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NOTE BY THE SECRETARY-GENERAL

The Secretary-General has the honour to transmit to the members of the Security Council the attached communication which he has received from the Director General of the International Atomic Energy Agency (IAEA).

Annex

Letter dated 14 July 1992 from the Director General of the International Atomic Energy Agency (IAEA) addressed to the Secretary-General

Dear Mr. Secretary-General,

With document S/22872/Rev. 1 dated 20 September 1991 you transmitted to the Security Council the revised plan of the IAEA for future ongoing monitoring and verification of Iraq's compliance with paragraph 12 of Part C of Security Council resolution 687 (1991) and with the requirements of paragraphs 3 and 5 of resolution 707 (1991). A corrigendum was issued on 10 October 1991 as document S/22872/Rev. 1/Corr. 1.

On 11 October 1991 the Security Council adopted resolution 715 (1991) in which, acting under Chapter VII of the Charter of the United Nations, inter alia, the Security Council:

- approved the plan submitted by the Director General of the IAEA contained in document S/22872/Rev. 1 and Corr. 1; and

- requested the Director General of the IAEA to carry out, with the assistance and co-operation of the Special Commission, the plan submitted by him contained in document S/22872/Rev. 1 and Corr. 1.

I wish now to refer to paragraph 41 of the IAEA plan contained in document S/22872 Rev. 1 and Corr. 1, which reads as follows:

> The plan may only be revised by the Security Council. The IAEA may, however, after informing the Security Council, update and revise the Annexes in the light of information and experience gained in the course of the implementation of resolutions 687 and 707 and of the plan. The IAEA shall inform Iraq of any such change.

The IAEA has determined that an update and revision of Annex 3 of document S22872/Rev. 1 and Corr. 1 is warranted in light of the experience gained in the course of the implementation of resolutions 687 and 707, and the agreement, earlier this year, by a group of twenty-seven nuclear supplier countries with respect to a detailed list of nuclear-related dual use equipment, materials and related technology for which export controls should be applied.

Accordingly, as provided for in paragraph 41 of the plan, the IAEA wishes to inform the Security Council, through you, that Annex 3 will be amended as reflected in the attachment to this letter and that the Iraqi authorities will be so informed.

I shall be grateful if you would bring this matter to the attention of the Security Council.

(Signed) Hans BLIX

Enclosure

LIST OF ITEMS TO BE REPORTED TO THE AGENCY

Security Council Resolution 707 demands that Iraq, inter alia, halt all nuclear activities of any kind, except for certain uses of isotopes, until the Security Council determines that Iraq is in full compliance with the provisions of Resolution 707 and paragraphs 12 and 13 of Resolution 687 and that the IAEA determines that Iraq is in full compliance with the provisions of its safeguards agreement with the IAEA. Once these determinations have been made affirmatively by the Security Council and by the IAEA, Iraq may seek to initiate the nuclear activities which are not prohibited by Resolution 687. Approval by the Security Council for Iraq to initiate one or more of these nuclear activities may necessitate a corresponding amendment to this list.

Items marked * are prohibited to Iraq under Resolution 687; the others may be prohibited if they are used, or are to be used, in activities prohibited under Resolution 687.

1. **Source materials (see Annex 1, para. 1.1)**

2. **Special fissionable materials (see Annex 1, para. 1.2)**

   *Special fissionable materials which fall within the definition of nuclear-weapon-usable materials are prohibited.

*3. **Nuclear-weapon-usable materials (see Annex 1, para. 1.3)**

4. **Equipment or materials** referred to in Section 2 of Memorandum B of INFCIRC/209/Rev. 1 and in the Annex to INFCIRC/209/Rev. 1
   *All items included in INFCIRC/209/Rev. 1 which are used for enrichment and reprocessing are prohibited.

   * Any item to be used in any activity listed in items 2.1 to 2.9 of Annex 1 is also prohibited.

5. EQUIPMENT AND MATERIALS USED IN ENRICHMENT

* 5.1 Rotor fabrication and assembly equipment and bellow-forming mandrels and dies

(a) Rotor assembly equipment specially designed or prepared for assembly of gas centrifuge rotor tube sections, baffles, and end caps. Such equipment includes specially designed precision mandrels, clamps, and shrink fit machines;

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

(c) Bellows-forming mandrels and dies, two-piece cylindrical with a single indented circumferential convolution bisected by the two halves.

*5.2 Centrifugal balancing machines

Centrifugal balancing machines, fixed or portable, horizontal or vertical as follows:

(a) Centrifugal balancing machines designed for balancing flexible rotors having a length of 400 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; and
(3) capable of balancing to a residual imbalance of 0.010 kg mm/kg per plane or better, and
(4) belt drive type;

and specially designed software therefor.

*5.3 **Filament winding machines**

Filament winding machines in which the motions for positioning, wrapping, and winding fibers are coordinated and programmed in two or more axes, specially designed to fabricate composite structures or laminates from fibrous and filamentary materials and capable of winding cylindrical rotors of diameter between 75 mm and 400 mm and lengths of 400 mm or greater; coordinating and programming controls therefor; precision mandrels; and specially designed software therefor.

See Appendix to Annex 3 for details.

*5.4 **Centrifuge housing/recipients**

Components to contain the rotor tube assembly of a centrifuge enrichment machine.

5.5 **Aluminium alloys**

Aluminium alloys capable of an ultimate strength of 460 MPa (0.46×10^9 N/m^2) or more at 293 K (20°C), in the form of tubes or solid forms (including forgings) having an outside diameter of more than 75 mm.

Technical Note: The phrase "capable of" encompasses aluminum alloys before or after heat treatment.

5.6 **Fibrous and filamentary materials (high strength)**

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

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

*(c) Composite structures in the form of tubes with an inside diameter of between 75 mm and 400 mm and lengths of 400 mm or more made with fibrous and filamentary materials described in (a) above.

Technical Note:

(i) The term "fibrous and filamentary materials" includes continuous monofilaments, continuous yarns, and tapes;
(ii) "Specific modulus" is the Young's modulus in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 23 ± 2°C and a relative humidity of 50 ± 5%;

(iii) "Specific tensile strength" is the ultimate tensile strength in N/m^2 divided by the specific weight in N/m^3 when measured at a temperature of 23 ± 2°C and a relative humidity of 50 ± 5%.

5.7 **Maraging steel**

- Maraging steel (high strength) with an ultimate tensile strength of 2.050×10^9 N/m^2 or more at 293 K (20°C) except forms in which no linear dimension exceeds 75 mm.

Technical Note: The phrase "capable of" encompasses maraging steel before or after heat treatment.

5.8 **Titanium**

Titanium alloys capable of an ultimate tensile strength of 900 MPa (0.9×10^9 N/m^2) or more at 293 K (20°C) in the form of tubes or solid forms (including forgings) with an outside diameter more than 75 mm.

Technical Note: The phrase "capable of" encompasses titanium alloys before or after heat treatment.

5.9 **Spin-forming and flow-forming machines**

Spin-forming and flow-forming machines which:

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

(b) have two or more axes that can be coordinated simultaneously for contouring control;

and precision rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 mm and 400 mm; and specially designed software therefor.

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

6. **Chlorine trifluoride**

7. **Electrolytic cells for fluorine production with a production capacity greater than 250 grams of fluorine per hour and specially designed parts and accessories therefor.**

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8. **Mass spectrometers**

Mass spectrometers capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, and ion sources therefor, as follows:

(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 or 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 or 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 or lined with or plated with materials resistant to UF_6;

*(f) Mass spectrometers equipped with a microfluorination ion source designed for use with actinides or actinide fluorides;

*(g) Specially designed or prepared magnetic or quadrupole mass spectrometers capable of taking on-line samples of feed, product, or tails from UF_6 gas streams and having all of the following characteristics:

(1) Unit resolution for mass greater than 320;
(2) Ion sources constructed of or lined with nichrome or monel, or nickel plated;
(3) Electron bombardment ionization sources;
(4) Having a collector system suitable for isotopic analysis.

9. **Lasers and related equipment as follows**

* (a) Copper vapor lasers with 40 W average output power;

(b) Argon ion lasers with greater than 40 W average output power;

* (c) Nd: YAG lasers that can be frequency doubled and, after doubling, have an average power output at the doubled frequency greater than 40 W;

* (d) Tunable pulsed dye laser amplifiers and oscillators, except single-mode oscillators, with an average power greater than 30 W, a repetition rate greater than 1 kHz and a wavelength between 500 nm and 700 nm;

(e) Tunable pulsed single-mode dye oscillators capable of an average power greater than 1 W, a repetition rate greater than 1 Khz, a pulse width less than 100 ns, and a wavelength between 500 nm and 700 nm.

(f) Alexandrite lasers with a bandwidth of 0.005 nm or less, a repetition rate greater than 124 Hz, and an average output power greater than 30 W;

* (g) Pulsed carbon dioxide lasers with a repetition rate greater than 250 Hz, an average output power greater than 500 W and a pulse length less than 200 ns;

(h) Pulsed excimer lasers (XeD, XeCl, KrF) with a repetition rate greater than 250 Hz and an average output power greater than 500 W;

* (i) Free electron lasers;

* (j) Para-hydrogen Raman shifters designed to operate at 16 μm output wavelength and repetition rate greater than 250 Hz;

* (k) Supersonic expansion nozzles designed for UF_6/carrier gas.

10. **Pipes, valves, boats and collectors**

*Pipes, valves, fittings, heat exchangers, or magnetic, electrostatic or other collectors made of graphite or coated in graphite, yttrium, or yttrium compounds resistant to the heat and corrosion of uranium vapor.

*11. **Resins and organic complexing agents capable of separating isotopes of uranium**

(a) Chemical exchange resins capable of separating isotopes of uranium;

(b) Fast reacting ion-exchange resins;

(c) Pellicular, reticulated resins in which the active chemical exchange groups are limited to a coating on the surface of an inert particle or fibre, and organic complexing agents developed for the same purpose.

*12. **Chemical enrichment equipment**

Solvent extraction or ion exchange equipment designed for use in the enrichment of isotopes as follows:

(a) Fast exchange liquid-liquid contactors: centrifugal contactors and pulsed columns made of fluorocarbon plastic-lined materials, solid fluorocarbon plastic or glass lined steel;

(b) Electrochemical reduction cells designed to reduce uranium from one valence state to another;

(c) Ion exchange columns with diameter greater than 100 cm, lined with material resistant to corrosion by hydrochloric acid, such as fluorocarbon plastics or titanium capable of operating at temperature greater than 120°C or pressure greater than 2 Mpa.

13. **Superconducting electromagnets**

Superconducting solenoidal electromagnets with all of the following characteristics:

(a) capable of creating magnetic fields of more than 2 teslas (20 kilogauss);
(b) with a L/D (length divided by inner diameter) greater than 2;
(c) with an inner diameter of more than 300 mm; and
(d) with a magnetic field uniform to better than 1% over the central 50% of the inner volume.

Note: The item does not cover magnets specially designed and used as parts of medical nuclear magnetic resonance (NMR) imaging systems.

14. **Power sources**

Microwave power sources, greater than 30 GHz and greater than 50 Kw for ion production.

*15. **Process control systems for use in enrichment**

Process control systems configured for use in uranium enrichment, as follows:

(a) Computer systems configured to read process variables, compute control levels, and automatically adjust process variables for such units;

(b) Arrays of instrumentation for monitoring process variables such as temperature, pressure, Ph, fluid level, and flow rate selected for specific production process and designed to operate in the hostile environment required by each process.

*16. **Equipment specially designed for the preparation of feed materials for enrichment processes, including the preparation of UF_6 and UCl_4**

*17. **Feed materials for enrichment processes including UF_6 and UCl_4**

*18. **Electromagnetic isotope separators**

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.

NUCLEAR REACTORS, INCLUDING CRITICAL AND SUB-CRITICAL ASSEMBLIES, REACTOR EQUIPMENT AND MATERIALS

19. **Reactor systems, sub-systems, equipment and components**

19.1 **Reactor vessels**

Reactor vessels, including pressurized and unpressurized types.

19.2 **Reactivity control mechanisms, devices and systems**

Reactivity control mechanisms, devices and systems, including manual, electro-mechanical, hydraulic, pneumatic and chemical injection/removal-type systems.

19.3 **Reactor process monitoring, measurement and control systems**

Reactor process monitoring, measurement and control systems, sub-systems and components. All analog and digital process control computers and hydraulic and pneumatic process monitoring and control instruments and equipment.

19.4 **Reactor fuel charging and discharging systems**

Reactor fuel charging and discharging systems and equipment, including manual, electro-mechanical, hydraulic and pneumatic systems and components.

19.5 **Calandrias**

Calandrias, calandria tubes, pressure tubes and other fuel channel assemblies and components.

19.6 **Primary heat transport and removal systems**

Primary heat transport and removal systems, including steam generators,

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heat exchangers, coolant purification, coolant recovery, high and low pressure injection and circulating pumps, pressure relief devices and other pressure-retaining components especially designed, manufactured or prepared for use in such systems.

PLANTS AND EQUIPMENT USED IN REPROCESSING

*20. **Process control systems for use in reprocessing**

Process control systems configured for use in reprocessing, as follows:

(a) Computer systems configured to read process variables, compute control levels, and automatically adjust process variables for such units;

(b) Arrays of instrumentation for monitoring process variables such as temperature, pressure, pH, fluid level, and flow rate selected for the specific production process and designed to operate in the hostile environment required by each process.

21. **Hot cells and associated equipment**

Hot cells and equipment as follows:

*(a) Hot cells and related equipment for the handling and processing of irradiated nuclear material;

(b) Other hot cells and equipment related to the handling of radioisotopes and radiation sources in medical and industrial applications as follows:

(1) 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. The manipulators have a capability to penetrate 0.6 m or more of cell wall or, alternatively, bridge over the top of a cell wall with a thickness of 0.6 m or more.

(2) 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.

(3) Radiation hardened TV cameras and specially designed or rated as radiation hardened to withstand greater than 5x10^4 grays (SI) (5x10^6 rad) without operational degradation and specially designed lenses used therein.

*22. **Other equipment for the reprocessing of irradiated fuel**

Equipment for the reprocessing of irradiated fuel by methods other than

solvent extraction, e.g., ion-exchange, fluoride volatility, pyrometallurgical.

23. **Radioactive waste treatment**

Plants and equipment for decontamination and for the treatment of radioactive waste.

OTHER EQUIPMENT AND MATERIALS

24. **Plants and equipment used for the following processes**

(a) Prospecting for ores containing source materials;
(b) Mining of ores containing source materials;
(c) Separation of source material from ores and other naturally occurring materials to form concentrates;
(d) Preparation of metals, alloys, or any chemical compound containing source material or uranium enriched to less than 20% in uranium-235;
(e) Fabrication of source material or uranium enriched to less than 20% in uranium-235 into a form suitable for irradiation in a nuclear reactor;
(f) Treatment of wastes from mining, conversion and fabrication processes and plants.

25. **Machine tools**

(a) Numerical control units, specially designed motion control boards for numerical control applications on machine tools, numerically controlled machine tools, specially designed software, and related technology. Detailed specifications of the equipment are set out in the Appendix to Annex 3.

* (b) Turning, milling and grinding machines having one or more of the following characteristics:

(1) Vacuum chucks suitable for holding hemispherical parts;
(2) Machines installed within glove boxes;
(3) Explosion-proofing features.

26. **Dimensional inspection machines**

Dimensional inspection machines, devices or systems, as follows, and specially designed software therefor.

(a) Computer controlled or numerically controlled (see Appendix of Annex 3 for details) 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 (6 + L/1000) μm (L is the measured length in millimeters) (Ref: VDI/VDE 2617 parts 1 and 2);

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

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

(i) non-contact type measuring systems with a "resolution" equal to or less (better) than 0.2 μm within a measuring range up to 0.2 mm;

(ii) linear variable differential transformer (LVDT) systems having both of the following characteristics:

(A) linearity equal to or less (better) than 0.1% within a measuring range up to 5 mm; and

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

(iii) measuring systems that have both of the following characteristics:

(A) contain a laser; and

(B) maintain for at least 12 hours, over a temperature range of ±1 K around a standard temperature and a standard pressure;

(1) a resolution over their full scale of 0.1 μm or better; and

(2) a measurement uncertainty equal to or less (better) than (0.2 + L/2000) μm (L is the measured length in millimeters); except 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;

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

Note: The sub-item (b)(2) of this item does not include optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.

(c) Systems for simultaneously 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 μm per 5 mm; and

(2) angular position deviation equal to or less then 0.02°.

Note: Specially designed software for the systems described in paragraph (c) of this item includes software for simultaneous measurement of wall thickness and contour.

Technical Note 1: Machine tools that can be used as measuring machines are included if they meet or exceed the criteria specified for the machine tool function or the measuring machine function.

Technical Note 2: A machine described in paragraph 26 is included if it exceeds the control threshold anywhere within its operating range.

Technical Note 3: The probe used in determining the measurement uncertainty of a dimensional inspection system shall be as described in VDI/VDE 2617 parts 2, 3, and 4.

Technical Note 4: All parameters of measurement values in this item represent plus/minus, i.e., not total band.

"Measurement uncertainty"

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/DE 2617).

"Resolution"

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

"Linearity"

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

"Angular position deviation"

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

27. **Electron beam welding machines**

Electron beam welding machines with a chamber of 0.5 m^3 or more.

28. **Plasma spray system**

Plasma spray systems, atmospheric or vacuum.

29. **Oxidation furnaces**

30. **High temperature furnaces**

*(a) Vacuum or controlled environment (inert gas) induction furnaces capable of operation above 850°C and having induction coils 600 mm or less in diameter, and power supplies specially designed for induction furnaces with a power supply of 5 kW or more.

Technical Note: This entry does not include furnaces designed and used for the processing of semiconductor wafers.

*(b) Vacuum or controlled environment metallurgical melting and casting furnaces as follows;

(1) Arc remelt and casting furnaces with consumable electrode capacities between 1000 cm^3 and 20000 cm^3 and capable of operating with melting temperatures above 1700°C.

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

and specially configured computer control and monitoring systems and specially designed software therefor:

31. **Isostatic presses**

Isostatic presses 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; specially designed dies and molds, components, accessories and controls; and specially designed software therefor.

32. **Vacuum pumps**

Vacuum pumps with an input throat size of 38 cm or greater with a pumping speed of 15,000 liters/second or greater and capable of producing an ultimate vacuum better than 10^{-4} Torr (0.76×10^{-4} mbar).

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

33. **Power supplies**

(a) 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%;

(b) 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%.

*34. **Crucibles resistant to liquid fissile metals**

Crucibles made of materials resistant to liquid fissile metals and designed to avoid nuclear criticality.

35. **Beryllium**

Beryllium as follows:
(a) Metal;
(b) Alloys containing more than 50% of beryllium by weight;
(c) Compounds containing beryllium;
(d) Manufactures thereof; and
(e) Waste and scrap;

except
(a) Metal windows for X-ray machines;
(b) Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits;
(c) Naturally-occurring compounds containing beryllium.

36. **Calcium**

High purity calcium containing both less than 0.1% by weight of impurities other than magnesium and less than 10 ppm (parts per million) of boron.

37. **Lithium**

*(a) Lithium and its compounds enriched in lithium-6;

*(b) Facilities or specialized equipment for the separation of the lithium-6 isotope;

except

for use in thermoluminescence dosimetry.

38. **Magnesium**

High purity magnesium containing both less then 0.02% by weight of impurities other than calcium and less than 10 ppm (parts per million) of boron.

39. **Tantalum**

Tantalum sheets with a thickness of 2.5 mm or greater.

40. **Plutonium, uranium-233 and uranium enriched to less than 20% in U-235 contained in irradiated fuel**

41. **Tungsten**

Parts made of tungsten, tungsten carbide, or tungsten alloys (greater than 90% tungsten) having a mass greater than 20 kg;

except

parts specifically designed for use as weights or gamma-ray collimators.

42. **Hafnium**

Hafnium of the following description: metal alloys, and compounds of hafnium containing more than 60% hafnium by weight and manufactures thereof.

43. **Boron**

Boron and boron compounds, mixtures and loaded materials in which the boron-10 isotope is more than 20% of the total boron content.

44. **Zirconium**

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.

Technical Note: This applies to waste and scrap containing zirconium as defined here.

EXPLOSIVES AND RELATED EQUIPMENT

*45. **Hydrodynamic testing facilities**

Hydrodynamic test facilities capable of handling the detonation of high explosive charges of 1 kg or greater and suitable for use of appropriate diagnostic instrumentation.

*46. **Computer codes for nuclear explosives**

Hydrodynamics codes, neutronic codes, and/or equation-of-state and related nuclear data files usable for calculating implosion or gun type weapons.

47. **Flash X-ray equipment**

Flash X-ray generators or pulsed electron accelerators with peak energy of 500 keV or greater, 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.

*48. **Gun systems**

Multistage gas guns or other high-velocity gun systems (coil, electromagnetic, electrothermal, or other advanced systems) capable of accelerating projectiles to 2 km per second or greater.

*49. **Shells, hollow spheres or portions thereof**

Shells, hollow spheres or portions of spheres made of high explosives or metals listed in 1, 2, or 35 and molds for such parts.

50. **Photographic equipment**

*(a) Mechanical framing cameras with recording rates greater than 225,000 frames per second; streak cameras with writing speeds greater than 0.5 mm per microsecond; and parts and accessories thereof, including synchronizing electronics specially designed for this purpose and rotor assemblies (including turbines, mirrors, and bearings);

*(b) Electronic streak cameras capable of 50 ns or less time resolution and framing cameras capable of 50 ns or less frame exposure time including single-frame cameras, and streak and framing tubes and solid state imaging devices usable in such cameras.

51. **Oscilloscopes**

Oscilloscopes and transient recorders as follows:

(a) Non-modular analog oscilloscopes having a bandwidth of 1 GHz or greater;

(b) Modular analog 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) Analog sampling oscilloscopes for the analysis of recurring phenomena with an effective bandwidth greater than 4 GHz;

(d) Digital oscilloscopes and transient recorders, using analog-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; and

Specially designed components including plug-in units, external amplifiers, pre-amplifiers, sampling devices, and cathode ray tubes for analog oscilloscopes.

Technical Note: "Bandwidth" is defined as 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.

52. **High-speed pulse generators**

High-speed pulse generators with output voltages greater than 6 V into a less than 55-ohm resistive load, and with pulse transition times less than 500 ps (defined as the time interval between 10% and 90% voltage amplitude).

*53. **Specialized equipment for hydrodynamic experiments**

(a) Velocity interferometers for measuring velocities in excess of 1 km per second during time intervals less than 10 μs. (VISARs, Doppler laser interferometers, DLIs, etc.);

(b) Manganin gauges for pressures greater than 100 kilobars;

(c) Quartz pressure transducers for pressures greater than 100 kilobars.

*54. **Detonators and multipoint initiator systems**

Detonators and multipoint initiation systems:

(a) Electrically driven explosive detonators of the types exploding bridge (EB), exploding bridgewire (EBW), slapper, or exploding foil initiators (EFI);

(b) Specially designed parts or bodies for any of the detonators described above;

(c) Arrangements of multiple detonators designed to nearly simultaneously initiate an explosive surface from a single firing signal;

(d) Explosive lenses designed to uniformly initiate the detonation of the surface of a high-explosive charge.

*55. **Firing sets and equivalent high-current pulsers (for controlled detonators)**

(a) Explosive detonator firing sets designed to drive multiple controlled detonators covered under item 54. above;

(b) Modular electrical pulse generators (pulsers) designed for portable, mobile or rugged use (including xenon flashlamp drivers), with the following characteristics:

- capable of delivering their energy in less than 15 microseconds;
- having an output greater than 100 A; and
- having a rise time of less than 10 microseconds into loads of less than 40 ohms.

56. **High explosives**

High explosives including the following:

(a) Cyclotetramethylenetetranitramine (HMX);

(b) Cyclotrimethylenetrinitramine (RDX);

(c) Triaminotrinitrobenzene (TATB);

(d) Pentaerythritoltetranitrate (PETN), <u>except</u> when contained in pharmaceuticals;

(e) Hexanitrostilbene (HNS), <u>except</u> when contained in pharmaceuticals;

(f) Any explosive with a crystal density greater than 1.8 g/cm^3 and having a detonation velocity greater than 8000 m/s.

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57. **Neutron generator systems**

*(a) Neutron generator systems, including tubes, designed for operation without an external vacuum system and utilizing electrostatic acceleration to induce a tritium-deuterium reaction, capable of producing more than 3 x 10^3 neutrons/μs.

(b) Neutron generator systems to utilize dense plasma focus for deuterium-deuterium or tritium-deuterium reaction.

*58. **Tritium and tritium related plants, equipment, and materials**

(a) Tritium, including compounds and mixtures containing tritium in which the ratio of tritium to hydrogen by atoms exceeds 1 part in 1000 except tritium in luminescent devices (e.g. safety devices installed in aircraft, watches, runway lights) containing less than 40 Ci of tritium in any chemical or physical form.

(b) Facilities or plants for the production, recovery, extraction, concentration, or handling of tritium, and equipment and materials suitable for use therein, including the following:

(1) Tritium storage, separation, purification, and pumping systems using metal hydrides as the storage, pumping or purification medium;

(2) Hydrogen or helium refrigeration units capable of cooling to -250°C or less, with heat removal capacity greater than 150 watts.

*59. **Helium-3**

Helium in any form isotopically enriched in the helium-3 isotope, whether or not mixed with other materials or contained in any equipment or device, except products or devices containing less than 1 g of helium-3.

60. **Deuterium and deuterium-related plants, equipment and materials**

(a) 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.

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

(1) airtight (i.e. hermetically sealed);
(2) for concentrated potassium amide solutions (1% or greater), operating pressure of 1.5-60 MPa; for dilute potassium amide solutions (less than 1%), operating pressure of 20-60 MPa; and
(3) a capacity greater then 8.5 m^3/h

(c) Water-hydrogen sulfide exchange tray columns constructed from the fine carbon steel (such as ASTM A516) with a diameter of 1.8 m or greater to operate at a nominal pressure of 2 MPa or greater. Internal contactors of the columns 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 sulfide/water mixtures, such as 304L or 316 stainless steel.

(d) Hydrogen-cryogenic distillation columns having all of the following applications:

(1) designed to operate with internal temperatures of -238°C or less;
(2) designed to operate at internal pressure of 0.5 to 5 MPa;
(3) constructed of fine-grain stainless steels of the 300 series with low sulfur content or equivalent cryogenic and H_2-compatible materials; and

(4) with internal diameters of 1 m or greater and effective lengths of 5 m or greater.

(e) Ammonia synthesis convertors, 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 said column.

(f) 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.

61. **Alpha sources**

All alpha-emitting radionuclides and equipment containing alpha-emitting radionuclides meeting the following specifications:

(a) All the radionuclides which have an alpha half-life of 10 days or greater, but less than 200 years, and Ra-226;

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(b) The radionuclides are contained in compounds or mixtures with a total alpha activity of 37 GBq per kilogram (1 curie per kilogram) or greater;

(c) The radionuclides have a total alpha activity of 3.7 GBq (100 millicuries) or greater;

except

radionuclides in medical implant devices.

62. **Photomultiplier tubes of the following descriptions;**

(a) A photocathode area of greater than 20 cm^2; and

(b) An anode pulse rise time of less than 1 ns.

63. **Capacitors with either of the following sets of characteristics:**

(a) Voltage rating greater than 1.4 kV, energy storage greater than 10 J, capacitance greater than 0.5 μF, and series inductance less than 50 nH; or

(b) Voltage rating greater than 750V, capacitance greater than 0.25 μF, and series inductance less than 10 nH.

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

65. **"Robots" and specially designed robot controllers, and robot "end-effectors" having any of the following characteristics:**

(a) Specially designed to comply with national safety standards applicable to explosive environments (for example, meeting electrical code ratings for explosive environments);

(b) Specially designed or rated as radiation hardened more than necessary to withstand normal industrial (i.e., non-nuclear industry) ionizing radiation and specially designed controllers and specially designed software therefor.

See Appendix to Annex 3 for details.

66. **Pulse amplifiers**

Pulse amplifiers with gain greater than 6 decibels and with a baseband bandwidth greater than 500 megahertz (having the low frequency half-

power point at less than 1 MHz and the high frequency half-power point at less than 1 MHz and the high frequency half-power point greater than 500 MHz) and output voltage greater than 2 volts into 55 ohms or less (this corresponds to an output greater than 16 dbm in a 50 ohm system).

67. **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 2500 V or more;
(2) Anode peak current rating of 100 A or more; and
(3) Anode delay time of 10 microseconds or less;

(b) Triggered spark-gaps having an anode delay time of 15 microseconds 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 2000 V;
(2) Anode peak current rating of 500 A or more; and
(3) Turn-on time of 1 μs or less.

68. **Vibration test equipment**

Vibration test equipment using digital control techniques and feedback or closed loop test equipment, and software therefor, capable of vibrating a system at 10 g RMS or more between 20 Hz and 2000 Hz, imparting forces of 50 kN or greater.

69. **Electronic digital computers**

Electronic digital computers with a composite theoretical performance (CTP) of 12.5 million theoretical operations per second (Mtops) or greater except:

(a) Computers contained in or associated with other equipment or systems where the computers are essential for the operation of the other equipment or systems and the computers are not the principal element of the other equipment or systems; or

(b) Computers essential for medical applications and incorporated in equipment or systems designed or modified for identifiable and dedicated medical applications.

70. **Electronic equipment for time delay generation or time interval measurement**

(a) Digital time delay generators with a resolution of 50 nanoseconds or less over time intervals of 1 microsecond or greater;

(b) Multichannel (three or more) or modular time interval meters and chronometry equipment with time resolution less than 50 nanoseconds over time ranges greater than 1 microsecond.

APPENDIX TO ANNEX 3: Detailed specifications for Machine Tools

Numerical control units, specially designed motion control boards for numerical control applications on machine tools, numerically controlled machine tools, specially designed software, and technology as follows.

(a) Numerical control units for machine tools, as follows:

(1) Having more than four interpolating axes that can be coordinated simultaneously for contouring control or

(2) Having two, three, or four interpolating axes that can be coordinated simultaneously for contouring control and when one or more of the following conditions are fulfilled:

(i) Capable of real-time processing of data to modify the tool path during the machining operation by automatic calculation and modification of part program data for machining in two or more axes by means of measuring cycles and access to source data;

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

(iii) Capable, without modification, according to the manufacturer's technical specifications, of accepting additional boards that would permit increasing the number of interpolating axes that can be coordinated simultaneously for contouring control, above the control levels, even if they do not contain these additional boards.

(b) Motion control boards specially designed for machine tools having one or more of the following characteristics:

(1) Providing interpolation in more than four axes;
(2) Capable of real time processing described in (a)(2)(i); or
(3) Capable of receiving and processing CAD data as described in (a)(2)(ii) above.

(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 that:
(i) Have two or more axes that can be coordinated simultaneously for contouring control; and
(ii) Have any of the following characteristics:
(A) Two or more contouring rotary axes;
(B) One or more contouring tilting spindles;
(C) Camming (axial displacement) in one revolution of the spindle less (better) than 0.0008 mm total indicator reading (TIR);
(D) Run out (out-of-true running) in one revolution of the spindle less

(better) than 0.0006 mm TIR for grinding or milling machines, 0.0008 mm TIR for turning machines;

(E) The positioning accuracies, with all compensations available, are less (better) than:
  (1) 0.001° on any rotary axis;
  (2) (a) 0.004 mm along any linear axis (overall positioning) for grinding machines;
  (b) 0.006 mm along any linear axis (overall positioning) for milling machines; and
  (c) 0.010 mm along any linear axis (overall positioning) for turning machines;

(F) Capable of turning or boring of diameters equal or greater than 2 meters;

(G) Can adapt application specific fixtures or accessories for the manufacturing of centrifuge components.

(2) Electrical discharge machines (EDM);
  (i) Of the wire feed type that have five or more axes that can be coordinated simultaneously for contouring control;
  (ii) Non-wire EDMs that have two or more contouring rotary axes and that can be coordinated simultaneously for contouring control.

(3) Other machine tools for removing metals, ceramics, or composites:
  (i) By means of:
    (A) Water or other liquid jets, including those employing abrasive additives;
    (B) Electron beam; or
    (C) Laser beam; and
  (ii) Having two or more rotary axes that:
    (A) Can be coordinated simultaneously for contouring control and
    (B) Have a positioning accuracy of less (better) than 0.003°.

(d) Software
  (1) Software specially designed or modified for the development, production, or use of equipment described in sub-categories (a), (b), or (c) above;
  (2) Specific software as follows:
    (i) Software to provide adaptive control and having both of the following characteristics:
      (A) For flexible manufacturing units (FMUs) that consist at least of equipment described in (b)(1) and (b)(2) of the definition of flexible manufacturing units; and
      (B) Capable of generating or modifying in real time processing, part program data by using the signals obtained simultaneously by means of at least two detection techniques, such as:
        (1) Machine vision (optical ranging);
        (2) Infrared imaging;
        (3) Acoustical imaging (acoustical ranging);
        (4) Tactile measurement;
        (5) Inertial positioning;

(6) Force measurement;
(7) Torque measurement.

(ii) Software for electronic devices other than those described in sub-items (a) or (b) that provides the numerical control capability of the equipment described in sub-item 1.2.

(e) Technology
(1) Technology for the development of equipment described in sub-items (a), (b), or (c) above, (f) or (g) below, and of the sub-item (d).
(2) Technology for the production of equipment described in sub-items (a), (b), or (c) above, (f) or (g) below;
(3) Other technology
(i) For the development of interactive graphics as an integrated part in numerical control units for preparation or modification of part programs;
(ii) For the development of integration software for incorporation of expert systems for advanced decision support of shop floor operations into numerical control units.

(f) Components and parts for machine tools included in sub-item (c) as follows:
(1) 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;
(2) Linear position feedback units (e.g., inductive-type devices, graduated scales, laser, or infrared systems) having with compensation, an overall accuracy better than 800 + (600 x L x 10^{-3}) nm, where L equals the effective length in millimeters of the linear measurement; except 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;
(3) Rotary position feedback units (e.g., inductive-type devices, graduated scales, laser, or infrared systems) having, with compensation, an accuracy less (better) than 0.00025° of arc; except 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;
(4) Slide way assemblies consisting of a minimal assembly of ways, bed, and slide having all of the following characteristics:
(i) A yaw, pitch, or roll of less (better) than 2 seconds of arc TIR (Ref. ISO/DIS 230-1 over full travel);
(ii) A horizontal straightness of less (better) than 2 µm per 300 mm length; and
(iii) A vertical straightness of less (better) than 2 µm overfull travel per 300 mm length;
(5) Single point diamond - cutting tool inserts having all of the following characteristics:
(i) A flawless and chip-free cutting edge when magnified 400 times in any direction;
(ii) A cutting radius out-of-roundness less (better) than 0.002 mm TIR (also

peak-to-peak); and
(iii) A cutting radium between 0.1 and 5.0 mm, inclusive.

(g) Specially designed components or sub-assemblies, as follows, capable of upgrading, according to the manufacturer's specifications, numerical control units, motion control boards, machine tools, or feedback devices to or above the levels described in sub-items (a), (b), (c), (f)(2), or (f)(3):
(1) Printed circuit boards with mounted components and software therefor;
(2) Compound rotary tables

Technical Note: Definitions of Terms:

"accuracy" - Usually measured in terms of inaccuracy, defined as the maximum deviation, positive or negative, of an indicated value from an accepted standard or true value.

"adaptive control" - a control system that adjusts the response from conditions detected during the operation (Ref. ISO 2806-1980).

"camming" (axial displacement) - Axial displacement in one revolution of the main spindle measured in a plane perpendicular to the spindle faceplate at a point next to the circumference of the spindle faceplate (Ref. ISO 230 Part 1-1986, paragraph 5.63).

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

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

"digital computer" - Equipment which can, in the form of one or more discrete variables:
a. Accept data;
b. Store data or instruction in fixed or alterable (writable) storage devices;
c. Process data by means of a stored sequence of instructions which is modifiable; and
d. Provide output of data.

N.B.: Modifications of a stored sequence of instructions include replacement of fixed storage devices, but not a physical change in wiring or interconnections.

"flexible manufacturing unit" (FMU) (sometimes also referred to as "flexible manufacturing system" (FMS) or "flexible manufacturing cell" (FMC))
An entity which includes 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 described in Annex 3 paragraph 25
   2. A dimensional inspection machine described in Annex 3 paragraph 26
   3. A robot described in Annex 3 paragraph 65
   4. Digitally controlled equipment described Annex 3 paragraph 5.3

"laser" - An assembly of components which produce coherent light that is amplified by stimulated emission of radiation.

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

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

"motion control board" - 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.

"numerical control" - The automatic control of a process performed by a device that makes use of numeric data usually introduced as the operation is in progress (Ref. ISO 2382).

"part program" - An ordered set of instructions in a language and in a format required to cause operations to be effected under automatic control, which is either written in the form of a machine program on an input medium or prepared as input data for processing in a computer to obtain a machine program (Ref. ISO 2806-1980).

"positioning accuracy"

Of numerically controlled machine tools is to be determined and presented in conjunction with the requirements below:

(a) Test conditions (ISO/DIS/230/2 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 identically to the way they will be cycled during the accuracy measurements;
   (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:

(i) Line voltage variation shall not be greater than ±10% of nominal rated voltage;
(ii) Frequency variation shall not be greater than ±2 Hz of normal frequency;
(iii) Lineouts or interrupted service are not permitted.

(b) Test Program (ISO/DIS/230/2 paragraph 4):
(1) Feed rate (velocity of slides) during measurement shall be the rapid traverse rate;
N.B.: 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 (ISO/DIS/230/2 paragraph 2):
The results of the measurements must include:
(1) Positioning accuracy (A) and
(2) The mean reversal error (B).

"program" - A sequence of instructions to carry out a process in, or convertible into, a form executable by an electronic computer.

"real-time processing" - Processing of data by an electronic computer in response to an external event according to time requirements imposed by the external event.

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

a. Is multifunctional;
b. Is capable of positioning or orienting material, parts,tools or special devices through variable movements in three-dimensional space;
c. Incorporates three or more closed or open loop servo-devices which may include stepping motors; and
d. Has user-accessible programmability by means of teach/playback method or by means of an electronic computer which may be a programmable logic controller, i.e., without mechanical intervention.

N.B.:The above definition does not include the following devices:
a. Manipulation mechanisms which are only manually/teleoperator controllable;
b. Fixed sequence manipulation mechanisms which are automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic or electrical means;
c. Mechanically controlled variable sequence manipulation mechanisms which are automated moving devices, operating according to

mechanically fixed programmed motions. The program is mechanically limited by fixed, but adjustable, stops, such as pins or cams. The sequence of motions and the selection of paths or angles are variable within the fixed program pattern. Variations or modifications of the program pattern (e.g. changes of pins 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 program 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.

f. Robots specially designed for nonnuclear industrial applications such as automobile paint-spraying booths.

"end effector" - 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.

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

"sensors" - Detectors of a physical phenomenon, the output of which (after conversion into a signal that can be interpreted by a controller) is able to generate programs or modify programmed instructions or numerical program data. This includes sensors with machine vision, infrared imaging, acoustical imaging, tactile feel, inertial position measuring, optical or acoustic ranging or force or torque measuring capabilities.

"software" - A collection of one or more programs or microprograms fixed in any tangible medium of expression.

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

"user-accessible programmability"

The facility allowing a user to insert, modify or replace programs by means other than:

(a) A physical change in wiring or interconnections; or

(b) The setting of function controls including entry of parameters.
