multiple layers of:

(a) Silicon;

(b) Germanium; or

(c) III/V compounds of gallium or indium.

Note: III/V compounds are polycrystalline or binary or complex monocrystalline products consisting of elements of groups IIIA and VA of Mendeleyev's periodic classification table (gallium arsenide, gallium-aluminium arsenide, indium phosphide, etc.).

(3C002) Resist materials, as follows, and **substrates** coated with controlled resists:

(a) Positive resists for semiconductor lithography specially adjusted (optimised) for use at wavelengths below 370 nm;

(b) All resists, for use with electron beams or ion beams, with a sensitivity of 0.01 microcoulomb/mm^2 or better;

(c) All resists, for use with X-rays, with a sensitivity of 2.5 mJ/mm^2 or better;

(d) All resists optimized for surface imaging technologies, including silylated resists.

Note: Silylation techniques are defined as processes incorporating oxidation of the resist surface to enhance performance for both wet and dry developing.

(3C003) Organo-inorganic compounds as follows:

(a) Organo-metallic compounds of aluminium, gallium or indium, having a purity (metal basis) better than 99.999%;

(b) Organo-arsenic, organo-antimony and organo-phosphorus compounds having a purity (inorganic element basis) better than 99.999%.

Note: This entry only specifies compounds whose metallic, partly metallic or non-metallic element is directly linked to carbon in the organic part of the molecule.

(3C004) Hydrides of phosphorus, arsenic or antimony, having a purity better than 99.999%, even diluted in inert gases or hydrogen.

Note: This entry does not specify hydrides containing 20% molar or more of inert gases or hydrogen.

3D Software

(3D001) Software specially designed for the **development** or **production** of **goods** specified in head b. of entry 3A001 to head h. of entry 3A002 or Sub-category 3B.

(3D002) **Software** specially designed for the **use** of **stored programme controlled** equipment specified in sub-category 3B.

(3D003) Computer-aided-design (CAD) **software** for semiconductor devices or integrated circuits, having any of the following:

(a) Design rules or circuit verification rules;

(b) Simulation of the physically laid out circuits; or

(c) Lithographic processing simulators for design.

Note: A lithographic processing simulator is a **software** package used in the design phase to define the sequence of lithographic, etching and deposition steps for translating masking patterns into specific topographical patterns in conductors, dielectrics or semiconductor material.

Note: This entry does not specify **software** specially designed for schematic entry, logic simulation, placing and routing, layout verification or pattern generation tape.

N.B.: Libraries, design attributes or associated data for the design of semiconductor devices or integrated circuits are considered as **technology.**

(3D101) **Software** specially designed for the **use** of **goods** specified in head b. of entry 3A101.

3E Technology

(3E001) **Technology required** for the **development** or **production** of **goods** specified in sub-categories 3A, 3B or 3C;

Note: This entry does not specify **technology** for the **development** or **production** of:

(a) Microwave transistors operating at frequencies below 31 GHz;

(b) Integrated circuits specified in sub-heads a.3. to a.12. of entry 3A001, having both of the following characteristics:

(1) Using technology of one micrometre or more; and

(2) Not incorporating multi-layer structures.

N.B.: This Note does not preclude the export of multilayer technology for devices incorporating a maximum of two metal layers and two polysilicon layers.

(3E002) Other **technology** for the **development** or **production** of:

(a) Vacuum microelectronic devices;

(b) Hetero-structure semiconductor devices such as high electron mobility transistors (HEMT), hetero-bipolar transistors (HBT), quantum well or super lattice devices;

(c) **Superconductive** electronic devices;

(d) Substrates of films of diamond for electronic components.

(3E101) **Technology required** for the **use** of **goods** specified in sub-heads a.1. or a.2. of entry 3A001, entries 3A101 or 3D101.

(3E102) **Technology required** for the **development** of **software** specified in entry 3D101.

(3E201) **Technology required** for the **use** of **goods** specified in sub-head e.2. of entry 3A001, sub-head e.3. of entry 3A001, sub-head e.5. of entry 3A001, or entries 3A201, 3A202, 3A225 to 3A233.

(3E990) **Technology required** for the **use** of **goods** specified in entry 3A990.

Category 4—Computers

Notes:

(1) In order to determine the export control requirements on computers, related equipment or **software** performing telecommunications or **local area network** functions they must also be evaluated against Category 5 (Part 1 – Telecommunications).

N.B.:

(1) Control units which directly interconnect the buses or channels of central processing units, **main storage** or disk controllers are not regarded as telecommunications equipment described in Category 5 (Part 1 – Telecommunications).

(2) **Software** which provides routing or switching of **datagram** or **fast select** packets (i.e., packet by packet route selection) or of **software** specially designed for packet switching, is specified in Category 5 (Part 1 – Telecommunications).

(2) Computers, related equipment or **software** performing cryptographic, cryptanalytic, certifiable **multilevel security** or certifiable user isolation functions, or which limit electromagnetic compatibility (EMC), must also be evaluated against the performance characteristics in Category 5 (Part 2—**Information Security**).

4A Equipment, Assemblies and Components

(4A001) Electronic computers and related equipment, as follows, and **electronic assemblies** and specially designed components therefor(**29**):

(a) Specially designed to have either of the following characteristics:

(1) Rated for operation at an ambient temperature below 228 K (-45°C) or above 358 K (85°C); or

Note: Sub-head a.1 of this entry does not apply to computers specially designed for civil automobile or railway train applications.

(2) Radiation hardened to exceed any of the following specifications:

(a) Total Dose 5×10^5 Rads (Si);

(b) Dose Rate Upset 5×10^8 Rads (Si)/sec; or

(c) Single Event Upset 1×10^{-7} Error/bit/day;

Note: For equipment designed or rated for transient ionising radiation, see Group 1 of Part III of this Schedule.

(b) Having characteristics or performing functions exceeding the limits in Category 5 (Part 2—**Information Security**).

(**29**) See also entry 4A101.

(4A002) **Hybrid computers**, as follows, and **electronic assemblies** and specially designed components therefor(**30**):

(a) Containing **digital computers** specified in entry 4A003;

(b) Containing analogue-to-digital converters having both of the following characteristics:

(1) 32 channels or more; and

(2) A resolution of 14 bits (plus sign bit) or more with a conversion rate of 200,000 conversions/s or more.

(4A003) **Digital computers**, **electronic assemblies**, and related equipment therefor, as follows, and specially designed components therefor:

Notes:

1. This entry includes vector processors, array processors, digital signal processors, logic processors, and equipment for **image enhancement** or **signal processing**.

2. The control on export of **digital computers** or related equipment described in or of a type described in this entry is determined by the export control requirements applying to the other equipment or systems, provided:

a. The **digital computers** or related equipment are essential for the operation of the other equipment or systems;

b. The **digital computers** or related equipment are not a **principal element** of the other equipment or systems.

*N.B.:***Digital computers** or related equipment for telecommunications equipment, are specified in Category 5 (Part 1 – Telecommunications).

Note: The **technology** for the **digital computers** and related equipment is evaluated against sub-category 4E.

(a) Designed or modified for **fault tolerance**;

Note: For the purposes of head a. of this entry, **digital computers** and related equipment are not considered to be designed or modified for **fault tolerance** if they use:

1. Error detection or correction algorithms in **main storage**;

2. The interconnection of two **digital computers** so that, if the active central processing unit fails, an idling but mirroring central processing unit can continue the system's functioning;

3. The interconnection of two central processing units by data channels or by use of shared storage to permit one central processing unit to perform other work until the second central processing unit fails, at which time the first central processing unit takes over in order to continue the system's functioning; or

4. The synchronisation of two central processing units by **software** so that one central processing unit recognises when the other central processing unit fails and recovers tasks from the failing unit.

(b) **Digital computers** having a **composite theoretical performance** (CTP) exceeding 260 million theoretical operations per second (Mtops);

(c) **Electronic assemblies** specially designed or modified to be capable of enhancing performance by aggregation of **computing elements** so that the **composite theoretical performance** (CTP) of the aggregation exceeds the limit in head b. of this entry;

Notes:

(**30**) See also entry 4A102.

1. Head c. of this entry applies only to **electronic assemblies** and programmable interconnections not exceeding the limit of head b. of this entry, when shipped as unintegrated **electronic assemblies**. It does not apply to **electronic assemblies** inherently limited by nature of their design for use as related equipment specified in heads d. to f. of this entry.
2. Head c. of this entry does not specify **electronic assemblies** specially designed for a product or family of products whose maximum configuration does not exceed the limit of head b. of this entry.

(d) Graphics accelerators or graphics coprocessors exceeding a **3-D vector rate** of 1,600,000;

(e) Equipment performing analogue-to-digital conversions exceeding the limits in sub-head a.5. of entry 3A001;

(f) Equipment containing **terminal interface equipment** exceeding the limits in sub-head b.3. of entry 5A001;

Note: For the purposes of head f. of this entry, **terminal interface equipment** includes **local area network** interfaces, modems and other communications interfaces. **Local area network** interfaces are evaluated as **network access controllers.**

(g) Equipment specially designed to provide for the external interconnection of **digital computers** or associated equipment which allows communications at data rates exceeding 80 Mbytes/s.

Note: Head g. of this entry does not control internal interconnection equipment (e.g. backplanes and buses) or passive interconnection equipment.

(4A004) Computers, as follows, and specially designed related equipment, **electronic assemblies** and components therefor:

(a) **Systolic array computers;**

(b) **Neural computers;**

(c) **Optical computers.**

(4A101) Analogue computers, **digital computers** or digital differential analysers, other than those specified in sub-head a.1. of entry 4A001, which are ruggedized and designed or modified for use in systems specified in entries 9A004 or 9A104.

(4A102) **Hybrid Computers** specially designed for modelling, simulation or design integration of systems specified in entries 9A004 or 9A104.

Notes:

1: This entry only applies when the equipment is supplied with software specified in entries 7D103 or 9D103.

2: Software for the goods specified in this entry is determined by the export control requirements of either entry 7D103 or 9D103.

4B Test, Inspection and Production Equipment

None

4C Materials

None

4D Software

*Note:***Software** for the **development, production,** or **use** of equipment described in other Categories is dealt with in the appropriate Category. **Software** for equipment described in this Category is dealt with herein.

(4D001) **Software** specially designed or modified for the **development, production** or **use** of **goods** specified in entries 4A001 to 4A004, or sub-category 4D.

(4D002) **Software** specially designed or modified to support **technology** specified in subcategory 4E.

(4D003) Specific **software,** as follows:

(a) Operating system **software, software** development tools and compilers specially designed for **multi-data-stream processing** equipment, in **source code**;

(b) **Expert systems** or **software** for **expert system** inference engines providing both:

(1) Time dependent rules; and

(2) Primitives to handle the time characteristics of the rules and the facts;

(c) **Software** having characteristics or performing functions exceeding the limits in Category 5 (Part 2-**Information Security**);

(d) Operating systems specially designed for **real time processing** equipment which guarantees a **global interrupt latency time** of less than 20 microseconds.

4E Technology

(4E001) **Technology required** for the **development, production** or **use** of **goods** specified in sub-categories 4A or 4D.

(a) (4E002) (a) **Technology** for the **development** or **production** of **goods** designed for **multi-data-stream processing** where the **composite theoretical performance** (CTP) exceeds 120 Mtops;

(b) **Technology required** for the **development** or **production** of magnetic hard disk drives with a **maximum bit transfer rate** exceeding 47 Mbit/s.

Category 5 —Telecommunications and Information Security