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**No. 23308**



**AIDS HELPLINE: 0800-0123-22 Prevention is the cure**

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## GOVERNMENT NOTICES GOEWERMENTSKENNISGEWINGS

### DEPARTMENT OF TRADE AND INDUSTRY DEPARTEMENT VAN HANDEL EN NYWERHEID

No. 428

10 April 2002

#### NOTICE UNDER SECTION 13 OF THE NON-PROLIFERATION OF WEAPONS OF MASS DESTRUCTION ACT, 1993 (ACT NO. 87 OF 1993): DECLARATION OF CERTAIN GOODS AND TECHNOLOGIES TO BE CONTROLLED AND CONTROL MEASURES APPLICABLE TO SUCH GOODS

I, Alec Erwin, Minister of Trade and Industry, on the recommendation of the South African Council for the Non-Proliferation of Weapons of Mass Destruction and under section 13 of the Non-Proliferation of Weapons of Mass Destruction Act (Act No. 87 of 1993), hereby -

- (a) in terms of South Africa's obligations as a State Party to the 1972 Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, prohibit -
  - (i) the development, production, stockpiling, acquisition or retention of microbial or other biological agents or toxins, whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;
  - (ii) the development, production, stockpiling, acquisition or retention of weapons, equipment or means of dispersion or delivery specifically designed to use such agents or toxins for hostile purposes or in armed conflict;
- (b) declare biological agents and toxins and related manufacturing equipment and technology that may be used for the manufacture of biological and toxin weapons, as listed in Annexures A, B and C of this notice to be controlled goods;
- (c) determine that the export, re-export or transit of such goods shall only take place under a permit issued by the said Council as provided for in Annexure D to this notice;
- (d) control the export, re-export or transit of such goods by -
  - (i) authorising the Council to demand from the applicant, on behalf of the Republic, an end-use certificate -

- (aa) for the controlled goods to be transferred to the territory of another country;
  - (bb) from the end-user(s) in the country of destination;
  - (cc) which provides information and assurance to the Council in issuing the permit; and
  - (dd) which the applicant must prove to be authentic.
- (ii) requiring the registration of all applicants with the Council in accordance with Section 13(3) of the above-mentioned Act.

Application forms for permits and registration in terms of Section 13(3) of the above-mentioned Act are obtainable from:

The Secretariat  
South African Council for the Non-Proliferation of Weapons of Mass Destruction  
Private Bag X84  
PRETORIA  
0001



**A ERWIN**  
**MINISTER OF TRADE AND INDUSTRY**

## ANNEXURE A

## I. HUMAN PATHOGENS, ZONOSES AND "TOXINS", AS FOLLOWS:

- 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:

- Chikungunya virus;
- Eastern equine encephalitis virus;
- Western equine encephalitis virus;
- Venezuelan equine encephalitis virus;
- Oropouche virus;
- Rocio virus;
- Dengue fever virus;
- Yellow fever virus;
- Japanese encephalitis virus;
- Tick-borne encephalitis complex viruses, including Russian Spring-Summer encephalitis, Kyasanur Forest, Louping ill, Omsk haemorrhagic fever and Powassan;
- St Louis encephalitis virus;
- Rift Valley fever virus;
- Crimean-Congo haemorrhagic fever virus;
- Hantaviruses, including Hantaan;
- Arenaviruses, including Lassa fever, Junin, Machupo and Lymphocytic choriomeningitis;

- Variola virus;
  - Monkey pox virus;
  - White pox virus;
  - Ebola virus;
  - Marburg 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:
- Coxiella burnetii;
  - Bartonella quintana (Rochalimaea quintana, Rickettsia quintana);
  - Rickettsia prowazekii;
  - 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:
- Bacillus anthracis;
  - Brucella abortus;
  - Brucella melitensis;
  - Brucella suis;
  - Chlamydia psittaci;
  - Clostridium botulinum;
  - Clostridium perfringens;
  - Clostridium tetani;



- Enterohaemorrhagic *Escherichia coli*, serotype 0157 and other verotoxin producing serotypes;
- *Francisella tularensis*;
- *Legionella pneumophila*;
- *Burkholderia mallei* (*Pseudomonas mallei*);
- *Burkholderia pseudomallei* (*Pseudomonas pseudomallei*);
- *Salmonella typhi*;
- *Shigella dysenteriae*;
- *Vibrio cholerae*;
- *Yersinia pestis*;
- *Yersinia pseudotuberculosis*;

d. "Toxins", as follows, and "sub-unit of toxins" thereof:

- Abrin;
- Botulinum toxins;
- Cholera toxin;
- *Clostridium perfringens* toxins;
- Conotoxin;
- Modeccin;
- Ricin;
- Saxitoxin;
- Shiga toxin;
- *Staphylococcus aureus* toxins;

- Tetanus toxin;
- Tetrodotoxin;
- Trichothecene mycotoxins;
- Verotoxin;
- Microcystin (Cyanginosin);
- Aflatoxin;
- Volkensin;
- Viscum album Lectin 1 (Viscumin);

**except:**

Any goods specified in (I.c) in the form of a "vaccine", or "toxoid".

**II. ANIMAL PATHOGENS, AS FOLLOWS:**

- 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:

- African swine fever virus;
- African horsesickness virus;
- Avian influenza virus, which can be:
  - a. Uncharacterised; or
  - b. Defined as having high pathogenicity, as follows:
    - i. Type A viruses with an IVPI (intravenous pathogenicity index) in six-week-old chickens of greater than 1.2; or

ii. Type A viruses, H5 or H7 subtype, for which nucleotide sequencing has demonstrated multiple basic amino acids at the cleavage site of haemagglutinin;

- Bluetongue virus;
- Foot and mouth disease virus;
- Goat pox virus;
- Porcine herpes virus (Aujeszky's disease);
- Swine fever virus (Hog cholera virus);
- Lyssaviruses;
- Newcastle disease virus;
- 'Peste des petits ruminants' virus;
- Porcine enterovirus type 9 (swine vesicular disease virus);
- Rinderpest virus;
- Sheep pox virus;
- Teschen disease virus;
- Vesicular stomatitis virus;

- b. *Mycoplasma mycoides* (mycoides sc), 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 *Mycoplasma mycoides* (mycoides sc).

**except:**

Any goods specified in (II) in the form of a "vaccine".

**III. GENETICALLY MODIFIED "MICRO-ORGANISMS", AS FOLLOWS:**

- a.** Genetically modified "micro-organisms" or genetic elements that contain nucleic acid sequences associated with pathogenicity of organisms specified in (I.a) to (I.c) or (II) or (IV);
- b.** Genetically modified "micro-organisms" or genetic elements that contain nucleic acid sequences coding for any of the "toxins" specified in (I.d) or "sub-units of toxins" thereof.

**IV. 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:
  - *Xanthomonas albilineans*;
  - *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*, *Xanthomonas campestris* pv. *citrumelo*, *Xanthomonas axonopodis* pv. *citri*, *Xanthomonas axonopodis* pv. *citrumelo*, *Xanthomonas axonopodis* pv. *aurantifolii*;
  - *Xanthomonas oryzae* pv. *oryzae*;
  - *Xylella fastidiosa*;
- 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:
  - *Colletotrichum kahawae* (*Colletotrichum coffeanum* var. *virulans*);
  - *Cochliobolus miyabeanus* (*Helminthosporium oryzae*);
  - *Deuterophomonas tracheiphila* (syn. *Phoma tracheiphila*);
  - *Microcyclus ulei* (syn. *Dothidella ulei*);



- *Monilia rorei* (syn. *Moniliophthora rorei*);
- *Puccinia graminis* (syn. *Puccinia graminis* f. sp. *tritici*);
- *Puccinia striiformis* (syn. *Puccinia glumarum*);
- *Magnaporthe grisea* (*Pyricularia grisea*/*Pyricularia oryzae*);
- *Sclerotinia sclerotiorum*;

c. 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:

- Banana bunchy top virus.

## ANNEXURE B

**I. EQUIPMENT CAPABLE OF USE IN HANDLING BIOLOGICAL MATERIALS, AS FOLLOWS:**

- a. Complete biological containment facilities at P3, P4 containment level;

**Technical Note:**

P3 or P4 (BL3, BL4, L3, L4) containment levels are as specified in the WHO Laboratory Biosafety Manual (Geneva, 1983).

- b. Fermenters capable of cultivation of pathogenic "micro-organisms", viruses or capable of toxin production, without the propagation of aerosols, and having a total capacity of 100 litres or more;

**Technical Note:**

Fermenters include bioreactors, chemostats and continuous-flow systems.

- c. Centrifugal separators, capable of continuous separation without the propagation of aerosols, having all the following characteristics:

Flow rate exceeding 100 litres per hour:

- Components of polished stainless steel or titanium;
- Double or multiple sealing joints within the steam containment area; and
- Capable of in-situ steam sterilisation in a closed state;

**Technical Note:**

Centrifugal separators include decanters.

- d. Cross-flow filtration equipment, capable of continuous separation without the propagation of aerosols, having both of the following characteristics:

- Equal to or greater than 5 square metres; and

- Capable of in-situ sterilisation;
- 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. Equipment that incorporates or is contained in P3 or P4 containment housing, as follows:
  - Independently ventilated protective full or half suits;
  - 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 (l.f.2), isolators include flexible isolators, drying boxes, anaerobic chambers and glove boxes.

- g. Chambers designed for aerosol challenge testing with "micro-organisms" or "toxins" and having a capacity of 1 m<sup>3</sup> or greater;
- h. Equipment for the micro-encapsulation of live micro-organisms and toxins in the range of 1-10 µm particle size, specifically:
  - Interfacial polycondensators;
  - Phase separators;
- i. Fermenters of less than 100-litre capacity with special emphasis on aggregate orders or designs for use in combined systems;
- j. Conventional or turbulent air-flow clean-air rooms and self-contained fan-HEPA filter units that may be used for P3 or P4 containment facilities.

**ANNEXURE C**

- I. "Technology" required for the "use" of goods specified in **ANNEXURE A**.
- II. "Technology", including licences, designed for the manufacture of equipment specified in **ANNEXURE B**.



**ANNEXURE D**

- I. Depending on the circumstances, the following permits may be issued by the South African Council for the Non-Proliferation of Weapons of Mass Destruction to organisations that have been registered with the Council for the export or transfer of goods that have been indicated in **ANNEXURE A** or equipment indicated in **ANNEXURE B**:
- a. Individual Permit (for a single transfer of fixed goods, a fixed country, fixed end-user or supplier, and fixed place of export or transfer);
  - b. Individual Issue-on-request Permit (for a number of approved single transfers of fixed goods, a fixed country, fixed end-user or supplier, and fixed place of export or transfer);
  - c. Open Multiple Permit (for multiple transfers of fixed goods, a fixed country, fixed end-user or supplier, and fixed place of export or transfer).

**KENNISGEWING KRAGTENS ARTIKEL 13 VAN DIE WET OP DIE NIE-PROLIFERASIE VAN WAPENS VAN GROOTSKAALSE Vernietiging, 1993 (WET NO. 87 VAN 1993): VERKLARING DAT BEPAALDE GOEDERE EN TEGNOLOGIEË BEHEER WORD EN BEHEERMAATREËLS VAN TOEPASSING OP SODANIGE GOEDERE**

Ek, Alec Erwin, Minister van Handel en Nywerheid, op aanbeveling van die Suid-Afrikaanse Raad vir die Nie-proliferasie van Wapens van Groot skaalse Vernietiging en kragtens artikel 13 van die Wet op die Nie-proliferasie van Wapens van Groot skaalse Vernietiging, 1993 (Wet No. 87 van 1993) -

- (a) verbied hierby in terme van Suid-Afrika se verpligtinge as Stateparty tot die *Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction* van 1972
  - (i) die ontwikkeling, vervaardiging, opberging, verkryging of retensie van mikrobiese of ander biologiese agense of toksiene, wat ook al hul oorsprong of vervaardigingsmetode, van tipes en in hoeveelhede wat geen regverdiging vir profilaktiese, beskermende of ander vredesdoeleindes het nie;
  - (ii) die ontwikkeling, vervaardiging, opberging, verkryging of retensie van wapens, toerusting of verspreidings- of afleweringsvermoëns wat spesifiek ontwerp is om sodanige agense of toksiene vir vyandige doeleindes of in gewapende stryd te gebruik;
- (b) verklaar hierby biologiese agense en toksiene en verwante vervaardigingstoerusting en tegnologie wat gebruik kan word vir die vervaardiging van biologiese en toksienwapens, soos gelys in Bylaes A, B, en C van hierdie kennisgewing, tot beheerde goedere.

- (c) bepaal hierby dat die uitvoer, heruitvoer of deurvoer van sodanige goedere slegs mag plaasvind kragtens 'n permit uitgereik deur genoemde Raad, waarvoor voorsiening gemaak word in Bylae D van hierdie kennisgewing;
- (d) beheer hierby die uitvoer, heruitvoer of deurvoer van sodanige goedere deur –
  - (i) namens die Republiek die Raad te magtig om van die aansoeker 'n eindgebruiksertifikaat te vereis –
    - (aa) vir die oorplasing van beheerde goedere na die grondgebied van 'n ander land;
    - (bb) van die eindgebruikers in die land van bestemming;
    - (cc) wat inligting en versekering verskaf aan die Raad by die uitreik van die permit; en
    - (dd) wat die aansoeker as outentiek moet bewys.
  - (ii) van alle aansoekers registrasie by die Raad te vereis, in ooreenstemming met artikel 13(3) van die bogenoemde wet.

Aansoekvorms vir permitte en registrasie ingevolge artikel 13(3) van bogenoemde Wet is verkrygbaar van:

Die Sekretariaat  
Suid-Afrikaanse Raad vir die Nie-proliferasie van Wapens van Grootse Vernietiging  
Privaat Sak X84  
PRETORIA  
0001



A. ERWIN

MINISTER VAN HANDEL EN NYWERHEID

**AANHANGSEL A****I. MENSLIKE PATOGENE, SOËNOSE EN "TOKSIENE", SOOS VOLG:**

- a. Virusse, hetsy natuurlik, met verhoogde virulensie of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal, insluitende lewende materiaal wat doelbewus geïnokuleer of gekontamineer is met kulture, soos volg:

- Chikungunya- virus;
- Oosterse perde-enkefalitisvirus;
- Westerse perde-enkefalitisvirus;
- Venezuelaanse perde-enkefalitisvirus;
- Oropouche-virus;
- Rocio-virus;
- Dengue-koorsvirus;
- Geelkoorsvirus;
- Japannese enkefalitis-virus;
- Bosluigedraagde enkefalitiskompleksvirusse, insluitende Russiese Lente-Somer-enkefalitis-, Kyasanurwoud-, louspsiekte-, Omsk-hemorragiese koors- en Powassan-virus;
- St. Louis-enkefalitisvirus;
- Slenkdalkoorsvirus;
- Krim-Kongo-hemorragiese koorsvirus;
- Hantavirusse, insluitende Hantaan;
- Arenavirusse, insluitende die Lassakoors-, Junin-, Machupo- en Limfositiese choriomeningitisvirus;
- Variolavirus;



- Aappokkevirus;
  - Witpokkevirus;
  - Ebolavirus;
  - Marburgvirus;
- b. Rickettsiae, hetsy natuurlik, met verhoogde virulensie of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal, insluitende lewende materiaal wat doelbewus geïnkuleer of gekontamineer is met kulture, soos volg:
- *Coxiella burnetii*;
  - *Bartonella quintana* (*Rochalimaea quintana*, *Rickettsia quintana*);
  - *Rickettsia prowazekii*;
  - *Rickettsia rickettsii*;
- c. Bakterië, hetsy natuurlik, met verhoogde virulensie of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal, insluitende lewende materiaal wat doelbewus geïnkuleer of gekontamineer is met sodanige kulture, soos volg:
- *Bacillus anthracis*;
  - *Brucella abortus*;
  - *Brucella melitensis*;
  - *Brucella suis*;
  - *Chlamydia psittaci*;
  - *Clostridium botulinum*;
  - *Clostridium perfringens*;
  - *Clostridium tetani*;

- Enterohemorragiese *Escherichia coli*, serotipe 0157 en ander verotoksien-produiserende serotipes;
- *Francisella tularensis*;
- *Legionella pneumophila*;
- *Burkholderia mallei* (*Pseudomonas mallei*);
- *Burkholderia pseudomallei* (*Pseudomonas pseudomallei*);
- *Salmonella typhi*;
- *Shigella dysenteriae*;
- *Vibrio cholerae*;
- *Yersinia pestis*;
- *Yersinia-pseudotuberculosis*;

d. "Toksiene", soos volg, en "subeenheid van toksiene" daarvan:

- Abrien;
- Botulinum-toksiene;
- Cholera-toksien;
- *Clostridium perfringens*-toksiene;
- Konotoksien;
- Modeccin;
- Risien;
- Saksitoksien;
- Shigatoksien;
- *Stafilokokkus aureus*-toksiene;

- Tetanustoksien;
- Tetrodotoksien;
- Trigoteseenmikotoksien;
- Verotoksien;
- Mikrosistien (Sianginosien);
- Aflatoksien;
- Volkensien;
- Viskum album Lektien 1 (Viskumien);

**uitgesonderd:**

Enige goedere gespesifiseer in (I.c) in die vorm van 'n "entstof", of "toksoïed".

**II. DIEREPATOGENE, SOOS VOLG:**

- a. Virusse, hetsy natuurlik, met verhoogde virulensie of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal, insluitende lewende materiaal wat met opset geïnkuleer of gekontamineer is met sodanige kulture, soos volg:

- Afrikaanse-varkpesvirus;
- Perdesiektevirus;
- Aviêregriepvirus, wat -

a. ongekarakteriseer is; of

b. omskryf word om hoë patogenisiteit te hê, soos volg:

- i. Tipe A-virusse met 'n IVPI (intraveneuse patogenisiteitsindeks) by kuikens van ses weke oud, van meer as 1.2; of

ii. Tipe A-virusse, H5- of H7-subtype, waarvoor nukleotied-  
volgordebepaling veelvuldige basies aminosure vertoon het  
by die splitsplek van hemagglutininien;

- Bloutongvirus;
- Bek-en-klou-seer-virus;
- Bokpokkevirus;
- Varkherpesvirus (Aujeszky se siekte);
- Europese-varkpesvirus (Varkcholeravirus);
- Lyssavirusse;
- Newcastle-siekte-virus;
- 'Peste des petits ruminants'-virus;
- Vark-enterovirus tipe 9 (vark-vesikulêre-siekte-virus);
- Rinderpesvirus;
- Skaappokkevirus;
- Teschen-siekte-virus;
- Vesikulêre stomatitis-virus;

b. *Mycoplasma mycoides* (*mycoides* sc), hetsy natuurlik, met verhoogde virulensie of gomodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal insluitende lewende materiaal wat met opset geïnokuleer of gekontamineer is met sodanige *Mycoplasma mycoides* (*mycoides* sc).

**Uitgesonderd:**

Enige goedere gespesifiseer in (II) in die vorm van 'n "entstof".

**III. GENETIES GEMODIFISEERDE "MIKRO-ORGANISMES", SOOS VOLG:**

- a. Geneties gemodifiseerde "mikro-organismes" of genetiese elemente wat nukleïensuursekwense bevat wat geassosieer word met die patogenisiteit van organismes gespesifiseer in (I.a) tot (I.c) of (II) of (IV);
- b. Geneties gemodifiseerde "mikro-organismes" of genetiese elemente wat nukleïensuursekwens bevat wat kodeer vir enige van die "toksiene" gespesifiseer in (I.d) of "sub-eenheid toksiene" daarvan.

**IV. PLANTPATOGENE, SOOS VOLG:**

- a. Bakterieë, hetsy natuurlik, met verhoogde virulensie of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal wat met opset geïnokuleer of gekontamineer is met sodanige kulture, soos volg:
  - *Xanthomonas albilineans*;
  - *Xanthomonas campestris* pv. *citri* insluitende stamme genoem *Xanthomonas campestris* pv. *citri*-tipes A, B, C, D, E of andersins geklassifiseer as *Xanthomonas citri*, *Xanthomonas campestris* pv. *aurantifolia*, *Xanthomonas campestris* pv. *citrumelo*, *Xanthomonas axonopodis* pv. *citri*, *Xanthomonas axonopodis* pv. *citrumelo*, *Xanthomonas axonopodis* pv. *aurantifolii*;
  - *Xanthomonas oryzae* pv. *oryzae*;
  - *Xylella fastidiosa*;
- b. Swamme, hetsy natuurlik, met verhoogde virulensie of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal wat met opset geïnokuleer of gekontamineer is met sodanige kulture, soos volg:
  - *Colletotrichum kahawae* (*Colletotrichum coffeanum* var. *virulans*);
  - *Cochliobolus miyabeanus* (*Helminthosporium oryzae*);
  - *Deuterophomonas tracheiphila* (sin. *Phoma tracheiphila*);
  - *Microcyclus ulei* (sin. *Dothidella ulei*);

- *Monilia rorei* (syn. *Moniliophthora rorei*);
  - *Puccinia graminis* (sin. *Puccinia graminis* f. sp. *tritici*);
  - *Puccinia striiformis* (sin. *Puccinia glumarum*);
  - *Magnaporthe grisea* (*Pyricularia grisea*/*Pyricularia oryzae*);
  - *Sclerotinia sclerotiorum*;
- c. Virusse, hetsy natuurlik, versterk of gemodifiseer, hetsy in die vorm van "geïsoleerde lewende kulture" of as materiaal, insluitende lewende materiaal wat met opset geïnokuleer of gekontamineer is met sodanige kulture, soos volg:
- Banana Bunchy Top-virus.

## AANHANGSEL B

## I. TOERUSTING WAT GEBRUIK KAN WORD BY DIE HANTERING VAN BIOLOGIESE MATERIALE, SOOS VOLG:

- a. Volledige biologiese beskermingsfasiliteite op P3-, P4-beskermingsvlak;

Tegniese opmerking:

P3 of P4 (BL3, BL4, L3, L4)-beskermingsvlakke is soos gespesifiseer in die WGO se handboek vir Laboratoriumveiligheid (Genève, 1983).

- b. Fermenteerders geskik vir die kweek van patogeniese "mikro-organismes", virusse, of geskik vir toksienproduksie, sonder die propagering van aërosols, en wat 'n totale kapasiteit van 100 liter of meer het;

Tegniese opmerking:

Fermenteerders insluitende bioreaktors, chemostate en volgehoevloeistelsels.

- c. Sentrifugale skeiers, geskik vir volgehoevloeï-skeiding sonder die propagering van aërosols, wat al die volgende kenmerke het:

Vloeikoers wat 100 liter per uur oorskry:

- Komponente van gepoleerde vlekvrystaal of -titanium;
- Dubbele of veelvuldige afdignate binne die stoominperkruimte; en
- Geskik vir *in situ*-sterilisasië in 'n geslote toestand;

Tegniese opmerking:

Sentrifugale afskeiers omvat afgieters.

- d. Kruisvloeifiltreertoerusting, met die vermoë van volgehoevloeï-skeiding sonder die voortplanting van aërosols, wat oor beide die volgende kenmerke beskik:

- Gelyk aan of groter as vyf vierkante meter; en



- Geskik vir *in situ*-sterilisasië;
- e. Stoomsteriliseerbare vriesdroogtoerusting met 'n kondensatorkapasiteit van meer as 50 kg ys in 24 uur en minder as 1 000 kg ys in 24 uur;
- f. Toerusting wat P3- of P4-beskerming inkorporeer of daarin bevat word, soos volg:
  - Onafhanklik geventileerde beskermende vol- of half-oorpakke;
  - Bioveiligheidskabinette of -isolators, wat handbediening daarbinne toelaat, terwyl 'n omgewing ekwivalent aan Klas III- biobeskerming verskaf word;

**Opmerking:** In (l.f.2) omvat isolators buigsame isolators, droogdromme, anaërobiese kamers en handskoen isolators.

- g. Kamers wat ontwerp is vir aërosol-daagtoetsing met "mikro-organismes" of "toksiene", en wat 'n kapasiteit van 1 m<sup>3</sup> of groter het.
- h. Toerusting vir die mikro-enkapsulering van lewende mikro-organismes en toksiene wat wissel van 1 – 10 µm-deeltjiegrootte, spesifiek:
  - Tussenvlak-polikondensators;
  - Faseskeiers;
- i. Fermenteerders met 'n kapasiteit van minder as 100 liter met spesiale klem op aggregaatordes of -ontwerpe vir gebruik in gekombineerde stelsels.
- j. Konvensionele of turbulentevloei-skoonlugkamers en selfstandige-waaier-HEPA-filtareenhede wat gebruik kan word vir P3- of P4-beskermingsfasiliteite.

**AANHANGSEL C**

- I. "Tegnologie" vereis vir die "gebruik" van goedere gespesifiseer in **AANHANGSEL A.**
- II. "Tegnologie", insluitende lisensies, bedoel vir die vervaardiging van toerusting gespesifiseer in **AANHANGSEL B.**

**AANHANGSEL D**

- I.** Na gelang van omstandighede kan die volgende permitte uitgereik word deur die Suid-Afrikaanse Raad vir die Nie-Proliferasie van Wapens van Grootse Vernietiging aan organisasies wat by die Raad geregistreer is vir die uitvoer of oorplaas van goedere wat in **AANHANGSEL A** of toerusting wat in **AANHANGSEL B** aangedui word:
- a.** Individuele Permit (vir 'n enkele oorplasing van vaste goedere, 'n bepaalde land, bepaalde eindgebruiker of verskaffer, en vaste plek van uitvoer of oorplasing);
  - b.** Individuele Uitreiking-op-versoek-permit (vir 'n aantal goedgekeurde enkele oorplasings van vaste goedere, 'n bepaalde land, 'n bepaalde eindgebruiker of verskaffer, en 'n vaste plek van uitvoer of oorplasing);
  - c.** Ope Veelvuldige Permit (vir veelvuldige oorplasings van vaste goedere, 'n bepaalde land, bepaalde eindgebruiker of verskaffer, en vaste plek van uitvoer of oordrag).

No. 429

10 April 2002

**NOTICE IN TERMS OF SECTION 13 OF THE  
NON-PROLIFERATION OF WEAPONS OF MASS DESTRUCTION ACT, 1993**


**DECLARATION OF CERTAIN MISSILE TECHNOLOGY AND RELATED ITEMS AS  
CONTROLLED GOODS AND CONTROL MEASURES APPLICABLE TO SUCH  
GOODS**

1. I, Alec Erwin, Minister of Trade and Industry, on the recommendation of the South African Council for the Non-Proliferation of Weapons of Mass Destruction, under section 13 of the Non-Proliferation of Weapons of Mass Destruction Act, 1993 (Act No. 87 of 1993), hereby -

- (a) declare all items listed in the Missile Technology Control Regime (MTCR) Equipment and Technology Annex, dated 14 October 1999, as quoted in Schedule A to this notice, to be controlled goods;
- (b) determine that the import, export, re-export and transit of such controlled goods shall take place only under a permit issued by the said Council, established under section 4 of the said Act;
- (c) determine that the local transfer or sale of such controlled goods by a person contemplated in section 13(3) of the said Act may take place only if the receiver of the goods has been registered in terms of this said section and the said Council was informed by means of a declaration of the transaction by the supplier; and
- (d) repeal Government Notice No. R.1789 of 14 October 1994.

2. Application forms for permits and registrations in terms of section 13(3) of the aforementioned Act are obtainable from:

The Secretariat  
South African Council for the Non-Proliferation of Weapons of Mass  
Destruction  
Private Bag X84  
**PRETORIA**  
0001



**ALEC ERWIN,**  
Minister of Trade and Industry

**SCHEDULE A****CONTROLLED GOODS CONCERNING MISSILE TECHNOLOGY  
AND RELATED ITEMS****QUOTE****1. INTRODUCTION**

- (a) This Annex consists of two categories of items, which term includes equipment, materials, "software" or "technology". Category 1 items, all of which are in Annex items 1 and 2, are those items of greatest sensitivity. If a Category 1 item is included in a system, that system will also be considered as Category I, except when the incorporated item cannot be separated, removed or duplicated. Category II items are those items in the Annex not designated Category I.
- (b) In reviewing the proposed applications for transfers of complete rocket and unmanned air vehicle systems described in Items 1 and 19, and of equipment, materials, "software" or "technology" which is listed in the Technical Annex, for potential use in such systems, the Government will take account of the ability to trade off range and payload.
- (c) **General Technology Note:**  
The transfer of "technology" directly associated with any goods controlled in the Annex is controlled according to the provisions in each Item to the extent permitted by national legislation. The approval of any Annex item for export also authorizes the export to the same end user of the minimum "technology" required for the installation, operation, maintenance, and repair of the item.

**Note:**

*Controls do not apply to "technology" "in the public domain" or to "basic scientific research".*

**(d) General Software Note:**

The Annex does not control "software" which is either:

1. Generally available to the public by being :
  - a. Sold from stock at retail selling points without restriction, by means of:
    1. Over-the-counter transactions;
    2. Mail order transactions; or
    3. Telephone call transactions; and
  - b. Designed for installation by the user without further substantial support by the supplier; or

## 2. "In the public domain".

### Note:

The General Software Note only applies to general purpose, mass market "software".

## 2. **DEFINITIONS**

For the purpose of this Annex, the following definitions apply:

### "Basic scientific research"

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

### "Development"

Is related to all phases prior to "production" such as:

- design
- design research
- design analysis
- design concepts
- assembly and testing of prototypes
- pilot production schemes
- design data
- process of transforming design data into a product
- configuration design
- integration design
- layouts

### "In the public domain"

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

### "Microcircuit"

A device in which a number of passive and/or active elements are considered as indivisibly associated on or within a continuous structure to perform the function of a circuit.

### "Microprogrammes"

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

### "Production"

Means all production phases such as:

- production engineering
- manufacture
- integration
- assembly (mounting)
- inspection
- testing

- quality assurance

**"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".

**"Programmes"**

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

**"Radiation hardened"**

Means that the component or equipment is designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of  $5 \times 10^5$  rads (Si).

**"Software"**

A collection of one or more "programmes", or "micro-programmes", fixed in any tangible medium of expression.

**"Technology"**

Means specific information which is required for the "development", "production" or "use" of a product. The information may take the form of "technical data" or "technical assistance".

**"Technical assistance"**

May take forms such as:

- instruction
- skills
- training
- working knowledge
- consulting service

**"Technical data"**

May take forms such as:

- blueprints
- plans
- diagrams
- models
- formulae
- engineering designs and specifications
- manuals and instructions written or recorded on other media or devices such as:
  - disk
  - tape
  - read-only memories

"Use"

Means:

- operation
- installation (including on-site installation)
- maintenance
- repair
- overhaul
- refurbishing

### **3. TERMINOLOGY**

Where the following terms appear in the text, they are to be understood according to the explanations below:

- (a) "Specially designed" describes equipment, parts, components or "software" which, as a result of "development", have unique properties that distinguish them for certain predetermined purposes. For example, a piece of equipment that is "specially designed" for use in a missile will only be considered so if it has no other function or use. Similarly, a piece of manufacturing equipment that is "specially designed" to produce a certain type of component will only be considered such if it is not capable of producing other types of components.
- (b) "Designed or modified" describes equipment, parts or components which, as a result of "development," or modification, have specified properties that make them fit for a particular application. "Designed or modified" equipment, parts, components or "software" can be used for other applications. For example, a titanium coated pump designed for a missile may be used with corrosive fluids other than propellants.
- (c) "Usable in" or "capable of" describes equipment, parts, components or "software" which are suitable for a particular purpose. There is no need for the equipment, parts, components or "software" to have been configured, modified or specified for the particular purpose. For example, any military specification memory circuit would be "capable of" operation in a guidance system.
- (d) "Modified" in the context of "software" describes "software" which has been intentionally changed such that it has properties that make it fit for specified purposes or applications. Its properties may also make it suitable for purposes or applications other than those for which it was "modified".

## **CATEGORY I**

### **ITEM 1      COMPLETE DELIVERY SYSTEMS**

#### **1.A.      EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 1.A.1. Complete rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets) capable of delivering at least a 500 kg payload to a range of at least 300 km.



- 1.A.2. Complete unmanned air vehicle systems (including cruise missile systems, target drones and reconnaissance drones) capable of delivering at least a 500 kg payload to a range of at least 300 km.

**1.B. TEST AND PRODUCTION EQUIPMENT**

- 1.B.1. "Production facilities" specially designed for the systems specified in 1.A.

**1.C. MATERIALS**

None.

**1.D. SOFTWARE**

- 1.D.1. "Software" specially designed or modified for the "use" of "production facilities" specified in 1.B.
- 1.D.2. "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in systems specified in 1.A.

**1.E. TECHNOLOGY**

- 1.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 1.A., 1.B., or 1.D.

**ITEM 2      COMPLETE SUBSYSTEMS USABLE FOR COMPLETE DELIVERY SYSTEMS**

**2.A.      EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 2.A.1. Complete subsystems usable in the systems specified in 1.A., as follows:

- a. Individual rocket stages usable in the systems specified in 1.A.;
- b. Re-entry vehicles, and equipment designed or modified therefor, usable in the systems specified in 1.A., as follows, except as provided in Note 1 below for those designed for non-weapon payloads:
  1. Heat shields, and components thereof, fabricated of ceramic or ablative materials;
  2. Heat sinks and components thereof fabricated of light-weight, high heat capacity materials;
  3. Electronic equipment specially designed for re-entry vehicles;
- c. Solid propellant rocket motors or liquid propellant rocket engines, usable in the systems specified in 1.A., having a total impulse capacity of  $1.1 \times 10^6$  Ns ( $2.5 \times 10^5$  lb.s) or greater;

Note:

*Liquid propellant apogee engines specified in 2.A.1.c., designed or modified for satellite applications, may be treated as Category II, if the subsystem is exported subject to end use statements and quantity limits appropriate for the excepted end use stated above, when having all of the following parameters:*

- a. nozzle throat diameter of 20 mm or less; and*
- b. combustion chamber pressure of 15 bar or less.*

- d. 'Guidance sets', usable in the systems specified in 1.A., capable of achieving system accuracy of 3.33% or less of the range (e.g. a 'CEP' of 10 km or less at a range of 300 km), except as provided in Note 1 below for those designed for missiles with a range under 300 km or manned aircraft;

Technical Notes:

- 1. A 'guidance set' integrates the process of measuring and computing a vehicle's position and velocity (i.e. navigation) with that of computing and sending commands to the vehicle's flight control systems to correct the trajectory.
- 2. 'CEP' (circle of equal probability) is 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.
- e. Thrust vector control sub-systems, usable in the systems specified in 1.A., except as provided in Note 1 below for those designed for rocket systems that do not exceed the range/payload capability of systems specified in 1.A.;

Technical Note:

*2.A.1.e. includes the following methods of achieving thrust vector control:*

- a. Flexible nozzle;*
- b. Fluid or secondary gas injection ;*
- c. Movable engine or nozzle;*
- d. Deflection of exhaust gas stream (jet vanes or probes);*
- e. Use of thrust tabs.*
- f. Weapon or warhead safing, arming, fusing, and firing mechanisms, usable in the systems specified in 1.A., except as provided in Note 1 below for those designed for systems other than those specified in 1.A.

Note:

*The exceptions in 2.A.1.b., 2.A.1.c., 2.A.1.d., 2.A.1.e. and 2.A.1.f. above may be treated as Category II if the subsystem is exported subject to end use statements and quantity limits appropriate for the excepted end use stated above.*

**2.B. TEST AND PRODUCTION EQUIPMENT**

- 2.B.1. "Production facilities" specially designed for the subsystems specified in 2.A.
- 2.B.2. "Production equipment" specially designed for the subsystems specified in 2.A.

## 2.C. MATERIALS

None.

## 2.D. SOFTWARE

- 2.D.1. "Software" specially designed or modified for the "use" of "production facilities" specified in 2.B.1.
- 2.D.2. "Software" specially designed or modified for the "use" of rocket motors or engines specified in 2.A.1.c.
- 2.D.3. "Software", specially designed or modified for the "use" of 'guidance sets' specified in 2.A.1.d.

Note:

2.D.3. includes "software", specially designed or modified to enhance the performance of 'guidance sets' to achieve or exceed the accuracy specified in 2.A.1.d.

- 2.D.4. "Software" specially designed or modified for the "use" of subsystems or equipment specified in 2.A.1.b.3.
- 2.D.5. "Software" specially designed or modified for the "use" of systems in 2.A.1.e.
- 2.D.6. "Software" specially designed or modified for the "use" of systems in 2.A.1.f.

Note:

Subject to end-use statements appropriate for the excepted end-use, "software" controlled by 2.D.2. - 2.D.6. may be treated as Category II as follows:

1. Under 2.D.2. if specially designed or modified for liquid propellant apogee engines, designed or modified for satellite applications as specified in the Note to 2.A.1.c.;
2. Under 2.D.3. if designed for missiles with a range of under 300 km or manned aircraft;
3. Under 2.D.4. if specially designed or modified for re-entry vehicles designed for non-weapon payloads;
4. Under 2.D.5. if designed for rocket systems that do not exceed the range payload capability of systems specified in 1.A.;
5. Under 2.D.6. if designed for systems other than those specified in 1.A.

## 2.E. TECHNOLOGY

- 2.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 2.A., 2.B. or 2.D.

**CATEGORY II****ITEM 3      PROPULSION COMPONENTS AND EQUIPMENT****3.A.      EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 3.A.1. Lightweight turbojet and turbofan engines (including turbocompound engines), usable in the systems specified in 1.A., that are small and fuel efficient, as follows:
- a. Engines having both of the following characteristics :
    1. Maximum thrust value greater than 1,000 N (achieved un-installed) excluding civil certified engines with a maximum thrust value greater than 8,890 N (achieved un-installed); and
    2. Specific fuel consumption of  $0.13 \text{ kg N}^{-1} \text{ h}^{-1}$  or less (at sea level static and standard conditions);
  - b. Engines designed or modified for systems specified in 1.A., regardless of thrust or specific fuel consumption.

**Note:**

*Engines specified in 3.A.1. may be exported as part of a manned aircraft or in quantities appropriate for replacement parts for a manned aircraft.*

- 3.A.2. Ramjet/scramjet/pulse jet/combined cycle engines, including devices to regulate combustion, and specially designed components therefor, usable in the systems specified in 1.A.
- 3.A.3. Rocket motor cases, 'insulation' components and nozzles therefor, usable in the systems specified in 1.A.

**Technical Note:**

*In 3.A.3. 'insulation' intended to be applied to the components of a rocket motor, i.e. the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber components comprising sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps.*

**Note:**

*Refer to 3.C.2. for 'insulation' material in bulk or sheet form.*

- 3.A.4. Staging mechanisms, separation mechanisms, and interstages therefor, usable in the systems specified in 1.A.
- 3.A.5. Liquid and slurry propellant (including oxidisers) control systems, and specially designed components therefor, usable in the systems specified in 1.A., designed or modified to operate in vibration environments of more than 10 g RMS between 20 Hz and 2 kHz.

Notes:

1. The only servo valves and pumps specified in 3.A.5. are the following:
  - a. Servo valves designed for flow rates of 24 litres per minute or greater, at an absolute pressure of 7,000 kPa (1,000 psi) or greater, that have an actuator response time of less than 100 ms;
  - b. Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 RPM or with discharge pressures equal to or greater than 7,000 kPa (1,000 psi).
2. Systems and components specified in 3.A.5. may be exported as part of a satellite.

3.A.6. Hybrid rocket motors and specially designed components therefor, usable in the systems specified in 1.A.

**3.B. TEST AND PRODUCTION EQUIPMENT**

- 3.B.1. "Production facilities" specially designed for equipment or materials specified in 3.A. or 3.C.
- 3.B.2. "Production equipment" specially designed for equipment or materials specified in 3.A. or 3.C.
- 3.B.3. Flow-forming machines, and specially designed components therefor, which:
  - a. according to the manufacturers technical specification can be equipped with numerical control units or a computer control, even when not equipped with such units at delivery; and
  - b. have more than two axes which can be co-ordinated simultaneously for contouring control.

Technical Note:

*Machines combining the function of spin-forming and flow-forming are, for the purpose of this item, regarded as flow-forming machines.*

Note:

*This item does not include machines that are not usable in the "production" of propulsion components and equipment (e.g. motor cases) for systems specified in 1.A.*

**3.C. MATERIALS**

- 3.C.1. 'Interior lining' usable for rocket motor cases in the systems specified in 1.A.

Technical Note:

*In 3.C.1. 'interior lining' suited for the bond interface between the solid propellant and the case or insulating liner is usually a liquid polymer based dispersion of*



*refractory or insulating materials e.g., carbon filled HTPB or other polymer with added curing agents to be sprayed or screeded over a case interior.*

- 3.C.2. 'Insulation' material in bulk form usable for rocket motor cases in the systems specified in 1.A.

Technical Note:

*In 3.C.2. 'insulation' intended to be applied to the components of a rocket motor, i.e., the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps specified in 3.A.3.*

**3.D. SOFTWARE**

- 3.D.1. "Software" specially designed or modified for the "use" of "production facilities" and flow forming machines specified in 3.B.1. or 3.B.3.
- 3.D.2. "Software" specially designed or modified for the "use" of equipment specified in 3.A.1., 3.A.2., 3.A.4., 3.A.5. or 3.A.6.

Notes:

- (a) "Software" specially designed or modified for the "use" of engines specified in 3.A.1. may be exported as part of a manned aircraft or as replacement "software" therefor.
- (b) "Software" specially designed or modified for the "use" of propellant control systems specified in 3.A.5. may be exported as part of a satellite or as replacement software therefor.

- 3.D.3. "Software" specially designed or modified for the "development" of equipment specified in 3.A.2., 3.A.3. or 3.A.4.

**3.E. TECHNOLOGY**

- 3.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 3.A., 3.B., 3.C. or 3.D.

**ITEM 4 PROPELLANTS AND CHEMICALS**

**4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**4.B. TEST AND PRODUCTION EQUIPMENT**

None.

**4.C. MATERIALS**

- 4.C.1. Composite and composite modified double base propellants.

#### 4.C.2. Fuel substances as follows:

- a. Hydrazine with a concentration of more than 70 percent and its derivatives including monomethylhydrazine (MMH);
- b. Unsymmetrical dimethylhydrazine (UDMH);
- c. Spherical aluminium powder with particles of uniform diameter of less than  $200 \times 10^{-6}$  m (200  $\mu$ m) and an aluminium content of 97 percent by weight or more, if at least 10 percent of the total weight is made up of particles of less than 63  $\mu$ m, according to ISO 2591:1988 or national equivalents such as JIS Z8820;

Technical Note:

*A particle size of 63  $\mu$ m (ISO R-565) corresponds to 250 mesh (Tyler) or 230 mesh (ASTM standard E-11).*

- d. Zirconium, beryllium, magnesium and alloys of these in particle size less than  $60 \times 10^{-6}$  m (60  $\mu$ m), whether spherical, atomised, spheroidal, flaked or ground, consisting of 97 percent by weight or more of any of the above mentioned metals;

Technical Note:

*The natural content of hafnium in the zirconium (typically 2% to 7%) is counted with the zirconium.*

- e. Boron and boron alloys in particle size less than  $60 \times 10^{-6}$  m (60  $\mu$ m), whether spherical, atomised, spheroidal, flaked or ground with a purity of 85 percent by weight or more;
- f. High energy density materials such as boron slurry, having an energy density of  $40 \times 10^6$  J/kg or greater.

#### 4.C.3. Oxidisers/Fuels as follows:

Perchlorates, chlorates or chromates mixed with powdered metals or other high energy fuel components.

#### 4.C.4. Oxidiser substances as follows:

- a. Liquid oxidiser substances as follows:
  1. Dinitrogen trioxide;
  2. Nitrogen dioxide/dinitrogen tetroxide;
  3. Dinitrogen pentoxide;
  4. Inhibited Red Fuming Nitric Acid (IRFNA);
  5. Compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen;

b. Solid oxidiser substances as follows:

1. Ammonium perchlorate;
2. Ammonium dinitramide (ADN);
3. Nitro-amines (cyclotetramethylene - tetranitramine (HMX); cyclotrimethylene - trinitramine (RDX).

4.C.5. Polymeric substances as follows:

- a. Carboxy - terminated polybutadiene (CTPB);
- b. Hydroxy - terminated polybutadiene (HTPB);
- c. Glycidyl azide polymer (GAP);
- d. Polybutadiene - Acrylic Acid (PBAA);
- e. Polybutadiene - Acrylic Acid- Acrylonitrile (PBAN).

4.C.6. Other propellant additives and agents as follows:

a. Bonding agents as follows:

1. tris (1-(2-methyl)aziridinyl) phosphine oxide (MAPO);
2. trimesoyl-1 (2-ethyl) aziridine (HX-868, BITA);
3. Tepanol (HX878), reaction product of tetraethylenepentamine, acrylonitrile and glycidol;
4. Tepan (HX-879), reaction product of tetraethylenepentamine and acrylonitrile;
5. Polyfunctional aziridine amides with isophthalic, trimesic, isocyanuric, or trimethyladipic backbone also having a 2-methyl or 2-ethyl aziridine group (HX-752, HX-874 and HX-877);

b. Curing agent and catalysts as follows:

Triphenyl bismuth (TPB);

c. Burning rate modifiers as follows:

1. Catocene;
2. N-butyl-ferrocene;
3. Butacene;
4. Other adducted polymer ferrocene derivatives;
5. Carboranes, decarboranes, pentaboranes and derivatives thereof;

d. Nitrate esters and nitrated plasticisers as follows:

1. Triethylene glycol dinitrate (TEGDN);
2. Trimethylolethane trinitrate (TMETN);
3. 1,2,4-butanetriol trinitrate (BTTN);
4. Diethylene glycol dinitrate (DEGDN);

e. Stabilisers as follows:

1. 2-Nitrodiphenylamine;
2. N-methyl-p-nitroaniline.

**4.D. SOFTWARE**

None.



#### **4.E. TECHNOLOGY**

- 4.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of materials specified in 4.C. (See also Item 5.E.).

### **ITEM 5 PROPELLANT PRODUCTION**

#### **5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

#### **5.B. TEST AND PRODUCTION EQUIPMENT**

- 5.B.1. "Production equipment", and specially designed components therefor, for the "production", handling or acceptance testing of liquid propellants or propellant constituents specified in Item 4.
- 5.B.2. "Production equipment", other than that described in 5.B.3., and specially designed components therefor, for the production, handling, mixing, curing, casting, pressing, machining, extruding or acceptance testing of solid propellants or propellant constituents specified in Item 4.
- 5.B.3. Equipment as follows, and specially designed components therefor:
- a. Batch mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:
    1. a total volumetric capacity of 110 litres or more; and
    2. at least one mixing/kneading shaft mounted off centre;
  - b. Continuous mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:
    1. two or more mixing/kneading shafts; and
    2. capability to open the mixing chamber;
  - c. Fluid energy mills usable for grinding or milling substances specified in Item 4;
  - d. Metal powder "production equipment" usable for the "production", in a controlled environment, of spherical or atomised materials specified in 4.C.2.c. or 4.C.2.d:

Note:

*5.B.3.d. includes:*

- a. *Plasma generators (high frequency arc-jet) usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;*
- b. *Electroburst equipment usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;*
- c. *Equipment usable for the "production" of spherical aluminium powders by powdering a melt in an inert medium (e.g. nitrogen).*

Notes:

1. *The only batch mixers, continuous mixers usable for solid propellants or propellants constituents specified in Item 4, and fluid energy mills controlled in Item 5, are those specified in 5.B.3.*
2. *Forms of metal powder "production equipment" not specified in 5.B.3.d. are to be evaluated in accordance with 5.B.2.*

**5.C. MATERIALS**

None.

**5.D. SOFTWARE**

- 5.D.1. "Software" specially designed or modified for the "use" of equipment specified in 5.B. for the "production" and handling of materials specified in Item 4.

**5.E. TECHNOLOGY**

- 5.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 5.B.

**ITEM 6 PRODUCTION OF STRUCTURAL COMPOSITES****6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**6.B. TEST AND PRODUCTION EQUIPMENT**

- 6.B.1. Equipment for the "production" of structural composites, fibres, prepreps or preforms, usable in the systems specified in 1.A., as follows, and specially designed components, and accessories therefor:
- a. Filament winding machines of which the motions for positioning, wrapping and winding fibres can be co-ordinated and programmed in three or more axes, designed to fabricate composite structures or laminates from fibrous or filamentary materials, and co-ordinating and programming controls;
  - b. Tape-laying machines of which the motions for positioning and laying tape and sheets can be co-ordinated and programmed in two or more axes, designed for the manufacture of composite airframes and missile structures;
  - 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;

Note:

*6.B.1.c. does not control textile machinery not modified for the end-uses stated.*

- 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;
  - 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, including rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.

Note:

*Examples of components and accessories for the machines specified in 6.B.1. are moulds, mandrels, dies, fixtures and tooling for the preform pressing, curing, casting, sintering or bonding of composite structures, laminates and manufactures thereof.*

**6.C. MATERIALS**

None.

**6.D. SOFTWARE**

- 6.D.1. "Software" specially designed or modified for the "use" of equipment specified in 6.B.

**6.E. TECHNOLOGY**

- 6.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6.B. or 6.D.
- 6.E.2. "Technical data" (including processing conditions) and procedures for the regulation of temperature, pressures or atmosphere in autoclaves or hydroclaves when used for the production of composites or partially processed composites, usable for equipment or materials specified in Item 8.

**ITEM 7 PYROLYTIC DEPOSITION AND DENSIFICATION**

**7.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**7.B. TEST AND PRODUCTION EQUIPMENT**

- 7.B.1. Nozzles specially designed for the processes referred to in 7.E.1.

**7.B.2. Isostatic presses having all of the following characteristics:**

- a. Maximum working pressure of 69 MPa (10,000 psi) or greater;
- b. Designed to achieve and maintain a controlled thermal environment of 600 °C or greater; and
- c. Possessing a chamber cavity with an inside diameter of 254 mm (10 inches) or greater.

**7.B.3. Chemical vapour deposition furnaces designed or modified for the densification of carbon-carbon composites.**

**7.B.4. Equipment and process controls, other than those specified in 7.B.2. or 7.B.3., designed or modified for densification and pyrolysis of structural composite rocket nozzles and reentry vehicle nose tips.**

**7.C. MATERIALS**

None.

**7.D. SOFTWARE**

**7.D.1. "Software" specially designed or modified for the equipment specified in 7.B.2., 7.B.3. or 7.B.4.**

**7.E. TECHNOLOGY**

**7.E.1. "Technology" for producing pyrolytically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1300 °C to 2900 °C temperature range at pressures of 130 Pa (1 mm Hg) to 20 kPa (150 mm Hg) including "technology" for the composition of precursor gases, flow-rates, and process control schedules and parameters.**

**7.E.2. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 7.B. or 7.D.**

**ITEM 8     STRUCTURAL MATERIALS**

**8.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

**8.A.1. Composite structures, laminates, and manufactures thereof, specially designed for use in the systems specified in 1.A. and the subsystems specified in 2.A.**

**8.A.2. Resaturated pyrolysed (i.e. carbon-carbon) components having all of the following:**

- a. designed for rocket systems; and
- b. usable in the systems specified in 1.A.

**8.B. TEST AND PRODUCTION EQUIPMENT**

None.

**8.C. MATERIALS**

- 8.C.1. Resin impregnated fibre preregs and metal coated fibre preforms, for the goods specified in 8.A.1., made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a specific tensile strength greater than  $7.62 \times 10^4$  m and a specific modulus greater than  $3.18 \times 10^6$  m.

Note:

*The only resin impregnated fibre preregs specified in 8.C.1. are those using resins with a glass transition temperature ( $T_g$ ), after cure, exceeding  $145^\circ\text{C}$  as determined by ASTM D4065 or national equivalents.*

- 8.C.2. Resaturated pyrolysed (i.e. carbon-carbon) materials having all of the following:  
a. designed for rocket systems; and  
b. usable in the systems specified in 1.A.
- 8.C.3. Fine grain recrystallised bulk graphites (with a bulk density of at least  $1.72 \text{ g/cm}^3$  measured at  $15^\circ\text{C}$ ) and having a particle size of  $100 \times 10^{-6} \text{ m}$  ( $100 \mu\text{m}$ ) or less, usable for rocket nozzles and re-entry vehicle nose tips usable in systems specified in 1.A.
- 8.C.4. Pyrolytic or fibrous reinforced graphites usable for rocket nozzles and re-entry vehicle nose tips usable in systems specified in 1.A.
- 8.C.5. Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10 GHz) for use in missile radomes usable in systems specified in 1.A.
- 8.C.6. Bulk machinable silicon-carbide reinforced unfired ceramic usable for nose tips usable in systems specified in 1.A.
- 8.C.7. Tungsten, molybdenum, and alloys of these metals in the form of uniform spherical or atomised particles of  $500 \times 10^{-6} \text{ m}$  ( $500 \mu\text{m}$ ) diameter or less with a purity of 97% or higher for fabrication of rocket motor components, i.e. heat shields, nozzle substrates, nozzle throats, and thrust vector control surfaces, usable in systems specified in 1.A.
- 8.C.8. Maraging steels having an ultimate tensile strength of  $1.5 \times 10^9 \text{ Pa}$  or greater, measured at  $20^\circ\text{C}$ , in the form of sheet, plate or tubing with a wall or plate thickness equal to or less than 5.0 mm usable in systems specified in 1.A.

Technical Note:

*Maraging steels are generally characterised by high nickel, very low carbon content and use substitutional elements or precipitates to produce age-hardening.*



8.C.9. Titanium-stabilized duplex stainless steel (Ti-DSS) usable in the systems specified in 1.A. and having all of the following:

- a. Having all of the following characteristics:
  - 1. containing 17.0 - 23.0 weight percent chromium and 4.5 - 7.0 weight percent nickel;
  - 2. having a titanium content of greater than 0.10 weight percent; and
  - 3. a ferritic-austenitic microstructure (also referred to as a two-phase microstructure) of which at least 10 percent is austenite by volume (according to ASTM E-1181-87 or national equivalents); and
- b. Having any of the following forms:
  - 1. ingots or bars having a size of 100 mm or more in each dimension;
  - 2. sheets having a width of 600 mm or more and a thickness of 3 mm or less; or
  - 3. tubes having an outer diameter of 600 mm or more and a wall thickness of 3 mm or less.

#### 8.D. SOFTWARE

None.

#### 8.E. TECHNOLOGY

- 8.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or materials specified in 8.A. or 8.C.

### ITEM 9 INSTRUMENTATION, NAVIGATION AND DIRECTION FINDING

#### 9.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 9.A.1. Integrated flight instrument systems which include gyrostabilisers or automatic pilots, designed or modified for use in the systems specified in 1.A., and specially designed components therefor.
- 9.A.2. Gyro-astro compasses and other devices which derive position or orientation by means of automatically tracking celestial bodies or satellites, and specially designed components therefor.
- 9.A.3. Accelerometers with a threshold of 0.05 g or less, or a linearity error within 0.25% of full scale output, or both, which are designed for use in inertial navigation systems or in guidance systems of all types, and specially designed components therefor.

Note:

*Accelerometers which are specially designed and developed as MWD (Measurement While Drilling) sensors for use in downhole well service operations are not controlled in 9.A.3.*

- 9.A.4. All types of gyros usable in the systems specified in 1.A., with a rated 'drift rate' 'stability' of less than 0.5 degrees (1 sigma or rms) per hour in a 1 g environment and specially designed components therefor.

Technical Notes:

1. 'Drift rate' is defined as the time rate of output deviation from the desired output. It consists of random and systematic components and is expressed as an equivalent angular displacement per unit time with respect to inertial space.
2. 'Stability' is defined as 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.

- 9.A.5. Continuous output accelerometers or gyros of any type, specified to function at acceleration levels greater than 100 g, and specially designed components therefor.

- 9.A.6. Inertial or other equipment using accelerometers specified in 9.A.3. or 9.A.5. or gyros specified in 9.A.4. or 9.A.5., and systems incorporating such equipment, and specially designed components therefor.

**9.B. TEST AND PRODUCTION EQUIPMENT**

- 9.B.1. "Production equipment", and other test, calibration and alignment equipment, other than that described in 9.B.2., designed or modified to be used with equipment specified in 9.A.

Note:

*Equipment specified in 9.B.1. includes the following:*

- a. For laser gyro equipment, the following equipment used to characterise mirrors, having the threshold accuracy shown or better:
  1. Scatterometer (10 ppm);
  2. Reflectometer (50 ppm);
  3. Profilometer (5 Angstroms);
- b. For other inertial equipment:
  1. Inertial Measurement Unit (IMU Module) Tester;
  2. IMU Platform Tester;
  3. IMU Stable Element Handling Fixture;
  4. IMU Platform Balance Fixture;
  5. Gyro Tuning Test Station;
  6. Gyro Dynamic Balance Station;
  7. Gyro Run-In/Motor Test Station;
  8. Gyro Evacuation and Filling Station;
  9. Centrifuge Fixture for Gyro Bearings;
  10. Accelerometer Axis Align Station;
  11. Accelerometer Test Station.

**9.B.2. Equipment as follows:**

- a. Balancing machines having all the following characteristics:
  1. not capable of balancing rotors/assemblies having a mass greater than 3 kg;
  2. capable of balancing rotors/assemblies at speeds greater than 12,500 rpm;
  3. capable of correcting unbalance in two planes or more; and
  4. capable of balancing to a residual specific unbalance of 0.2 g mm per kg of rotor mass;
- b. Indicator heads (sometimes known as balancing instrumentation) designed or modified for use with machines specified in 9.B.2.a.;
- c. Motion simulators/rate tables (equipment capable of simulating motion) having all of the following characteristics:
  1. two axes or more;
  2. slip rings capable of transmitting electrical power and/or signal information; and
  3. having any of the following characteristics:
    - a. for any single axis having all of the following:
      1. capable of rates of 400 degrees/s or more, or 30 degrees/s or less; and
      2. a rate resolution equal to or less than 6 degrees/s and an accuracy equal to or less than 0.6 degrees/s;
    - b. having a worst-case rate stability equal to or better (less) than plus or minus 0.05% averaged over 10 degrees or more; or
    - c. a positioning accuracy equal to or better than 5 arc second;
- d. Positioning tables (equipment capable of precise rotary positioning in any axes) having the following characteristics:
  1. two axes or more; and
  2. a positioning accuracy equal to or better than 5 arc second;
- e. Centrifuges capable of imparting accelerations above 100 g and having slip rings capable of transmitting electrical power and signal information.

**Notes:**

1. *The only balancing machines, indicator heads, motion simulators, rate tables, positioning tables and centrifuges specified in Item 9 are those specified in 9.B.2.*
2. *9.B.2.a. does not control balancing machines designed or modified for dental or other medical equipment.*
3. *9.B.2.c. and 9.B.2.d. do not control rotary tables designed or modified for machine tools or for medical equipment.*
4. *Rate tables not controlled by 9.B.2.c. and providing the characteristics of a positioning table are to be evaluated according to 9.B.2.d.*
5. *Equipment that has the characteristics specified in 9.B.2.d. which also meets the characteristics of 9.B.2.c. will be treated as equipment specified in 9.B.2.c.*



**9.C. MATERIALS**

None.

**9.D. SOFTWARE**

9.D.1. "Software" specially designed or modified for the "use" of equipment specified in 9.A. or 9.B.

9.D.2. Integration "software" for the equipment specified in 9.A.1.

9.D.3. Integration "software" specially designed for the equipment specified in 9.A.6.

**9.E. TECHNOLOGY**

9.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 9.A., 9.B. or 9.D.

**Note:**

*Equipment or "software" specified in 9.A. or 9.D. may be exported as part of a manned aircraft, satellite, land vehicle or marine vessel or in quantities appropriate for replacement parts for such applications.*

**ITEM 10 FLIGHT CONTROL****10.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

10.A.1. Hydraulic, mechanical, electro-optical, or electromechanical flight control systems (including fly-by-wire systems) designed or modified for the systems specified in 1.A.

10.A.2. Attitude control equipment designed or modified for the systems specified in 1.A.

**Note:**

*Systems or equipment specified in 10.A. may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*

**10.B. TEST AND PRODUCTION EQUIPMENT**

10.B.1. Test, calibration, and alignment equipment specially designed for equipment specified in 10.A.

**10.C. MATERIALS**

None.

## 10.D. SOFTWARE

- 10.D.1. "Software" specially designed or modified for the "use" of equipment specified in 10.A. or 10.B.

Note:

"Software" specified in 10.D.1. may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

## 10.E. TECHNOLOGY

- 10.E.1. Design "technology" for integration of air vehicle fuselage, propulsion system and lifting control surfaces, designed or modified for the systems specified in 1.A., to optimise aerodynamic performance throughout the flight regime of an unmanned air vehicle.
- 10.E.2. Design "technology" for integration of the flight control, guidance, and propulsion data into a flight management system, designed or modified for the systems specified in 1.A., for optimisation of rocket system trajectory.
- 10.E.3. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 10.A., 10.B. or 10.D.

## ITEM 11 AVIONICS

### 11.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 11.A.1. Radar and laser radar systems, including altimeters, designed or modified for use in the systems specified in 1.A.

Technical Note:

*Laser radar systems embody specialised transmission, scanning, receiving and signal processing techniques for utilisation of lasers for echo ranging, direction finding and discrimination of targets by location, radial speed and body reflection characteristics.*

- 11.A.2. Passive sensors for determining bearings to specific electromagnetic sources (direction finding equipment) or terrain characteristics, designed or modified for use in the systems specified in 1.A.
- 11.A.3. Global Positioning System (GPS) or similar satellite receivers, designed or modified for use in the systems specified in 1.A., having any of the following characteristics:
- a. Capable of providing navigation information under the following operational conditions:

1. At speeds in excess of 515 m/s (1,000 nautical miles/hour); and
2. At altitudes in excess of 18 km (60,000 feet); or

b. Designed or modified for use with unmanned air vehicles specified in 1.A.2.

11.A.4. Electronic assemblies and components, designed or modified for use in the systems specified in 1.A. and specially designed for military use and operation at temperatures in excess of 125 °C.

Notes:

1. *Equipment specified in 11.A. includes the following:*
  - a. *Terrain contour mapping equipment;*
  - b. *Scene mapping and correlation (both digital and analogue) equipment;*
  - c. *Doppler navigation radar equipment;*
  - d. *Passive interferometer equipment;*
  - e. *Imaging sensor equipment (both active and passive).*
2. *Equipment specified in 11.A. may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*

**11.B. TEST AND PRODUCTION EQUIPMENT**

None.

**11.C. MATERIALS**

None.

**11.D. SOFTWARE**

11.D.1. "Software" specially designed or modified for the "use" of equipment specified in 11.A.1., 11.A.2. or 11.A.4.

11.D.2. "Software" specially designed for the "use" of equipment specified in 11.A.3.

**11.E. TECHNOLOGY**

11.E.1. Design "technology" for protection of avionics and electrical subsystems against electromagnetic pulse (EMP) and electromagnetic interference (EMI) hazards from external sources, as follows:

- a. Design "technology" for shielding systems;
- b. Design "technology" for the configuration of hardened electrical circuits and subsystems;
- c. Design "technology" for determination of hardening criteria for the above.

11.E.2. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 11.A. or 11.D.

**ITEM 12 LAUNCH SUPPORT****12.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 12.A.1. Apparatus and devices, designed or modified for the handling, control, activation and launching of the systems specified in 1.A.
- 12.A.2. Vehicles designed or modified for the transport, handling, control, activation and launching of the systems specified in 1.A.
- 12.A.3. Gravity meters (gravimeters), gravity gradiometers, and specially designed components therefor, designed or modified for airborne or marine use, and having a static or operational accuracy of  $7 \times 10^{-6} \text{ m/s}^2$  (0.7 milligal) or better, with a time to steady-state registration of two minutes or less, usable for systems specified in 1.A.
- 12.A.4. Telemetry and telecontrol equipment having all of the following:
- usable for unmanned air vehicles or rocket systems; and
  - usable for systems specified in 1.A.
- 12.A.5. Precision tracking systems, usable for systems specified in 1.A., as follows:
- Tracking systems which use a code translator installed on the rocket or unmanned air vehicle in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of inflight position and velocity;
  - Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
    - angular resolution better than 3 mrad (0.5 mils);
    - range of 30 km or greater with a range resolution better than 10 m RMS; and
    - velocity resolution better than 3 m/s.

**12.B. TEST AND PRODUCTION EQUIPMENT**

None.

**12.C. MATERIALS**

None.

**12.D. SOFTWARE**

- 12.D.1. "Software" specially designed or modified for the "use" of equipment specified in 12.A.1.

12.D.2. "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for systems specified in 1.A.

12.D.3. "Software" specially designed or modified for the "use" of equipment specified in 12.A.4. or 12.A.5., usable for systems specified in 1.A.

## **12.E. TECHNOLOGY**

12.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 12.A. or 12.D.

## **ITEM 13 COMPUTERS**

### **13.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

13.A.1. Analogue computers, digital computers or digital differential analysers, designed or modified for use in the systems specified in 1.A., having any of the following characteristics:

- a. Rated for continuous operation at temperatures from below  $-45^{\circ}\text{C}$  to above  $+55^{\circ}\text{C}$ ; or
- b. Designed as ruggedised or "radiation hardened".

### **13.B. TEST AND PRODUCTION EQUIPMENT**

None.

### **13.C. MATERIALS**

None.

### **13.D. SOFTWARE**

None.

### **13.E. TECHNOLOGY**

13.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 13.A.

#### **Note:**

*Item 13 equipment may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*

**ITEM 14 ANALOGUE TO DIGITAL CONVERTERS****14.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

14.A.1. Analogue-to-digital converters, usable in the systems specified in 1.A., having any of the following characteristics:

- a. Designed to meet military specifications for ruggedised equipment; or
- b. Designed or modified for military use and being any of the following types:
  1. Analogue-to-digital converter "microcircuits", which are "radiation-hardened" or have all of the following characteristics:
    - a. Having a quantisation corresponding to 8 bits or more when coded in the binary system;
    - b. Rated for operation in the temperature range from below  $-54^{\circ}\text{C}$  to above  $+125^{\circ}\text{C}$ ; and
    - c. Hermetically sealed; or
  2. Electrical input type analogue-to-digital converter printed circuit boards or modules, having all of the following characteristics:
    - a. Having a quantisation corresponding to 8 bits or more when coded in the binary system;
    - b. Rated for operation in the temperature range from below  $-45^{\circ}\text{C}$  to above  $+55^{\circ}\text{C}$ ; and
    - c. Incorporating "microcircuits" specified in 14.A.1.b.1.

**14.B. TEST AND PRODUCTION EQUIPMENT**

None.

**14.C. MATERIALS**

None.

**14.D. SOFTWARE**

None.

**14.E. TECHNOLOGY**

14.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 14.A.

**ITEM 15 TEST FACILITIES AND EQUIPMENT****15.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.



**15.B. TEST AND PRODUCTION EQUIPMENT**

- 15.B.1. Vibration test equipment, usable for the systems specified in 1.A. or the subsystems specified in 2.A., and components therefor, as follows:
- 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 2 kHz and imparting forces of 50 kN (11,250 lbs), measured bare table, or greater;
  - 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 specified in 15.B.1.a.;
  - 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 specified in 15.B.1.a.;
  - Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN, measured bare table, or greater, and usable in vibration test systems specified in 15.B.1.a.

Technical Note:

*Vibration test systems incorporating a digital controller are those systems, the functions of which are, partly or entirely, automatically controlled by stored and digitally coded electrical signals.*

- 15.B.2. Wind-tunnels for speeds of Mach 0.9 or more, usable for the systems specified in 1.A. or the subsystems specified in 2.A.
- 15.B.3. Test benches/stands, usable for the systems specified in 1.A. or the subsystems specified in 2.A., which have the capacity to handle solid or liquid propellant rockets, motors or engines of more than 90 kN (20,000 lbs) of thrust, or which are capable of simultaneously measuring the three axial thrust components.
- 15.B.4. Environmental chambers and anechoic chambers, as follows, usable for the systems specified in 1.A. or the subsystems specified in 2.A.:
- Environmental chambers capable of simulating all of the following flight conditions:
    - Vibration environments of 10 g RMS or greater between 20 Hz and 2 kHz imparting forces of 5 kN or greater; and
    - any of the following:
      - Altitude of 15,000 m or greater; or
      - Temperature range of at least -50 °C to 125 °C;
  - Anechoic chambers capable of simulating all of the following flight conditions:
    - Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to  $2 \times 10^{-5}$  N/m<sup>2</sup>) or with a rated power output of 4 kW or greater; and
    - any of the following:
      - Altitude of 15,000 m or greater; or

b. Temperature range of at least  $-50^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

- 15.B.5. Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and equipment containing those accelerators, usable for the systems specified in 1.A. or the subsystems specified in 2.A.

Note:

*15.B.5. does not control equipment specially designed for medical purposes.*

**15.C. MATERIALS**

None.

**15.D. SOFTWARE**

- 15.D.1. "Software" specially designed or modified for the "use" of equipment specified in 15.B. usable for testing systems specified in 1.A. or subsystems specified in 2.A.

**15.E. TECHNOLOGY**

- 15.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 15.B. or 15.D.

**ITEM 16 MODELLING-SIMULATION AND DESIGN INTEGRATION**

**16.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 16.A.1. Specially designed hybrid (combined analogue/digital) computers for modelling, simulation or design integration of systems specified in 1.A. or the subsystems specified in 2.A.

Note:

*This control only applies when the equipment is supplied with "software" specified in 16.D.1.*

**16.B. TEST AND PRODUCTION EQUIPMENT**

None.

**16.C. MATERIALS**

None.

**16.D. SOFTWARE**

- 16.D.1. "Software" specially designed for modelling, simulation, or design integration of the systems specified in 1.A. or the subsystems specified in 2.A.



Technical Note:

*The modelling includes in particular the aerodynamic and thermodynamic analysis of the systems.*

**16.E. TECHNOLOGY**

- 16.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 16.A. or 16.D.

**ITEM 17 STEALTH**

**17.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 17.A.1. Devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 1.A. or the subsystems specified in 2.A.

**17.B. TEST AND PRODUCTION EQUIPMENT**

- 17.B.1. Systems, specially designed for radar cross section measurement, usable for the systems specified in 1.A. or the subsystems specified in 2.A.

**17.C. MATERIALS**

- 17.C.1. Materials for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 1.A. or the subsystems specified in 2.A.

Notes:

1. 17.C.1. includes structural materials and coatings (including paints), specially designed for reduced or tailored reflectivity or emissivity in the microwave, infrared or ultraviolet spectra.-
2. 17.C.1. does not control coatings (including paints) when specially used for thermal control of satellites.

**17.D. SOFTWARE**

- 17.D.1. "Software" specially designed for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 1.A. or the subsystems specified in 2.A.

Note:

- 17.D.1. includes "software" specially designed for analysis of signature reduction.

**17.E. TECHNOLOGY**

- 17.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 17.A., 17.B., 17.C. or 17.D.

Note:

17.E.1. includes databases specially designed for analysis of signature reduction.

**ITEM 18 NUCLEAR EFFECTS PROTECTION****18.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 18.A.1. "Radiation Hardened" "microcircuits" usable in protecting rocket systems and unmanned air vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 1.A.
- 18.A.2. 'Detectors' specially designed or modified to protect rocket systems and unmanned air vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 1.A.

Technical Note:

A 'detector' is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material.

- 18.A.3. Radomes designed to withstand a combined thermal shock greater than  $4.184 \times 10^6 \text{ J/m}^2$  accompanied by a peak over pressure of greater than 50 kPa, usable in protecting rocket systems and unmanned air vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 1.A.

**18.B. TEST AND PRODUCTION EQUIPMENT**

None.

**18.C. MATERIALS**

None.

**18.D. SOFTWARE**

None.

**18.E. TECHNOLOGY**

- 18.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 18.A.

**ITEM 19 OTHER COMPLETE DELIVERY SYSTEMS****19.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 19.A.1. Complete rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets), not specified in 1.A.1., capable of a maximum range equal to or greater than 300 km.
- 19.A.2. Complete unmanned air vehicle systems (including cruise missile systems, target drones and reconnaissance drones), not specified in 1.A.2., capable of a maximum range equal to or greater than 300 km.

**19.B. TEST AND PRODUCTION EQUIPMENT**

None.

**19.C. MATERIALS**

None.

**19.D. SOFTWARE**

- 19.D.1. "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in the systems specified in 19.A.

**19.E. TECHNOLOGY**

- 19.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 19.A.

**ITEM 20 OTHER COMPLETE SUBSYSTEMS****20.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 20.A.1. Complete subsystems as follows:

- a. Individual rocket stages, not specified in 2.A.1., usable in systems specified in 19.A.;
- b. Solid propellant rocket motors or liquid propellant rocket engines, not specified in 2.A.1., usable in systems specified in 19.A., having a total impulse capacity

of  $8.41 \times 10^5$  Ns ( $1.91 \times 10^5$  lb.s) or greater, but less than  $1.1 \times 10^6$  Ns ( $2.5 \times 10^5$  lb.s).

**20.B. TEST AND PRODUCTION EQUIPMENT**

20.B.1. "Production facilities" specially designed for the subsystems specified in 20.A.

20.B.2. "Production equipment" specially designed for the subsystems specified in 20.A.

**20.C. MATERIALS**

None.

**20.D. SOFTWARE**

20.D.1. "Software" specially designed or modified for the systems specified in 20.B.1.

20.D.2. "Software", not specified in 20.D.1., specially designed or modified for the "use" of rocket motors or engines specified in 20.A.1.b.

**20.E. TECHNOLOGY**

20.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 20.A., 20.B. or 20.D.

**END QUOTE**

**KENNISGEWING INGEVOLGE ARTIKEL 13 VAN DIE WET OP DIE NIE-PROLIFERASIE  
VAN WAPENS VAN GROOTSKAALSE Vernietiging, 1993**

**VERKLARING VAN SEKERE MISSIELTEGNOLOGIE EN VERWANTE ITEMS TOT  
BEHEERDE GOEDERE EN BEHEERMAATREËLS WAT OP SODANIGE GOEDERE VAN  
TOEPASSING IS**

1. Ek, Alec Erwin, Minister van Handel en Nywerheid, handelende op aanbeveling van die Suid-Afrikaanse Raad vir die Nie-proliferasie van Wapens van Groot skaalse Vernietiging, en kragtens artikel 13 van die Wet op die Nie-proliferasie van Wapens van Groot skaalse Vernietiging, 1993 (Wet No. 87 van 1993) -
  - (a) verklaar hierby alle items gelys in die *Missile Technology Control Regime (MTCR) Equipment and Technology Annex*, gedateer 14 Oktober 1999, soos in Bylae A van hierdie kennisgewing in Engels aangehaal, tot beheerde goedere;
  - (b) bepaal hierby dat die invoer, uitvoer en deurvoer van sodanige beheerde goedere mag plaasvind slegs kragtens 'n permit wat deur genoemde Raad, ingestel by artikel 4 van genoemde Wet, uitgereik is;
  - (c) bepaal hierby dat die plaaslike oordrag of verkoop van sodanig beheerde goedere deur 'n persoon bedoel in artikel 13(3) van genoemde Wet slegs mag plaasvind indien die ontvanger van van die goedere ingevolge genoemde artikel geregistreer is en genoemde Raad deur middel van 'n verklaring deur die verskaffer van die transaksie in kennis gestel is; en
  - (d) herroep hierby Goewermentskennisgewing No. R. 1789 van 14 Oktober 1994.
2. Aansoekvorms vir permitte en registrasies ingevolge artikel 13(3) van genoemde Wet is verkrygbaar van:

Die Sekretariaat  
Die Suid-Afrikaanse Raad vir die Nie-proliferasie van Wapens van Groot skaalse  
Vernietiging  
Privaat Sak X84  
**PRETORIA**  
0001



**ALEC ERWIN,**  
Minister van Handel en Nywerheid

**BYLAE A****BEHEERDE GOEDERE TEN OPSIGTE VAN MISSIELTEGNOLOGIE  
EN VERWANTE ITEMS****AANHALING BEGIN****1. INTRODUCTION**

- (a) This Annex consists of two categories of items, which term includes equipment, materials, "software" or "technology". Category 1 items, all of which are in Annex items 1 and 2, are those items of greatest sensitivity. If a Category 1 item is included in a system, that system will also be considered as Category I, except when the incorporated item cannot be separated, removed or duplicated. Category II items are those items in the Annex not designated Category I.
- (b) In reviewing the proposed applications for transfers of complete rocket and unmanned air vehicle systems described in Items 1 and 19, and of equipment, materials, "software" or "technology" which is listed in the Technical Annex, for potential use in such systems, the Government will take account of the ability to trade off range and payload.
- (c) **General Technology Note:**  
The transfer of "technology" directly associated with any goods controlled in the Annex is controlled according to the provisions in each Item to the extent permitted by national legislation. The approval of any Annex item for export also authorizes the export to the same end user of the minimum "technology" required for the installation, operation, maintenance, and repair of the item.

**Note:**

*Controls do not apply to "technology" "in the public domain" or to "basic scientific research".*

(d) **General Software Note:**

The Annex does not control "software" which is either:

1. Generally available to the public by being :
  - a. Sold from stock at retail selling points without restriction, by means of:
    1. Over-the-counter transactions;
    2. Mail order transactions; or
    3. Telephone call transactions; and
  - b. Designed for installation by the user without further substantial support by the supplier; or
2. "In the public domain".



Note:

The General Software Note only applies to general purpose, mass market "software".

## 2. DEFINITIONS

For the purpose of this Annex, the following definitions apply:

**"Basic scientific research"**

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

**"Development"**

Is related to all phases prior to "production" such as:

- design
- design research
- design analysis
- design concepts
- assembly and testing of prototypes
- pilot production schemes
- design data
- process of transforming design data into a product
- configuration design
- integration design
- layouts

**"In the public domain"**

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

**"Microcircuit"**

A device in which a number of passive and/or active elements are considered as indivisibly associated on or within a continuous structure to perform the function of a circuit.

**"Microprogrammes"**

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

**"Production"**

Means all production phases such as:

- production engineering
- manufacture
- integration
- assembly (mounting)
- inspection



- testing
- quality assurance

**"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".

**"Programmes"**

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

**"Radiation hardened"**

Means that the component or equipment is designed or rated to withstand radiation levels which meet or exceed a total irradiation dose of  $5 \times 10^5$  rads (Si).

**"Software"**

A collection of one or more "programmes", or "micro-programmes", fixed in any tangible medium of expression.

**"Technology"**

Means specific information which is required for the "development", "production" or "use" of a product. The information may take the form of "technical data" or "technical assistance".

**"Technical assistance"**

May take forms such as:

- instruction
- skills
- training
- working knowledge
- consulting service

**"Technical data"**

May take forms such as:

- blueprints
- plans
- diagrams
- models
- formulae
- engineering designs and specifications
- manuals and instructions written or recorded on other media or devices such as:

- disk
- tape
- read-only memories

**"Use"**

**Means:**

- operation
- installation (including on-site installation)
- maintenance
- repair
- overhaul
- refurbishing

### **3. TERMINOLOGY**

Where the following terms appear in the text, they are to be understood according to the explanations below:

- (a) "Specially designed" describes equipment, parts, components or "software" which, as a result of "development", have unique properties that distinguish them for certain predetermined purposes. For example, a piece of equipment that is "specially designed" for use in a missile will only be considered so if it has no other function or use. Similarly, a piece of manufacturing equipment that is "specially designed" to produce a certain type of component will only be considered such if it is not capable of producing other types of components.
- (b) "Designed or modified" describes equipment, parts or components which, as a result of "development," or modification, have specified properties that make them fit for a particular application. "Designed or modified" equipment, parts, components or "software" can be used for other applications. For example, a titanium coated pump designed for a missile may be used with corrosive fluids other than propellants.
- (c) "Usable in" or "capable of" describes equipment, parts, components or "software" which are suitable for a particular purpose. There is no need for the equipment, parts, components or "software" to have been configured, modified or specified for the particular purpose. For example, any military specification memory circuit would be "capable of" operation in a guidance system.
- (d) "Modified" in the context of "software" describes "software" which has been intentionally changed such that it has properties that make it fit for specified purposes or applications. Its properties may also make it suitable for purposes or applications other than those for which it was "modified".

### **CATEGORY I**

#### **ITEM 1      COMPLETE DELIVERY SYSTEMS**

##### **1.A.      EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 1.A.1. Complete rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets) capable of delivering at least a 500 kg payload to a range of at least 300 km.

- 1.A.2. Complete unmanned air vehicle systems (including cruise missile systems, target drones and reconnaissance drones) capable of delivering at least a 500 kg payload to a range of at least 300 km.

**1.B. TEST AND PRODUCTION EQUIPMENT**

- 1.B.1. "Production facilities" specially designed for the systems specified in 1.A.

**1.C. MATERIALS**

None.

**1.D. SOFTWARE**

- 1.D.1. "Software" specially designed or modified for the "use" of "production facilities" specified in 1.B.
- 1.D.2. "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in systems specified in 1.A.

**1.E. TECHNOLOGY**

- 1.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 1.A., 1.B., or 1.D.

**ITEM 2      COMPLETE SUBSYSTEMS USABLE FOR COMPLETE DELIVERY SYSTEMS**

**2.A.      EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 2.A.1. Complete subsystems usable in the systems specified in 1.A., as follows:
- a. Individual rocket stages usable in the systems specified in 1.A.;
  - b. Re-entry vehicles, and equipment designed or modified therefor, usable in the systems specified in 1.A., as follows, except as provided in Note 1 below for those designed for non-weapon payloads:
    - 1. Heat shields, and components thereof, fabricated of ceramic or ablative materials;
    - 2. Heat sinks and components thereof fabricated of light-weight, high heat capacity materials;
    - 3. Electronic equipment specially designed for re-entry vehicles;

- c. Solid propellant rocket motors or liquid propellant rocket engines, usable in the systems specified in 1.A., having a total impulse capacity of  $1.1 \times 10^6$  Ns ( $2.5 \times 10^5$  lb.s) or greater;

Note:

*Liquid propellant apogee engines specified in 2.A.1.c., designed or modified for satellite applications, may be treated as Category II, if the subsystem is exported subject to end use statements and quantity limits appropriate for the excepted end use stated above, when having all of the following parameters:*

- a. nozzle throat diameter of 20 mm or less; and  
b. combustion chamber pressure of 15 bar or less.*

- d. 'Guidance sets', usable in the systems specified in 1.A., capable of achieving system accuracy of 3.33% or less of the range (e.g. a 'CEP' of 10 km or less at a range of 300 km), except as provided in Note 1 below for those designed for missiles with a range under 300 km or manned aircraft;

Technical Notes:

1. A 'guidance set' integrates the process of measuring and computing a vehicle's position and velocity (i.e. navigation) with that of computing and sending commands to the vehicle's flight control systems to correct the trajectory.
  2. 'CEP' (circle of equal probability) is 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.
- e. Thrust vector control sub-systems, usable in the systems specified in 1.A., except as provided in Note 1 below for those designed for rocket systems that do not exceed the range/payload capability of systems specified in 1.A.;

Technical Note:

*2.A.1.e. includes the following methods of achieving thrust vector control:*

- a. Flexible nozzle;*
  - b. Fluid or secondary gas injection ;*
  - c. Movable engine or nozzle;*
  - d. Deflection of exhaust gas stream (jet vanes or probes);*
  - e. Use of thrust tabs.*
- f. Weapon or warhead safing, arming, fusing, and firing mechanisms, usable in the systems specified in 1.A., except as provided in Note 1 below for those designed for systems other than those specified in 1.A.

Note:

*The exceptions in 2.A.1.b., 2.A.1.c., 2.A.1.d., 2.A.1.e. and 2.A.1.f. above may be treated as Category II if the subsystem is exported subject to end use statements and quantity limits appropriate for the excepted end use stated above.*

**2.B. TEST AND PRODUCTION EQUIPMENT**

- 2.B.1. "Production facilities" specially designed for the subsystems specified in 2.A.
- 2.B.2. "Production equipment" specially designed for the subsystems specified in 2.A.

**2.C. MATERIALS**

None.

**2.D. SOFTWARE**

- 2.D.1. "Software" specially designed or modified for the "use" of "production facilities" specified in 2.B.1.
- 2.D.2. "Software" specially designed or modified for the "use" of rocket motors or engines specified in 2.A.1.c.
- 2.D.3. "Software", specially designed or modified for the "use" of 'guidance sets' specified in 2.A.1.d.

Note:

2.D.3. includes "software", specially designed or modified to enhance the performance of 'guidance sets' to achieve or exceed the accuracy specified in 2.A.1.d.

- 2.D.4. "Software" specially designed or modified for the "use" of subsystems or equipment specified in 2.A.1.b.3.
- 2.D.5. "Software" specially designed or modified for the "use" of systems in 2.A.1.e.
- 2.D.6. "Software" specially designed or modified for the "use" of systems in 2.A.1.f.

Note:

*Subject to end-use statements appropriate for the excepted end-use, "software" controlled by 2.D.2. - 2.D.6. may be treated as Category II as follows:*

- 1. *Under 2.D.2. if specially designed or modified for liquid propellant apogee engines, designed or modified for satellite applications as specified in the Note to 2.A.1.c.;*
- 1000.2. *Under 2.D.3. if designed for missiles with a range of under 300 km or manned aircraft;*
- 1000.3. *Under 2.D.4. if specially designed or modified for re-entry vehicles designed for non-weapon payloads;*
- 4. *Under 2.D.5. if designed for rocket systems that do not exceed the range payload capability of systems specified in 1.A.;*
- 1000.5. *Under 2.D.6. if designed for systems other than those specified in 1.A.*

## 2.E. TECHNOLOGY

- 2.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 2.A., 2.B. or 2.D.

## CATEGORY II

### ITEM 3      PROPULSION COMPONENTS AND EQUIPMENT

#### 3.A.      EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 3.A.1. Lightweight turbojet and turbofan engines (including turbocompound engines), usable in the systems specified in 1.A., that are small and fuel efficient, as follows:
- a. Engines having both of the following characteristics :
    1. Maximum thrust value greater than 1,000 N (achieved un-installed) excluding civil certified engines with a maximum thrust value greater than 8,890 N (achieved un-installed); and
    2. Specific fuel consumption of  $0.13 \text{ kg N}^{-1} \text{ h}^{-1}$  or less (at sea level static and standard conditions);
  - b. Engines designed or modified for systems specified in 1.A., regardless of thrust or specific fuel consumption.

Note:

*Engines specified in 3.A.1. may be exported as part of a manned aircraft or in quantities appropriate for replacement parts for a manned aircraft.*

- 3.A.2. Ramjet/scramjet/pulse jet/combined cycle engines, including devices to regulate combustion, and specially designed components therefor, usable in the systems specified in 1.A.
- 3.A.3. Rocket motor cases, 'insulation' components and nozzles therefor, usable in the systems specified in 1.A.

Technical Note:

*In 3.A.3. 'insulation' intended to be applied to the components of a rocket motor, i.e. the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber components comprising sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps.*

Note:

*Refer to 3.C.2. for 'insulation' material in bulk or sheet form.*



- 3.A.4. Staging mechanisms, separation mechanisms, and interstages therefor, usable in the systems specified in 1.A.
- 3.A.5. Liquid and slurry propellant (including oxidisers) control systems, and specially designed components therefor, usable in the systems specified in 1.A., designed or modified to operate in vibration environments of more than 10 g RMS between 20 Hz and 2 kHz.

Notes:

1. *The only servo valves and pumps specified in 3.A.5. are the following:*
  - a. *Servo valves designed for flow rates of 24 litres per minute or greater, at an absolute pressure of 7,000 kPa (1,000 psi) or greater, that have an actuator response time of less than 100 ms;*
  - b. *Pumps, for liquid propellants, with shaft speeds equal to or greater than 8,000 RPM or with discharge pressures equal to or greater than 7,000 kPa (1,000 psi).*
2. *Systems and components specified in 3.A.5. may be exported as part of a satellite.*

- 3.A.6. Hybrid rocket motors and specially designed components therefor, usable in the systems specified in 1.A.

**3.B. TEST AND PRODUCTION EQUIPMENT**

- 3.B.1. "Production facilities" specially designed for equipment or materials specified in 3.A. or 3.C.
- 3.B.2. "Production equipment" specially designed for equipment or materials specified in 3.A. or 3.C.
- 3.B.3. Flow-forming machines, and specially designed components therefor, which:
- a. according to the manufacturers technical specification can be equipped with numerical control units or a computer control, even when not equipped with such units at delivery; and
  - b. have more than two axes which can be co-ordinated simultaneously for contouring control.

Technical Note:

*Machines combining the function of spin-forming and flow-forming are, for the purpose of this item, regarded as flow-forming machines.*

Note:

*This item does not include machines that are not usable in the "production" of propulsion components and equipment (e.g. motor cases) for systems specified in 1.A.*



### 3.C. MATERIALS

- 3.C.1. 'Interior lining' usable for rocket motor cases in the systems specified in 1.A.

Technical Note:

*In 3.C.1. 'interior lining' suited for the bond interface between the solid propellant and the case or insulating liner is usually a liquid polymer based dispersion of refractory or insulating materials e.g., carbon filled HTPB or other polymer with added curing agents to be sprayed or screeded over a case interior.*

- 3.C.2. 'Insulation' material in bulk form usable for rocket motor cases in the systems specified in 1.A.

Technical Note:

*In 3.C.2. 'insulation' intended to be applied to the components of a rocket motor, i.e., the case, nozzle inlets, case closures, includes cured or semi-cured compounded rubber sheet stock containing an insulating or refractory material. It may also be incorporated as stress relief boots or flaps specified in 3.A.3.*

### 3.D. SOFTWARE

- 3.D.1. "Software" specially designed or modified for the "use" of "production facilities" and flow forming machines specified in 3.B.1. or 3.B.3.
- 3.D.2. "Software" specially designed or modified for the "use" of equipment specified in 3.A.1., 3.A.2., 3.A.4., 3.A.5. or 3.A.6.

Notes:

- (a) "Software" specially designed or modified for the "use" of engines specified in 3.A.1. may be exported as part of a manned aircraft or as replacement "software" therefor.
- (b) "Software" specially designed or modified for the "use" of propellant control systems specified in 3.A.5. may be exported as part of a satellite or as replacement software" therefor.
- 3.D.3. "Software" specially designed or modified for the "development" of equipment specified in 3.A.2., 3.A.3. or 3.A.4.

### 3.E. TECHNOLOGY

- 3.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 3.A., 3.B., 3.C. or 3.D.

## ITEM 4 PROPELLANTS AND CHEMICALS

### 4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

None.

**4.B. TEST AND PRODUCTION EQUIPMENT**

None.

**4.C. MATERIALS**

4.C.1. Composite and composite modified double base propellants.

4.C.2. Fuel substances as follows:

- a. Hydrazine with a concentration of more than 70 percent and its derivatives including monomethylhydrazine (MMH);
- b. Unsymmetrical dimethylhydrazine (UDMH);
- c. Spherical aluminium powder with particles of uniform diameter of less than  $200 \times 10^{-6}$  m (200  $\mu$ m) and an aluminium content of 97 percent by weight or more, if at least 10 percent of the total weight is made up of particles of less than 63  $\mu$ m, according to ISO 2591:1988 or national equivalents such as JIS Z8820;

Technical Note:

*A particle size of 63  $\mu$ m (ISO R-565) corresponds to 250 mesh (Tyler) or 230 mesh (ASTM standard E-11).*

- d. Zirconium, beryllium, magnesium and alloys of these in particle size less than  $60 \times 10^{-6}$  m (60  $\mu$ m), whether spherical, atomised, spheroidal, flaked or ground, consisting of 97 percent by weight or more of any of the above mentioned metals;

Technical Note:

*The natural content of hafnium in the zirconium (typically 2% to 7%) is counted with the zirconium.*

- e. Boron and boron alloys in particle size less than  $60 \times 10^{-6}$  m (60  $\mu$ m), whether spherical, atomised, spheroidal, flaked or ground with a purity of 85 percent by weight or more;
- f. High energy density materials such as boron slurry, having an energy density of  $40 \times 10^6$  J/kg or greater.

4.C.3. Oxidisers/Fuels as follows:

Perchlorates, chlorates or chromates mixed with powdered metals or other high energy fuel components.

4.C.4. Oxidiser substances as follows:

- a. Liquid oxidiser substances as follows:
  1. Dinitrogen trioxide;

2. Nitrogen dioxide/dinitrogen tetroxide;
  3. Dinitrogen pentoxide;
  4. Inhibited Red Fuming Nitric Acid (IRFNA);
  5. Compounds composed of fluorine and one or more of other halogens, oxygen or nitrogen;
- b. Solid oxidiser substances as follows:
1. Ammonium perchlorate;
  2. Ammonium dinitramide (ADN);
  3. Nitro-amines (cyclotetramethylene - tetranitramine (HMX); cyclotrimethylene - trinitramine (RDX)).

4.C.5. Polymeric substances as follows:

- a. Carboxy - terminated polybutadiene (CTPB);
- b. Hydroxy - terminated polybutadiene (HTPB);
- c. Glycidyl azide polymer (GAP);
- d. Polybutadiene - Acrylic Acid (PBAA);
- e. Polybutadiene - Acrylic Acid- Acrylonitrile (PBAN).

4.C.6. Other propellant additives and agents as follows:

- a. Bonding agents as follows:
1. tris (1-(2-methyl)aziridinyl) phosphine oxide (MAPO);
  2. trimesoyl-1 (2-ethyl) aziridine (HX-868, BITA);
  3. Tepanol (HX878), reaction product of tetraethylenepentamine, acrylonitrile and glycidol;
  4. Tepan (HX-879), reaction product of tetraethylenepentamine and acrylonitrile;
  5. Polyfunctional aziridine amides with isophthalic, trimesic, isocyanuric, or trimethyladipic backbone also having a 2-methyl or 2-ethyl aziridine group (HX-752, HX-874 and HX-877);
- b. Curing agent and catalysts as follows:  
Triphenyl bismuth (TPB);
- c. Burning rate modifiers as follows:
1. Catocene;
  2. N-butyl-ferrocene;
  3. Butacene;
  4. Other adducted polymer ferrocene derivatives;
  5. Carboranes, decaboranes, pentaboranes and derivatives thereof;
- d. Nitrate esters and nitrated plasticisers as follows:
1. Triethylene glycol dinitrate (TEGDN);
  2. Trimethylolethane trinitrate (TMETN);
  3. 1,2,4-butanetriol trinitrate (BTTN);
  4. Diethylene glycol dinitrate (DEGDN);
- e. Stabilisers as follows:
1. 2-Nitrodiphenylamine;
  2. N-methyl-p-nitroaniline.

**4.D. SOFTWARE**

None.

**4.E. TECHNOLOGY**

- 4.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of materials specified in 4.C. (See also Item 5.E.).

**ITEM 5 PROPELLANT PRODUCTION****5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**5.B. TEST AND PRODUCTION EQUIPMENT**

- 5.B.1. "Production equipment", and specially designed components therefor, for the "production", handling or acceptance testing of liquid propellants or propellant constituents specified in Item 4.
- 5.B.2. "Production equipment", other than that described in 5.B.3., and specially designed components therefor, for the production, handling, mixing, curing, casting, pressing, machining, extruding or acceptance testing of solid propellants or propellant constituents specified in Item 4.
- 5.B.3. Equipment as follows, and specially designed components therefor:
- a. Batch mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:
    1. a total volumetric capacity of 110 litres or more; and
    2. at least one mixing/kneading shaft mounted off centre;
  - b. Continuous mixers with provision for mixing under vacuum in the range of zero to 13.326 kPa and with temperature control capability of the mixing chamber and having all of the following:
    1. two or more mixing/kneading shafts; and
    2. capability to open the mixing chamber;
  - c. Fluid energy mills usable for grinding or milling substances specified in Item 4;
  - d. Metal powder "production equipment" usable for the "production", in a controlled environment, of spherical or atomised materials specified in 4.C.2.c. or 4.C.2.d.

Note:

5.B.3.d. includes:

- a. *Plasma generators (high frequency arc-jet) usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;*
- b. *Electroburst equipment usable for obtaining sputtered or spherical metallic powders with organization of the process in an argon-water environment;*
- c. *Equipment usable for the "production" of spherical aluminium powders by powdering a melt in an inert medium (e.g. nitrogen).*

Notes:

1. *The only batch mixers, continuous mixers usable for solid propellants or propellants constituents specified in Item 4, and fluid energy mills controlled in Item 5, are those specified in 5.B.3.*
2. *Forms of metal powder "production equipment" not specified in 5.B.3.d. are to be evaluated in accordance with 5.B.2.*

**5.C. MATERIALS**

None.

**5.D. SOFTWARE**

- 5.D.1. "Software" specially designed or modified for the "use" of equipment specified in 5.B. for the "production" and handling of materials specified in Item 4.

**5.E. TECHNOLOGY**

- 5.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 5.B.

**ITEM 6 PRODUCTION OF STRUCTURAL COMPOSITES**

**6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**6.B. TEST AND PRODUCTION EQUIPMENT**

- 6.B.1. Equipment for the "production" of structural composites, fibres, preregs or preforms, usable in the systems specified in 1.A., as follows, and specially designed components, and accessories therefor:
- a. Filament winding machines of which the motions for positioning, wrapping and winding fibres can be co-ordinated and programmed in three or more axes, designed to fabricate composite structures or laminates from fibrous or filamentary materials, and co-ordinating and programming controls;
  - b. Tape-laying machines of which the motions for positioning and laying tape and sheets can be co-ordinated and programmed in two or more axes, designed for the manufacture of composite airframes and missile structures;

- 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;

Note:

*6.B.1.c. does not control textile machinery not modified for the end-uses stated.*

- 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;
  - 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 preregs and preforms, including rollers, tension stretchers, coating equipment, cutting equipment and clicker dies.

Note:

*Examples of components and accessories for the machines specified in 6.B.1. are moulds, mandrels, dies, fixtures and tooling for the preform pressing, curing, casting, sintering or bonding of composite structures, laminates and manufactures thereof.*

## **6.C. MATERIALS**

None.

## **6.D. SOFTWARE**

- 6.D.1. "Software" specially designed or modified for the "use" of equipment specified in 6.B.

## **6.E. TECHNOLOGY**

- 6.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 6.B. or 6.D.
- 6.E.2. "Technical data" (including processing conditions) and procedures for the regulation of temperature, pressures or atmosphere in autoclaves or hydroclaves when used for the production of composites or partially processed composites, usable for equipment or materials specified in Item 8.



**ITEM 7 PYROLYTIC DEPOSITION AND DENSIFICATION****7.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**7.B. TEST AND PRODUCTION EQUIPMENT**

7.B.1. Nozzles specially designed for the processes referred to in 7.E.1.

7.B.2. Isostatic presses having all of the following characteristics:

- a. Maximum working pressure of 69 MPa (10,000 psi) or greater;
- b. Designed to achieve and maintain a controlled thermal environment of 600 °C or greater; and
- c. Possessing a chamber cavity with an inside diameter of 254 mm (10 inches) or greater.

7.B.3. Chemical vapour deposition furnaces designed or modified for the densification of carbon-carbon composites.

7.B.4. Equipment and process controls, other than those specified in 7.B.2. or 7.B.3., designed or modified for densification and pyrolysis of structural composite rocket nozzles and reentry vehicle nose tips.

**7.C. MATERIALS**

None.

**7.D. SOFTWARE**

7.D.1. "Software" specially designed or modified for the equipment specified in 7.B.2., 7.B.3. or 7.B.4.

**7.E. TECHNOLOGY**

7.E.1. "Technology" for producing pyrolytically derived materials formed on a mould, mandrel or other substrate from precursor gases which decompose in the 1300 °C to 2900 °C temperature range at pressures of 130 Pa (1 mm Hg) to 20 kPa (150 mm Hg) including "technology" for the composition of precursor gases, flow-rates, and process control schedules and parameters.

7.E.2. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 7.B. or 7.D.



**ITEM 8     STRUCTURAL MATERIALS****8.A.     EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 8.A.1. Composite structures, laminates, and manufactures thereof, specially designed for use in the systems specified in 1.A. and the subsystems specified in 2.A.
- 8.A.2. Resaturated pyrolised (i.e. carbon-carbon) components having all of the following:
- a. designed for rocket systems; and
  - b. usable in the systems specified in 1.A.

**8.B.     TEST AND PRODUCTION EQUIPMENT**

None.

**8.C.     MATERIALS**

- 8.C.1. Resin impregnated fibre prepregs and metal coated fibre preforms, for the goods specified in 8.A.1., made either with organic matrix or metal matrix utilising fibrous or filamentary reinforcements having a specific tensile strength greater than  $7.62 \times 10^4$  m and a specific modulus greater than  $3.18 \times 10^6$  m.

Note:

*The only resin impregnated fibre prepregs specified in 8.C.1. are those using resins with a glass transition temperature ( $T_g$ ), after cure, exceeding  $145^\circ\text{C}$  as determined by ASTM D4065 or national equivalents.*

- 8.C.2. Resaturated pyrolised (i.e. carbon-carbon) materials having all of the following:
- a. designed for rocket systems; and
  - b. usable in the systems specified in 1.A.
- 8.C.3. Fine grain recrystallised bulk graphites (with a bulk density of at least  $1.72 \text{ g/cm}^3$  measured at  $15^\circ\text{C}$ ) and having a particle size of  $100 \times 10^{-6} \text{ m}$  ( $100 \mu\text{m}$ ) or less, usable for rocket nozzles and re-entry vehicle nose tips usable in systems specified in 1.A.
- 8.C.4. Pyrolytic or fibrous reinforced graphites usable for rocket nozzles and re-entry vehicle nose tips usable in systems specified in 1.A.
- 8.C.5. Ceramic composite materials (dielectric constant less than 6 at frequencies from 100 Hz to 10 GHz) for use in missile radomes usable in systems specified in 1.A.
- 8.C.6. Bulk machinable silicon-carbide reinforced unfired ceramic usable for nose tips usable in systems specified in 1.A.
- 8.C.7. Tungsten, molybdenum, and alloys of these metals in the form of uniform spherical or atomised particles of  $500 \times 10^{-6} \text{ m}$  ( $500 \mu\text{m}$ ) diameter or less with a purity of 97% or higher for fabrication of rocket motor components, i.e. heat shields, nozzle substrates, nozzle throats, and thrust vector control surfaces, usable in systems specified in 1.A.
- 8.C.8. Maraging steels having an ultimate tensile strength of  $1.5 \times 10^9 \text{ Pa}$  or greater, measured at  $20^\circ\text{C}$ , in the form of sheet, plate or tubing with a wall or plate thickness

equal to or less than 5.0 mm usable in systems specified in 1.A.

Technical Note:

*Maraging steels are generally characterised by high nickel, very low carbon content and use substitutional elements or precipitates to produce age-hardening.*

- 8.C.9. Titanium-stabilized duplex stainless steel (Ti-DSS) usable in the systems specified in 1.A. and having all of the following:
- a. Having all of the following characteristics:
    1. containing 17.0 - 23.0 weight percent chromium and 4.5 - 7.0 weight percent nickel;
    2. having a titanium content of greater than 0.10 weight percent; and
    3. a ferritic-austenitic microstructure (also referred to as a two-phase microstructure ) of which at least 10 percent is austenite by volume (according to ASTM E-1181-87 or national equivalents); and
  - b. Having any of the following forms:
    1. ingots or bars having a size of 100 mm or more in each dimension;
    2. sheets having a width of 600 mm or more and a thickness of 3 mm or less; or
    3. tubes having an outer diameter of 600 mm or more and a wall thickness of 3 mm or less.

**8.D. SOFTWARE**

None.

**8.E. TECHNOLOGY**

- 8.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or materials specified in 8.A. or 8.C.

**ITEM 9 INSTRUMENTATION, NAVIGATION AND DIRECTION FINDING**

**9.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 9.A.1. Integrated flight instrument systems which include gyrostabilisers or automatic pilots, designed or modified for use in the systems specified in 1.A., and specially designed components therefor.
- 9.A.2. Gyro-astro compasses and other devices which derive position or orientation by means of automatically tracking celestial bodies or satellites, and specially designed components therefor.

- 9.A.3. Accelerometers with a threshold of 0.05 g or less, or a linearity error within 0.25% of full scale output, or both, which are designed for use in inertial navigation systems or in guidance systems of all types, and specially designed components therefor.

Note:

*Accelerometers which are specially designed and developed as MWD (Measurement While Drilling) sensors for use in downhole well service operations are not controlled in 9.A.3.*

- 9.A.4. All types of gyros usable in the systems specified in 1.A., with a rated 'drift rate' 'stability' of less than 0.5 degrees (1 sigma or rms) per hour in a 1 g environment and specially designed components therefor.

Technical Notes:

1. *'Drift rate' is defined as the time rate of output deviation from the desired output. It consists of random and systematic components and is expressed as an equivalent angular displacement per unit time with respect to inertial space.*
2. *'Stability' is defined as 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.*

- 9.A.5. Continuous output accelerometers or gyros of any type, specified to function at acceleration levels greater than 100 g, and specially designed components therefor.

- 9.A.6. Inertial or other equipment using accelerometers specified in 9.A.3. or 9.A.5. or gyros specified in 9.A.4. or 9.A.5., and systems incorporating such equipment, and specially designed components therefor.

## **9.B. TEST AND PRODUCTION EQUIPMENT**

- 9.B.1. "Production equipment", and other test, calibration and alignment equipment, other than that described in 9.B.2., designed or modified to be used with equipment specified in 9.A.

Note:

*Equipment specified in 9.B.1. includes the following:*

- a. *For laser gyro equipment, the following equipment used to characterise mirrors, having the threshold accuracy shown or better:*
  1. Scatterometer (10 ppm);
  2. Reflectometer (50 ppm);
  3. Profilometer (5 Angstroms);
- b. *For other inertial equipment:*
  1. Inertial Measurement Unit (IMU Module) Tester;
  2. IMU Platform Tester;
  3. IMU Stable Element Handling Fixture;
  4. IMU Platform Balance Fixture;
  5. Gyro Tuning Test Station;

6. Gyro Dynamic Balance Station;
7. Gyro Run-In/Motor Test Station;
8. Gyro Evacuation and Filling Station;
9. Centrifuge Fixture for Gyro Bearings;
10. Accelerometer Axis Align Station;
11. Accelerometer Test Station.

9.B.2. Equipment as follows:

- a. Balancing machines having all the following characteristics:
  1. not capable of balancing rotors/assemblies having a mass greater than 3 kg;
  2. capable of balancing rotors/assemblies at speeds greater than 12,500 rpm;
  3. capable of correcting unbalance in two planes or more; and
  4. capable of balancing to a residual specific unbalance of 0.2 g mm per kg of rotor mass;
- b. Indicator heads (sometimes known as balancing instrumentation) designed or modified for use with machines specified in 9.B.2.a.;
- c. Motion simulators/rate tables (equipment capable of simulating motion) having all of the following characteristics:
  1. two axes or more;
  2. slip rings capable of transmitting electrical power and/or signal information; and
  3. having any of the following characteristics:
    - a. for any single axis having all of the following:
      1. capable of rates of 400 degrees/s or more, or 30 degrees/s or less; and
      2. a rate resolution equal to or less than 6 degrees/s and an accuracy equal to or less than 0.6 degrees/s;
    - b. having a worst-case rate stability equal to or better (less) than plus or minus 0.05% averaged over 10 degrees or more; or
    - c. a positioning accuracy equal to or better than 5 arc second;
- d. Positioning tables (equipment capable of precise rotary positioning in any axes) having the following characteristics:
  1. two axes or more; and
  2. a positioning accuracy equal to or better than 5 arc second;
- e. Centrifuges capable of imparting accelerations above 100 g and having slip rings capable of transmitting electrical power and signal information.

Notes:

1. *The only balancing machines, indicator heads, motion simulators, rate tables, positioning tables and centrifuges specified in Item 9 are those specified in 9.B.2.*
2. *9.B.2.a. does not control balancing machines designed or modified for dental or other medical equipment.*

3. *9.B.2.c. and 9.B.2.d. do not control rotary tables designed or modified for machine tools or for medical equipment.*
4. *Rate tables not controlled by 9.B.2.c. and providing the characteristics of a positioning table are to be evaluated according to 9.B.2.d.*
5. *Equipment that has the characteristics specified in 9.B.2.d. which also meets the characteristics of 9.B.2.c. will be treated as equipment specified in 9.B.2.c.*

#### **9.C. MATERIALS**

None.

#### **9.D. SOFTWARE**

- 9.D.1. "Software" specially designed or modified for the "use" of equipment specified in 9.A. or 9.B.
- 9.D.2. Integration "software" for the equipment specified in 9.A.1.
- 9.D.3. Integration "software" specially designed for the equipment specified in 9.A.6.

#### **9.E. TECHNOLOGY**

- 9.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 9.A., 9.B. or 9.D.

#### Note:

*Equipment or "software" specified in 9.A. or 9.D. may be exported as part of a manned aircraft, satellite, land vehicle or marine vessel or in quantities appropriate for replacement parts for such applications.*

### **ITEM 10 FLIGHT CONTROL**

#### **10.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 10.A.1. Hydraulic, mechanical, electro-optical, or electromechanical flight control systems (including fly-by-wire systems) designed or modified for the systems specified in 1.A.
- 10.A.2. Attitude control equipment designed or modified for the systems specified in 1.A.

#### Note:

*Systems or equipment specified in 10.A. may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*



**10.B. TEST AND PRODUCTION EQUIPMENT**

- 10.B.1. Test, calibration, and alignment equipment specially designed for equipment specified in 10.A.

**10.C. MATERIALS**

None.

**10.D. SOFTWARE**

- 10.D.1. "Software" specially designed or modified for the "use" of equipment specified in 10.A. or 10.B.

Note:

"Software" specified in 10.D.1. may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.

**10.E. TECHNOLOGY**

- 10.E.1. Design "technology" for integration of air vehicle fuselage, propulsion system and lifting control surfaces, designed or modified for the systems specified in 1.A., to optimise aerodynamic performance throughout the flight regime of an unmanned air vehicle.
- 10.E.2. Design "technology" for integration of the flight control, guidance, and propulsion data into a flight management system, designed or modified for the systems specified in 1.A., for optimisation of rocket system trajectory.
- 10.E.3. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 10.A., 10.B. or 10.D.

**ITEM 11 AVIONICS****11.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 11.A.1. Radar and laser radar systems, including altimeters, designed or modified for use in the systems specified in 1.A.

Technical Note:

*Laser radar systems embody specialised transmission, scanning, receiving and signal processing techniques for utilisation of lasers for echo ranging, direction finding and discrimination of targets by location, radial speed and body reflection characteristics.*

- 11.A.2. Passive sensors for determining bearings to specific electromagnetic sources (direction finding equipment) or terrain characteristics, designed or modified for use in the systems specified in 1.A.
- 11.A.3. Global Positioning System (GPS) or similar satellite receivers, designed or modified for use in the systems specified in 1.A., having any of the following characteristics:
- a. Capable of providing navigation information under the following operational conditions:
    1. At speeds in excess of 515 m/s (1,000 nautical miles/hour); and
    2. At altitudes in excess of 18 km (60,000 feet); or
  - b. Designed or modified for use with unmanned air vehicles specified in 1.A.2.
- 11.A.4. Electronic assemblies and components, designed or modified for use in the systems specified in 1.A. and specially designed for military use and operation at temperatures in excess of 125 °C.

Notes:

1. *Equipment specified in 11.A. includes the following:*
  - a. *Terrain contour mapping equipment;*
  - b. *Scene mapping and correlation (both digital and analogue) equipment;*
  - c. *Doppler navigation radar equipment;*
  - d. *Passive interferometer equipment;*
  - e. *Imaging sensor equipment (both active and passive).*
2. *Equipment specified in 11.A. may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*

**11.B. TEST AND PRODUCTION EQUIPMENT**

None.

**11.C. MATERIALS**

None.

**11.D. SOFTWARE**

- 11.D.1. "Software" specially designed or modified for the "use" of equipment specified in 11.A.1., 11.A.2. or 11.A.4.
- 11.D.2. "Software" specially designed for the "use" of equipment specified in 11.A.3.

**11.E. TECHNOLOGY**

- 11.E.1. Design "technology" for protection of avionics and electrical subsystems against electromagnetic pulse (EMP) and electromagnetic interference (EMI) hazards from external sources, as follows:



- a. Design "technology" for shielding systems;
- b. Design "technology" for the configuration of hardened electrical circuits and subsystems;
- c. Design "technology" for determination of hardening criteria for the above.

11.E.2. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 11.A. or 11.D.

## **ITEM 12 LAUNCH SUPPORT**

### **12.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 12.A.1. Apparatus and devices, designed or modified for the handling, control, activation and launching of the systems specified in 1.A.
- 12.A.2. Vehicles designed or modified for the transport, handling, control, activation and launching of the systems specified in 1.A.
- 12.A.3. Gravity meters (gravimeters), gravity gradiometers, and specially designed components therefor, designed or modified for airborne or marine use, and having a static or operational accuracy of  $7 \times 10^{-6} \text{ m/s}^2$  (0.7 milligal) or better, with a time to steady-state registration of two minutes or less, usable for systems specified in 1.A.
- 12.A.4. Telemetry and telecontrol equipment having all of the following:
  - a. usable for unmanned air vehicles or rocket systems; and
  - b. usable for systems specified in 1.A.
- 12.A.5. Precision tracking systems, usable for systems specified in 1.A., as follows:
  - a. Tracking systems which use a code translator installed on the rocket or unmanned air vehicle in conjunction with either surface or airborne references or navigation satellite systems to provide real-time measurements of inflight position and velocity;
  - b. Range instrumentation radars including associated optical/infrared trackers with all of the following capabilities:
    - 1. angular resolution better than 3 mrad (0.5 mils);
    - 2. range of 30 km or greater with a range resolution better than 10 m RMS; and
    - 3. velocity resolution better than 3 m/s.

### **12.B. TEST AND PRODUCTION EQUIPMENT**

None.

**12.C. MATERIALS**

None.

**12.D. SOFTWARE**

- 12.D.1. "Software" specially designed or modified for the "use" of equipment specified in 12.A.1.
- 12.D.2. "Software" which processes post-flight, recorded data, enabling determination of vehicle position throughout its flight path, specially designed or modified for systems specified in 1.A.
- 12.D.3. "Software" specially designed or modified for the "use" of equipment specified in 12.A.4. or 12.A.5., usable for systems specified in 1.A.

**12.E. TECHNOLOGY**

- 12.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 12.A. or 12.D.

**ITEM 13 COMPUTERS****13.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 13.A.1. Analogue computers, digital computers or digital differential analysers, designed or modified for use in the systems specified in 1.A., having any of the following characteristics:
  - a. Rated for continuous operation at temperatures from below  $-45^{\circ}\text{C}$  to above  $+55^{\circ}\text{C}$ ; or
  - b. Designed as ruggedised or "radiation hardened".

**13.B. TEST AND PRODUCTION EQUIPMENT**

None.

**13.C. MATERIALS**

None.

**13.D. SOFTWARE**

None.

**13.E. TECHNOLOGY**

- 13.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 13.A.

**Note:**

*Item 13 equipment may be exported as part of a manned aircraft or satellite or in quantities appropriate for replacement parts for manned aircraft.*

**ITEM 14 ANALOGUE TO DIGITAL CONVERTERS****14.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

14.A.1. Analogue-to-digital converters, usable in the systems specified in 1.A., having any of the following characteristics:

- a. Designed to meet military specifications for ruggedised equipment; or
- b. Designed or modified for military use and being any of the following types:
  1. Analogue-to-digital converter "microcircuits", which are "radiation-hardened" or have all of the following characteristics:
    - a. Having a quantisation corresponding to 8 bits or more when coded in the binary system;
    - b. Rated for operation in the temperature range from below  $-54^{\circ}\text{C}$  to above  $+125^{\circ}\text{C}$ ; and
    - c. Hermetically sealed; or
  2. Electrical input type analogue-to-digital converter printed circuit boards or modules, having all of the following characteristics:
    - a. Having a quantisation corresponding to 8 bits or more when coded in the binary system;
    - b. Rated for operation in the temperature range from below  $-45^{\circ}\text{C}$  to above  $+55^{\circ}\text{C}$ ; and
    - c. Incorporating "microcircuits" specified in 14.A.1.b.1.

**14.B. TEST AND PRODUCTION EQUIPMENT**

None.

**14.C. MATERIALS**

None.

**14.D. SOFTWARE**

None.

**14.E. TECHNOLOGY**

14.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 14.A.

**ITEM 15 TEST FACILITIES AND EQUIPMENT****15.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

None.

**15.B. TEST AND PRODUCTION EQUIPMENT**

15.B.1. Vibration test equipment, usable for the systems specified in 1.A. or the subsystems specified in 2.A., and components therefor, as follows:

- 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 2 kHz 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 specified in 15.B.1.a.;
- 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 specified in 15.B.1.a.;
- d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN, measured bare table, or greater, and usable in vibration test systems specified in 15.B.1.a.

Technical Note:

*Vibration test systems incorporating a digital controller are those systems, the functions of which are, partly or entirely, automatically controlled by stored and digitally coded electrical signals.*

15.B.2. Wind-tunnels for speeds of Mach 0.9 or more, usable for the systems specified in 1.A. or the subsystems specified in 2.A.

15.B.3. Test benches/stands, usable for the systems specified in 1.A. or the subsystems specified in 2.A., which have the capacity to handle solid or liquid propellant rockets, motors or engines of more than 90 kN (20,000 lbs) of thrust, or which are capable of simultaneously measuring the three axial thrust components.

15.B.4. Environmental chambers and anechoic chambers, as follows, usable for the systems specified in 1.A. or the subsystems specified in 2.A.:

- a. Environmental chambers capable of simulating all of the following flight conditions:
  1. Vibration environments of 10 g RMS or greater between 20 Hz and 2 kHz imparting forces of 5 kN or greater; and
  2. any of the following:
    - a. Altitude of 15,000 m or greater; or
    - b. Temperature range of at least -50 °C to 125 °C;

- b. Anechoic chambers capable of simulating all of the following flight conditions:
  - 1. Acoustic environments at an overall sound pressure level of 140 dB or greater (referenced to  $2 \times 10^{-5} \text{ N/m}^2$ ) or with a rated power output of 4 kW or greater; and
  - 2. any of the following:
    - a. Altitude of 15,000 m or greater; or
    - b. Temperature range of at least  $-50^\circ\text{C}$  to  $125^\circ\text{C}$ .

15.B.5. Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and equipment containing those accelerators, usable for the systems specified in 1.A. or the subsystems specified in 2.A.

Note:

*15.B.5. does not control equipment specially designed for medical purposes.*

**15.C. MATERIALS**

None.

**15.D. SOFTWARE**

15.D.1. "Software" specially designed or modified for the "use" of equipment specified in 15.B. usable for testing systems specified in 1.A. or subsystems specified in 2.A.

**15.E. TECHNOLOGY**

15.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 15.B. or 15.D.

**ITEM 16 MODELLING-SIMULATION AND DESIGN INTEGRATION**

**16.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

16.A.1. Specially designed hybrid (combined analogue/digital) computers for modelling, simulation or design integration of systems specified in 1.A. or the subsystems specified in 2.A.

Note:

*This control only applies when the equipment is supplied with "software" specified in 16.D.1.*

**16.B. TEST AND PRODUCTION EQUIPMENT**

None.

**16.C. MATERIALS**

None.

**16.D. SOFTWARE**

- 16.D.1. "Software" specially designed for modelling, simulation, or design integration of the systems specified in 1.A. or the subsystems specified in 2.A.

Technical Note:

*The modelling includes in particular the aerodynamic and thermodynamic analysis of the systems.*

**16.E. TECHNOLOGY**

- 16.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 16.A. or 16.D.

**ITEM 17 STEALTH****17.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 17.A.1. Devices for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 1.A. or the subsystems specified in 2.A.

**17.B. TEST AND PRODUCTION EQUIPMENT**

- 17.B.1. Systems, specially designed for radar cross section measurement, usable for the systems specified in 1.A. or the subsystems specified in 2.A.

**17.C. MATERIALS**

- 17.C.1. Materials for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for applications usable for the systems specified in 1.A. or the subsystems specified in 2.A.

Notes:

1. 17.C.1. includes structural materials and coatings (including paints), specially designed for reduced or tailored reflectivity or emissivity in the microwave, infrared or ultraviolet spectra.-
2. 17.C.1. does not control coatings (including paints) when specially used for thermal control of satellites.

**17.D. SOFTWARE**

- 17.D.1. "Software" specially designed for reduced observables such as radar reflectivity, ultraviolet/infrared signatures and acoustic signatures (i.e. stealth technology), for



applications usable for the systems specified in 1.A. or the subsystems specified in 2.A.

Note:

17.D.1. includes "software" specially designed for analysis of signature reduction.

**17.E. TECHNOLOGY**

- 17.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment, materials or "software" specified in 17.A., 17.B., 17.C. or 17.D.

Note:

17.E.1. includes databases specially designed for analysis of signature reduction.

**ITEM 18 NUCLEAR EFFECTS PROTECTION**

**18.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 18.A.1. "Radiation Hardened" "microcircuits" usable in protecting rocket systems and unmanned air vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 1.A.
- 18.A.2. 'Detectors' specially designed or modified to protect rocket systems and unmanned air vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 1.A.

Technical Note:

A 'detector' is defined as a mechanical, electrical, optical or chemical device that automatically identifies and records, or registers a stimulus such as an environmental change in pressure or temperature, an electrical or electromagnetic signal or radiation from a radioactive material.

- 18.A.3. Radomes designed to withstand a combined thermal shock greater than  $4.184 \times 10^6 \text{ J/m}^2$  accompanied by a peak over pressure of greater than 50 kPa, usable in protecting rocket systems and unmanned air vehicles against nuclear effects (e.g. Electromagnetic Pulse (EMP), X-rays, combined blast and thermal effects), and usable for the systems specified in 1.A.

**18.B. TEST AND PRODUCTION EQUIPMENT**

None.

**18.C. MATERIALS**

None.



**18.D. SOFTWARE**

None.

**18.E. TECHNOLOGY**

- 18.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 18.A.

**ITEM 19 OTHER COMPLETE DELIVERY SYSTEMS****19.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 19.A.1. Complete rocket systems (including ballistic missile systems, space launch vehicles, and sounding rockets), not specified in 1.A.1., capable of a maximum range equal to or greater than 300 km.
- 19.A.2. Complete unmanned air vehicle systems (including cruise missile systems, target drones and reconnaissance drones), not specified in 1.A.2., capable of a maximum range equal to or greater than 300 km.

**19.B. TEST AND PRODUCTION EQUIPMENT**

None.

**19.C. MATERIALS**

None.

**19.D. SOFTWARE**

- 19.D.1. "Software" which coordinates the function of more than one subsystem, specially designed or modified for "use" in the systems specified in 19.A.

**19.E. TECHNOLOGY**

- 19.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment specified in 19.A.

**ITEM 20 OTHER COMPLETE SUBSYSTEMS****20.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 20.A.1. Complete subsystems as follows:

- a. Individual rocket stages, not specified in 2.A.1., usable in systems specified in 19.A.;
- b. Solid propellant rocket motors or liquid propellant rocket engines, not specified in 2.A.1., usable in systems specified in 19.A., having a total impulse capacity of  $8.41 \times 10^5$  Ns ( $1.91 \times 10^5$  lb.s) or greater, but less than  $1.1 \times 10^6$  Ns ( $2.5 \times 10^5$  lb.s).

## **20.B. TEST AND PRODUCTION EQUIPMENT**

20.B.1. "Production facilities" specially designed for the subsystems specified in 20.A.

20.B.2. "Production equipment" specially designed for the subsystems specified in 20.A.

## **20.C. MATERIALS**

None.

## **20.D. SOFTWARE**

20.D.1. "Software" specially designed or modified for the systems specified in 20.B.1.

20.D.2. "Software", not specified in 2.D.2., specially designed or modified for the "use" of rocket motors or engines specified in 20.A.1.b.

## **20.E. TECHNOLOGY**

20.E.1. "Technology", in accordance with the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified in 20.A., 20.B. or 20.D.

**AAHALING EINDIG**

No. 430

10 April 2002

**NOTICE IN TERMS OF SECTION 13 OF THE  
NON-PROLIFERATION OF WEAPONS OF MASS DESTRUCTION ACT, 1993**

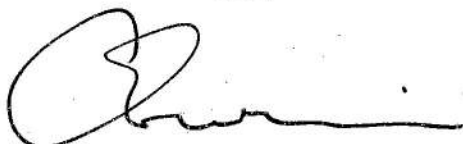
**DECLARATION OF CERTAIN NUCLEAR-RELATED DUAL-USE EQUIPMENT,  
MATERIALS AND RELATED TECHNOLOGY ITEMS AS CONTROLLED GOODS  
AND CONTROL MEASURES APPLICABLE TO SUCH GOODS**

1. I, Alec Erwin, Minister of Trade and Industry, on the recommendation of the South African Council for the Non-Proliferation of Weapons of Mass Destruction, under section 13 of the Non-Proliferation of Weapons of Mass Destruction Act, 1993 (Act No. 87 of 1993), hereby -

- (a) declare all items listed in the IAEA (International Atomic Energy Agency) document INFCIRC/254/Rev.4/Part 2, dated March 2000, as quoted in Schedule A to this notice, to be controlled goods;
- (b) determine that the import, export, re-export and transit of such controlled goods shall take place only under a permit issued by the said Council, established under section 4 of the said Act;
- (c) determine that the local transfer or sale of such controlled goods by a person contemplated in section 13(3) of the said Act may take place only if the receiver of the goods has been registered in terms of the said section and the said Council was informed by means of a declaration of the transaction by the supplier;
- (d) declare component parts contemplated in General Note 4, as quoted in Schedule A, that can be described as an integral part of plants, systems, assemblies or equipment listed in Schedule A and without which the plant, system, assemblies or equipment will not perform their intended function or achieve the characteristics or performance level that make the above-mentioned plants, systems, assemblies or equipment controlled according to a Schedule A entry or entries, to be controlled goods; and

- (e) repeal Government Notice No. R.1790 of 14 October 1994.
2. Application forms for permits and registrations in terms of section 13(3) of the  
aforementioned Act are obtainable from:

The Secretariat  
South African Council for the Non-Proliferation of Weapons of Mass  
Destruction  
Private Bag X84  
**PRETORIA**  
0001



**ALEC ERWIN,**  
Minister of Trade and Industry

**SCHEDULE A****NUCLEAR-RELATED DUAL-USE CONTROLLED GOODS**

The list of Nuclear related Dual-Use Equipment, Materials, Software, and Related Technology Items contained in the Annex to IAEA document INFCIRC/254/Rev.4/Part 2, dated March 2000, is quoted in its entirety.

**QUOTE****ANNEX**

Note: The International System of Units (SI) is used in this Annex. In all cases the physical quantity defined in SI units should be considered the official recommended control value. However, some machine tool parameters are given in their customary units, which are not SI.

Commonly used abbreviations (and their prefixes denoting size) in this Annex are as follows:

A	---	ampere(s)
Bq	---	becquerel(s)
°C	---	degree(s) Celsius
CAS	---	chemical abstracts service
Ci	---	curie(s)
cm	---	centimeter(s)
dB	---	decibel(s)
dBm	---	decibel referred to 1 milliwatt
g	---	gram(s); also, acceleration of gravity (9.81 m/s <sup>2</sup> )
GBq	---	gigabecquerel(s)
GHz	---	gigahertz
GPa	---	gigapascal(s)
Gy	---	gray
h	---	hour(s)
Hz	---	hertz
J	---	joule(s)
K	---	kelvin
keV	---	thousand electron volt(s)
kg	---	kilogram(s)
kHz	---	kilohertz
kN	---	kilonewton(s)
kPa	---	kilopascal(s)
kV	---	kilovolt(s)
kW	---	kilowatt(s)
m	---	meter(s)
mA	---	milliampere(s)
MeV	---	million electron volt(s)
MHz	---	megahertz
ml	---	milliliter(s)
mm	---	millimeter(s)

MPa	---	megapascal(s)
mPa	---	millipascal(s)
MW	---	megawatt(s)
µF	---	microfarad(s)
µm	---	micrometer(s)
µs	---	microsecond(s)
N	---	newton(s)
nm	---	nanometer(s)
ns	---	nanosecond(s)
nH	---	nanohenry(ies)
ps	---	picosecond(s)
RMS	---	root mean square
rpm	---	revolutions per minute
s	---	second(s)
T	---	tesla(s)
TIR	---	total indicator reading
V	---	volt(s)
W	---	watt(s)

#### GENERAL NOTE

The following paragraphs are applied to the List of Nuclear-Related Dual-Use Equipment, Material, Software, and Related Technology.

1. The description of any item on the List includes that item in either new or second-hand condition.
2. When the description of any item on the List contains no qualifications or specifications, it is regarded as including all varieties of that item. Category captions are only for convenience in reference and do not affect the interpretation of item definitions.
3. The object of these controls should not be defeated by the transfer of any non-controlled item (including plants) containing one or more controlled components when the controlled component or components are the principal element of the item and can feasibly be removed or used for other purposes.

**Note:** In judging whether the controlled component or components are to be considered the principal element, governments should weigh the factors of quantity, value, and technological know-how involved and other special circumstances which might establish the controlled component or components as the principal element of the item being procured.

4. The object of these controls should not be defeated by the transfer of component parts. Each government will take such action as it can to achieve this aim and will continue to seek a workable definition for component parts, which could be used by all the suppliers.

#### TECHNOLOGY CONTROLS

The transfer of "technology" is controlled according to the Guidelines and as described in each section of the Annex. "Technology" directly associated with any item in the Annex will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation.

The approval of any Annex item for export also authorizes the export to the same end user of the minimum "technology" required for the installation, operation, maintenance, and repair of the item.

Note: Controls on "technology" transfer do not apply to information "in the public domain" or to "basic scientific research".

### GENERAL SOFTWARE NOTE

The transfer of "software" is controlled according to the Guidelines and as described in the Annex.

Note: Controls on "software" transfers do not apply to "software" as follows:

1. Generally available to the public by being:
  - a. Sold from stock at retail selling points without restriction;  
and
  - b. Designed for installation by the user without further substantial support by the supplier;  
or
2. "In the public domain".

### DEFINITIONS

"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.

"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. (Ref: VDI/VDE 2617 Draft: "Rotary table on coordinate measuring machines")

"Basic scientific research" --

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

"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 2806-1980 as amended)



**"Development" --**

is related to all phases before "production" such as:

- design
- design research
- design analysis
- design concepts
- assembly and testing of prototypes
- pilot production schemes
- design data
- process of transforming design data into a product
- configuration design
- integration design
- layouts

**"Fibrous or filamentary materials" --**

means continuous 'monofilaments', 'yarns', 'rovings', 'tows' or 'tapes'.

**N.B.:****1. 'Filament' or 'monofilament' --**

is the smallest increment of fiber, usually several  $\mu\text{m}$  in diameter.

**2. 'Roving' --**

is a bundle (typically 12-120) of approximately parallel 'strands'.

**N.B.:****'Strand' --**

is a bundle of 'filaments' (typically over 200) arranged approximately parallel.

**3. 'Tape' --**

is a material constructed of interlaced or unidirectional 'filaments', 'strands', 'rovings', 'tows' or 'yarns', etc., usually preimpregnated with resin.

**4. 'Tow' --**

is a bundle of 'filaments', usually approximately parallel.

**5. 'Yarn' --**

is a bundle of twisted 'strands'.

**6. 'Filament' --**

See "Fibrous or filamentary materials".

**"In the public domain" –**

"In the public domain", as it applies herein, means "technology" or "software" that has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove "technology" or "software" from being "in the public domain".)

**"Linearity" –**

(Usually measured in terms of non linearity) 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.

**"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/VDE 2617)

**"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.

**'Monofilament' --**

See "Fibrous or filamentary materials".

**"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)

**"Positioning accuracy" --**

of "numerically controlled" machine tools is to be determined and presented in accordance with Item 1.B.2., 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  $\pm 10\%$  of nominal rated voltage;
  - (ii) Frequency variation shall not be greater than  $\pm 2$  Hz of normal frequency;
  - (iii) Lineouts or interrupted service are not permitted.

(b) Test Program (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 the test results (paragraph 2):

The results of the measurements must include:

- (1) "positioning accuracy" (A) and
- (2) The mean reversal error (B).

"Production" –

means all production phases such as:

- construction
- production engineering
- manufacture
- integration
- assembly (mounting)
- inspection
- testing
- quality assurance

"Program" --

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

**"Resolution" --**

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

**'Roving' --**

See "Fibrous or filamentary materials".

**"Software" --**

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

**'Strand' --**

See "Fibrous or filamentary materials".

**'Tape' --**

See "Fibrous or filamentary materials".

**"Technical assistance" --**

"Technical assistance" may take forms such as: instruction, skills, training, working knowledge, consulting services.

Note: "Technical assistance" may involve transfer of "technical data".

**"Technical data" --**

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

**"Technology" --**

means specific information required for the "development", "production", or "use" of any item contained in the List. This information may take the form of "technical data" or "technical assistance".

**'Tow' --**

See "Fibrous or filamentary materials".

**"Use" --**

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

**'Yarn' --**

See "Fibrous or filamentary materials".

## ANNEX CONTENTS

### 1. INDUSTRIAL EQUIPMENT

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#### 1.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 1.A.1. High-density radiation shielding windows
- 1.A.2. Radiation-hardened TV cameras, or lenses therefore
- 1.A.3. Robots, end-effectors' and control units
- 1.A.4. Remote manipulators

#### 1.B. TEST AND PRODUCTION EQUIPMENT

- 1.B.1. Flow-forming machines, spin-forming machines capable of flow-forming functions, and mandrels
- 1.B.2. Machine tools
- 1.B.3. Dimensional inspection machines, instruments, or systems
- 1.B.4. Controlled atmosphere induction furnaces, and power supplies therefore
- 1.B.5. Isostatic presses, and related equipment
- 1.B.6. Vibration test systems, equipment, and components
- 1.B.7. Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment

#### 1.C. MATERIALS

#### 1.D. SOFTWARE

#### 1.E. TECHNOLOGY

### 2. MATERIALS

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#### 2.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 2.A.1. Crucibles made of materials resistant to liquid actinide metals
- 2.A.2. Platinized catalysts
- 2.A.3. Composite structures in the forms of tubes

#### 2.B. TEST AND PRODUCTION EQUIPMENT

- 2.B.1. Tritium facilities or plants, and equipment therefore
- 2.B.2. Lithium isotope separation facilities or plants, and equipment therefore

#### 2.C. MATERIALS

- 2.C.1. Aluminium
- 2.C.2. Beryllium
- 2.C.3. Bismuth
- 2.C.4. Boron
- 2.C.5. Calcium
- 2.C.6. Chlorine trifluoride
- 2.C.7. Fibrous or filamentary materials, and prepregs
- 2.C.8. Hafnium
- 2.C.9. Lithium
- 2.C.10. Magnesium

- 2.C.11. Maraging Steel
- 2.C.12. Radium-226
- 2.C.13. Titanium
- 2.C.14. Tungsten
- 2.C.15. Zirconium
- 2.C.16. Nickel powder and porous nickel metal
- 2.C.17. Tritium
- 2.C.18. Helium-3
- 2.C.19. Alpha-emitting radionuclides
- 2.D. **SOFTWARE**
- 2.E. **TECHNOLOGY**

### **3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS (Other Than Trigger List Items)**

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#### **3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 3.A.1. Frequency changers or generators
- 3.A.2. Lasers, laser amplifiers and oscillators
- 3.A.3. Valves
- 3.A.4. Superconducting solenoidal electromagnets
- 3.A.5. High-power direct current power supplies
- 3.A.6. High-voltage direct current power supplies
- 3.A.7. Pressure transducers
- 3.A.8. Vacuum pumps

#### **3.B. TEST AND PRODUCTION EQUIPMENT**

- 3.B.1. Electrolytic cells for fluorine production
- 3.B.2. Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies
- 3.B.3. Centrifugal multiplane balancing machines
- 3.B.4. Filament winding machines and related equipment
- 3.B.5. Electromagnetic isotope separators
- 3.B.6. Mass spectrometers

#### **3.C. MATERIALS**

#### **3.D. SOFTWARE**

#### **3.E. TECHNOLOGY**

### **4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT (Other Than Trigger List Items)**

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#### **4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 4.A.1. Specialized packings
- 4.A.2. Pumps
- 4.A.3. Turboexpanders or turboexpander-compressor sets

#### **4.B. TEST AND PRODUCTION EQUIPMENT**

- 4.B.1. Water-hydrogen sulfide exchange tray columns and internal contactors
- 4.B.2. Hydrogen-cryogenic distillation columns
- 4.B.3. Ammonia synthesis converters or synthesis units
- 4.C. MATERIALS
- 4.D. SOFTWARE
- 4.E. TECHNOLOGY

## **5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR EXPLOSIVE DEVICES**

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### **5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 5.A.1. Photomultiplier tubes

### **5.B. TEST AND PRODUCTION EQUIPMENT**

- 5.B.1. Flash X-ray generators or pulsed electron accelerators
- 5.B.2. Multistage light gas guns or other high-velocity gun systems
- 5.B.3. Mechanical rotating mirror cameras
- 5.B.4. Electronic streak cameras, electronic framing cameras, tubes and devices
- 5.B.5. Specialized instrumentation for hydrodynamic experiments
- 5.B.6. High-speed pulse generators

### **5.C. MATERIALS**

### **5.D. SOFTWARE**

### **5.E. TECHNOLOGY**

## **6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES**

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### **6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 6.A.1. Detonators and multipoint initiation systems
- 6.A.2. Firing sets and equivalent high-current pulse generators
- 6.A.3. Switching devices
- 6.A.4. Pulse discharge capacitors
- 6.A.5. Neutron generator systems

### **6.B. TEST AND PRODUCTION EQUIPMENT**

### **6.C. MATERIALS**

- 6.C.1. High explosive substances or mixtures

### **6.D. SOFTWARE**

### **6.E. TECHNOLOGY**

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## **1. INDUSTRIAL EQUIPMENT**

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### **1.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 1.A.1. High-density (lead glass or other) radiation shielding windows, having all of the following characteristics, and specially designed frames therefor:



- a. A 'cold area' greater than  $0.09 \text{ m}^2$  ;
- b. A density greater than  $3 \text{ g/cm}^3$ ; and
- c. A thickness of 100 mm or greater.

**Technical Note:** In Item 1.A.1.a. the term 'cold area' means the viewing area of the window exposed to the lowest level of radiation in the design application.

- 1.A.2. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than  $5 \times 10^4 \text{ Gy}$  (Silicon) without operational degradation.

**Technical Note:** The term Gy (Silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation.

- 1.A.3. 'Robots', 'end-effectors' and control units as follows:

- a. 'Robots' or 'end-effectors' having either of the following characteristics:
  1. Specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives); or
  2. Specially designed or rated as radiation hardened to withstand a total radiation dose greater than  $5 \times 10^4 \text{ Gy}$  (Silicon) without operational degradation;

**Technical Note:** The term Gy (Silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation.

- b. Control units specially designed for any of the 'robots' or 'end-effectors' specified in Item 1.A.3.a.

**Note:** Item 1.A.3. does not control 'robots' specially designed for non-nuclear industrial applications such as automobile paint-spraying booths.

**Technical Notes:**

1. 'Robots'

In Item 1.A.3. 'Robot' means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use 'sensors', and has all of 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.1:**

In the above definition 'sensors' means detectors of a physical phenomenon, the output of which (after conversion into a signal that can be interpreted by a control unit) 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.

**N.B.2:**

In the above definition 'user-accessible programmability' means 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.

**N.B.3:**

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 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 "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.

**2. 'End-effectors'**

In Item 1.A.3. 'end-effectors' are grippers, 'active tooling units', and any other tooling that is attached to the baseplate on the end of a 'robot' manipulator arm.

N.B.:

*In the above definition 'active tooling units' is a device for applying motive power, process energy or sensing to the workpiece.*

- 1.A.4. Remote manipulators that can be used to provide remote actions in radiochemical separation operations or hot cells, having either of the following characteristics:
- a. A capability of penetrating 0.6 m or more of hot cell wall (through-the-wall operation); or
  - b. A capability of bridging over the top of a hot cell wall with a thickness of 0.6 m or more (over-the-wall operation).

Technical Note: Remote manipulators provide translation of human operator actions to a remote operating arm and terminal fixture. They may be of a master/slave type or operated by joystick or keypad.

1.B. TEST AND PRODUCTION EQUIPMENT

- 1.B.1. Flow-forming machines, spin-forming machines capable of flow-forming functions, and mandrels, as follows:
- a. Machines having both of the following characteristics:
    1. Three or more rollers (active or guiding); and
    2. Which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control;
  - b. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 and 400 mm.

Note: Item 1.B.1.a. includes machines which have only a single roller designed to deform metal plus two auxiliary rollers which support the mandrel, but do not participate directly in the deformation process.

- 1.B.2. 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:

N.B.: For "numerical control" units controlled by their associated "software", see Item 1.D.3.

- a. Machine tools for turning, that have "positioning accuracies" with all compensations available better (less) than 6  $\mu\text{m}$  according to ISO 230/2 (1988) along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: Item 1.B.2.a. does not control bar machines (Swissturn), limited to machining only bar feed thru, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. Machines may have drilling and/or milling capabilities for machining parts with diameters less than 42 mm.

b. Machine tools for milling, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 6  $\mu\text{m}$  according to ISO 230/2 (1988) along any linear axis (overall positioning); or
2. Two or more contouring rotary axes;

Note: Item 1.B.2.b. does not control milling machines having both of the following characteristics:

1. X-axis travel greater than 2 m; and
2. Overall "positioning accuracy" on the x-axis worse (more) than 30  $\mu\text{m}$  according to ISO 230/2 (1988).

c. Machine tools for grinding, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 4  $\mu\text{m}$  according to ISO 230/2 (1988) along any linear axis (overall positioning); or
2. Two or more contouring rotary axes;

Note: Item 1.B.2.c. does not control grinding machines as follows:

1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics:
  - a. Limited to cylindrical grinding;
  - b. A maximum workpiece outside diameter or length of 150 mm;
  - c. Not more than two axes that can be coordinated simultaneously for "contouring control"; and
  - d. No contouring c-axis;
2. Jig grinders with axes limited to x,y,c, and a, where c-axis is used to maintain the grinding wheel normal to the work surface, and the a-axis is configured to grind barrel cams;
3. Tool or cutter grinding machines with "software" specially designed for the manufacturing of tools or cutters;
4. Crankshaft or camshaft grinding machines.

d. Non-wire type Electrical Discharge Machines (EDM) that have two or more contouring rotary axes and that can be coordinated simultaneously for "contouring control".

Note: Stated "positioning accuracy" levels derived from measurements made according to ISO 230/2 or national equivalents may be used for each machine tool model instead of individual machine tests.

Stated "positioning accuracy" are to be derived as follows:

1. Select five machines of a model to be evaluated;
2. Measure the linear axis accuracies according to ISO 230/2;
3. Determine the A-values for each axis of each machine. The method of calculating the A-value is described in the ISO standard;



4. Determine the mean value of the A-value of each axis. This mean value becomes the stated value of each axis for the model (Ax Ay...);
5. Since the Category 2 list refers to each linear axis there will be as many stated values as there are linear axes;
6. If any axis of a machine model not controlled by Items 1.B.1.a. to 1.B.1.c. has a stated accuracy A of 6  $\mu\text{m}$  or better (less) for grinding machines, and 8  $\mu\text{m}$  or better (less) for milling and turning machines, both according to ISO 230/2 (1988), then the builder should be required to reaffirm the accuracy level once every eighteen months.

Technical Notes:

1. *Axis nomenclature shall be in accordance with International Standard ISO 841, "Numerical Control Machines - Axis and Motion Nomenclature".*
2. *Not counted in the total number of contouring rotary axes are secondary parallel contouring rotary axes the center line of which is parallel to the primary rotary axis.*
3. *Rotary axes do not necessarily have to rotate over 360 degrees. A rotary axis can be driven by a linear device, e.g., a screw or a rack-and-pinion.*

1.B.3. Dimensional inspection machines, instruments, or systems, as follows:

- a. Computer controlled or numerically 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 better (less) than  $(1.25 + L/1000) \mu\text{m}$  tested with a probe of an "accuracy" of better (less) than 0.2  $\mu\text{m}$  (L is the measured length in millimeters) (Ref: VDI/VDE 2617 parts 1 and 2);
- b. Linear displacement measuring instruments, as follows:
  1. Non-contact type measuring systems with a "resolution" equal to or better (less) than 0.2  $\mu\text{m}$  within a measuring range up to 0.2 mm;
  2. Linear variable differential transformer (LVDT) systems having both of the following characteristics:
    - a. "Linearity" equal to or better (less) than 0.1% within a measuring range up to 5 mm;  
and
    - b. Drift equal to or better (less) than 0.1% per day at a standard ambient test room temperature  $\pm 1 \text{ K}$ ;
  3. Measuring systems having both of the following characteristics:
    - a. Contain a laser; and
    - b. Maintain for at least 12 hours, over a temperature range of  $\pm 1 \text{ K}$  around a standard temperature and a standard pressure:
      1. A "resolution" over their full scale of 0.1  $\mu\text{m}$  or better; and
      2. With a "measurement uncertainty" equal to or better (less) than  $(0.2 + L/2000) \mu\text{m}$  (L is the measured length in millimeters);

Note: Item 1.B.3.b.3. does not control 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.

- c. Angular displacement measuring instruments having an "angular position deviation" equal to or better (less) than 0.00025°;

Note: Item 1.B.3.c. does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.

- d. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:
1. "Measurement uncertainty" along any linear axis equal to or better (less) than 3.5  $\mu\text{m}$  per 5 mm; and
  2. "Angular position deviation" equal to or less than 0.02°.

Notes: 1. Item 1.B.3. includes machine tools that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.

2. Machines described in Item 1.B.3. are controlled if they exceed the threshold specified anywhere within their operating range.

Technical Notes: 1. *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.*

2. *All parameters of measurement values in this item represent plus/minus, i.e., not total band.*

- 1.B.4. Controlled atmosphere (vacuum or inert gas) induction furnaces, and power supplies therefor, as follows:

- a. Furnaces having all of the following characteristics:

1. Capable of operation at temperatures above 1123 K (850 °C);
2. Induction coils 600 mm or less in diameter; and
3. Designed for power inputs of 5 kW or more;

Note: Item 1.B.4.a. does not control furnaces designed for the processing of semiconductor wafers.

- b. Power supplies, with a specified output power of 5 kW or more, specially designed for furnaces specified in Item 1.B.4.a.

- 1.B.5. 'Isostatic presses', and related equipment, as follows:

- a. 'Isostatic presses' having both of the following characteristics:

1. Capable of achieving a maximum working pressure of 69 MPa or greater; and
2. A chamber cavity with an inside diameter in excess of 152 mm;

- b. Dies, molds, and controls specially designed for the 'isostatic presses' specified in Item 1.B.5.a.

Technical Notes: 1. In Item 1.B.5. 'Isostatic presses' means equipment capable of pressurizing a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.

2. In Item 1.B.5. 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.

1.B.6. Vibration test systems, equipment, and components as follows:

- a. Electrodynamic vibration test systems, having all of the following characteristics:
1. Employing feedback or closed loop control techniques and incorporating a digital control unit;
  2. Capable of vibrating at 10 g RMS or more between 20 and 2000 Hz; and
  3. Capable of imparting forces of 50 kN or greater measured 'bare table';
- b. Digital control units, combined with "software" specially designed for vibration testing, with a real-time bandwidth greater than 5 kHz and being designed for a system specified in Item 1.B.6.a.;
- c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN or greater measured 'bare table', which are usable for the systems specified in Item 1.B.6.a.;
- d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN or greater, measured 'bare table', which are usable for the systems specified in Item 1.B.6.a.

Technical Note: In Item 1.B.6. 'bare table' means a flat table, or surface, with no fixtures or fittings.

1.B.7. Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment, as follows:

- a. Arc remelt and casting furnaces having both of the following characteristics:
1. Consumable electrode capacities between 1000 and 20000 cm<sup>3</sup>; and
  2. Capable of operating with melting temperatures above 1973 K (1700 °C);
- b. Electron beam melting furnaces and plasma atomization and melting furnaces, having both of the following characteristics:
1. A power of 50 kW or greater; and



2. Capable of operating with melting temperatures above 1473 K (1200 °C);
- c. Computer control and monitoring systems specially configured for any of the furnaces specified in Item 1.B.7.a. or 1.B.7.b.

#### 1.C. MATERIALS

None.

#### 1.D. SOFTWARE

- 1.D.1. "Software" specially designed for the "use" of equipment specified in Item 1.A.3, 1.B.1., 1.B.3., 1.B.5., 1.B.6.a., 1.B.6.b., 1.B.6.d. or 1.B.7.

Note: "Software" specially designed for systems specified in Item 1.B.3.d. includes "software" for simultaneous measurements of wall thickness and contour.

- 1.D.2. "Software" specially designed or modified for the "development", "production", or "use" of equipment specified in Item 1.B.2.;

- 1.D.3. "Software" for any combination of electronic devices or system enabling such device(s) to function as a "numerical control" unit capable of controlling five or more interpolating axes that can be coordinated simultaneously for "contouring control".

Notes: 1. "Software" is controlled whether exported separately or residing in a "numerical control" unit or any electronic device or system.

2. Item 1.D.3. does not control "software" specially designed or modified by the manufacturers of the control unit or machine tool to operate a machine tool that is not specified in Item 1.B.2.

#### 1.E. TECHNOLOGY

- 1.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 1.A. through 1.D.

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## 2. MATERIALS

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#### 2.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 2.A.1. Crucibles made of materials resistant to liquid actinide metals, as follows:

- a. Crucibles having both of the following characteristics:

1. A volume of between 150 cm<sup>3</sup> (150 ml) and 8000 cm<sup>3</sup> (8 liters); and
2. Made of or coated with any of the following materials, having a purity of 98% or greater by weight:
  - a. Calcium fluoride (CaF<sub>2</sub>);
  - b. Calcium zirconate (metazirconate) (CaZrO<sub>3</sub>);
  - c. Cerium sulfide (Ce<sub>2</sub>S<sub>3</sub>);
  - d. Erbium oxide (erbia) (Er<sub>2</sub>O<sub>3</sub>);
  - e. Hafnium oxide (hafnia) (HfO<sub>2</sub>);

- f. Magnesium oxide (MgO);
    - g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);
    - h. Yttrium oxide (yttria) ( $Y_2O_3$ ); or
    - i. Zirconium oxide (zirconia) ( $ZrO_2$ );
  - b. Crucibles having both of the following characteristics:
    - 1. A volume of between 50 cm<sup>3</sup> (50 ml) and 2000 cm<sup>3</sup> (2 litres); and
    - 2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight;
  - c. Crucibles having all of the following characteristics:
    - 1. A volume of between 50 cm<sup>3</sup> (50 ml) and 2000 cm<sup>3</sup> (2 litres);
    - 2. Made of or lined with tantalum, having a purity of 98% or greater by weight; and
    - 3. Coated with tantalum carbide, nitride, boride, or any combination thereof.
- 2.A.2. 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.
- 2.A.3. Composite structures in the form of tubes having both of the following characteristics:
  - a. An inside diameter of between 75 and 400 mm; and
  - b. Made with any of the "fibrous or filamentary materials" specified in Item 2.C.7.a. or carbon prepreg materials specified in Item 2.C.7.c.
- 2.B. TEST AND PRODUCTION EQUIPMENT
- 2.B.1. Tritium facilities or plants, and equipment therefor, as follows:
  - a. Facilities or plants for the production, recovery, extraction, concentration or handling of tritium;
  - b. Equipment for tritium facilities or plants, as follows:
    - 1. Hydrogen or helium refrigeration units capable of cooling to 23 K (-250 °C) or less, with heat removal capacity greater than 150 W;
    - 2. Hydrogen isotope storage or purification systems using metal hydrides as the storage or purification medium.
- 2.B.2. Lithium isotope separation facilities or plants, and equipment therefor, as follows:
  - a. Facilities or plants for the separation of lithium isotopes;
  - b. Equipment for the separation of lithium isotopes, as follows:
    - 1. Packed liquid-liquid exchange columns specially designed for lithium amalgams;
    - 2. Mercury or lithium amalgam pumps;
    - 3. Lithium amalgam electrolysis cells;
    - 4. Evaporators for concentrated lithium hydroxide solution.

## 2.C. MATERIALS

### 2.C.1. Aluminium alloys having both of the following characteristics:

- a. Capable of an ultimate tensile strength of 460 MPa or more at 293 K (20 °C); and
- b. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

Technical Note: In Item 2.C.1. the phrase, capable of, encompasses aluminium alloys before or after heat treatment.

### 2.C.2. Beryllium metal, alloys containing more than 50% beryllium by weight, beryllium compounds, manufactures thereof, and waste or scrap of any of the foregoing.

Note: Item 2.C.2. does not control the following:

- a. Metal windows for X-ray machines or for bore-hole logging devices;
- b. Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits;
- c. Beryl (silicate of beryllium and aluminium) in the form of emeralds or aquamarines.

### 2.C.3. Bismuth having both of the following characteristics:

- a. A purity of 99.99% or greater by weight, and
- b. Containing less than 10 parts per million by weight of silver.

### 2.C.4. Boron enriched in the boron-10 ( $^{10}\text{B}$ ) isotope to greater than its natural isotopic abundance, as follows: elemental boron, compounds, mixtures containing boron, manufactures thereof, waste or scrap of any of the foregoing.

Note: In Item 2.C.4. mixtures containing boron include boron loaded materials.

Technical Note: The natural isotopic abundance of boron-10 is approximately 18.5 weight percent (20 atom percent).

### 2.C.5. Calcium having both of the following characteristics:

- a. Containing less than 1000 parts per million by weight of metallic impurities other than magnesium; and
- b. Containing less than 10 parts per million by weight of boron.

### 2.C.6. Chlorine trifluoride ( $\text{ClF}_3$ ).

### 2.C.7. "Fibrous or filamentary materials", and prepregs, as follows:

- a. Carbon or aramid "fibrous or filamentary materials" having either of the following characteristics:

1. A 'specific modulus' of  $12.7 \times 10^6$  m or greater; or
2. A 'specific tensile strength' of  $23.5 \times 10^4$  m or greater;

Note: Item 2.C.7.a. does not control aramid "fibrous or filamentary materials" having 0.25% or more by weight of an ester based fiber surface modifier.

- b. Glass "fibrous or filamentary materials" having both of the following characteristics:
  1. A 'specific modulus' of  $3.18 \times 10^6$  m or greater; and
  2. A 'specific tensile strength' of  $7.62 \times 10^4$  m or greater;
- c. Thermoset resin impregnated continuous "yarns", "rovings", "tows" or "tapes" with a width of 15 mm or less (prepregs), made from carbon or glass "fibrous or filamentary materials" specified in Item 2.C.7.a. or Item 2.C.7.b. .

Technical Note: The resin forms the matrix of the composite.

- Technical Notes:
1. In Item 2.C.7. '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  $296 \pm 2$  K ( $23 \pm 2^\circ$  C) and a relative humidity of  $50 \pm 5\%$ .
  2. In Item 2.C.7. '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  $296 \pm 2$  K ( $23 \pm 2^\circ$  C) and a relative humidity of  $50 \pm 5\%$ .

2.C.8. Hafnium metal, alloys containing more than 60% hafnium by weight, hafnium compounds containing more than 60% hafnium by weight, manufactures thereof, and waste or scrap of any of the foregoing.

2.C.9. Lithium enriched in the lithium-6 ( $^6\text{Li}$ ) isotope to greater than its natural isotopic abundance and products or devices containing enriched lithium, as follows: elemental lithium, alloys, compounds, mixtures containing lithium, manufactures thereof, waste or scrap of any of the foregoing.

Note: Item 2.C.9. does not control thermoluminescent dosimeters.

Technical Note: The natural isotopic abundance of lithium-6 is approximately 6.5 weight percent (7.5 atom percent).

2.C.10. Magnesium having both of the following characteristics:

- a. Containing less than 200 parts per million by weight of metallic impurities other than calcium; and
- b. Containing less than 10 parts per million by weight of boron.

- 2.C.11. Maraging steel 'capable of' an ultimate tensile strength of 2050 MPa or more at 293 K (20° C).

Note: Item 2.C.11. does not control forms in which all linear dimensions are 75 mm or less.

Technical Note: In Item 2.C.11. the phrase 'capable of' encompasses maraging steel before or after heat treatment.

- 2.C.12. Radium-226 ( $^{226}\text{Ra}$ ), radium-226 alloys, radium-226 compounds, mixtures containing radium-226, manufactures thereof, and products or devices containing any of the foregoing.

Note: Item 2.C.12. does not control the following:

- a. Medical applicators;
- b. A product or device containing less than 0.37 GBq of radium-226.

- 2.C.13. Titanium alloys having both of the following characteristics:
- a. 'Capable of' an ultimate tensile strength of 900 MPa or more at 293 K (20 °C); and
  - b. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

Technical Note: In Item 2.C.13. the phrase 'capable of' encompasses titanium alloys before or after heat treatment.

- 2.C.14. Tungsten, tungsten carbide, and alloys containing more than 90% tungsten by weight, having both of the following characteristics:
- a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 and 300 mm; and
  - b. A mass greater than 20 kg.

Note: Item 2.C.14. does not control manufactures specially designed as weights or gamma-ray collimators.

- 2.C.15. Zirconium with a hafnium content of less than 1 part hafnium to 500 parts zirconium by weight, as follows: metal, alloys containing more than 50% zirconium by weight, compounds, manufactures thereof, waste or scrap of any of the foregoing.

Note: Item 2.C.15. does not control zirconium in the form of foil having a thickness of 0.10 mm or less.



**2.C.16. Nickel powder and porous nickel metal, as follows:**

**N.B.:** For nickel powders which are especially prepared for the manufacture of gaseous diffusion barriers see Section 5 of INFCIRC/254/Part 1 (as amended).

- a. Nickel powder having both of the following characteristics:
  - 1. A nickel purity content of 99.0% or greater by weight; and
  - 2. A mean particle size of less than 10 µm measured by the ASTM B 330 standard;
- b. Porous nickel metal produced from materials specified in Item 2.C.16.a.

**Note:** Item 2.C.16. does not control the following:

- a. Filamentary nickel powders;
- b. Single porous nickel metal sheets with an area of 1000 cm<sup>2</sup> per sheet or less.

**Technical Note:** *Item 2.C.16.b. refers to porous metal formed by compacting and sintering the material in Item 2.C.16.a. to form a metal material with fine pores interconnected throughout the structure.*

**2.C.17. Tritium, tritium compounds, mixtures containing tritium in which the ratio of tritium to hydrogen atoms exceeds 1 part in 1000, and products or devices containing any of the foregoing.**

**Note:** Item 2.C.17. does not control a product or device containing less than  $1.48 \times 10^3$  GBq of tritium.

**2.C.18. Helium-3 (<sup>3</sup>He), mixtures containing helium-3, and products or devices containing any of the foregoing.**

**Note:** Item 2.C.18. does not control a product or device containing less than 1 g of helium-3.

**2.C.19. Alpha-emitting radionuclides having an alpha half-life of 10 days or greater but less than 200 years, in the following forms:**

- a. Elemental;
- b. Compounds having a total alpha activity of 37 GBq per kg or greater;
- c. Mixtures having a total alpha activity of 37 GBq per kg or greater;
- d. Products or devices containing any of the foregoing.

**Note:** Item 2.C.19. does not control a product or device containing less than 3.7 GBq of alpha activity.

**2.D. SOFTWARE**

None

**2.E. TECHNOLOGY**

- 2.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 2.A. through 2.D.

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**3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS**  
**(Other Than Trigger List Items)**

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**3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 3.A.1. Frequency changers or generators having all of the following characteristics:

N.B.: Frequency changers and generators especially designed or prepared for the gas centrifuge process are controlled under Section 5 Annex B of INFCIRC/254/Part 1 (as amended).

- a. Multiphase output capable of providing a power of 40 W or greater;
- b. Capable of operating in the frequency range between 600 and 2000 Hz;
- c. Total harmonic distortion better (less) than 10%; and
- d. Frequency control better (less) than 0.1%.

Technical Note: Frequency changers in Item 3.A.1. are also known as converters or inverters.

- 3.A.2. Lasers, laser amplifiers and oscillators as follows:

- a. Copper vapour lasers having both of the following characteristics:
  - 1. Operating at wavelengths between 500 and 600 nm; and
  - 2. An average output power equal to or greater than 40 W;
- b. Argon ion lasers having both of the following characteristics:
  - 1. Operating at wavelengths between 400 and 515 nm; and
  - 2. An average output power greater than 40 W;
- c. Neodymium-doped (other than glass) lasers with an output wavelength between 1000 and 1100 nm having either of the following:
  - 1. Pulse-excited and Q-switched with a pulse duration equal to or greater than 1 ns, and having either of the following:
    - a. A single-transverse mode output with an average output power greater than 40 W; or
    - b. A multiple-transverse mode output with an average output power greater than 50 W;
  - or
  - 2. Incorporating frequency doubling to give an output wavelength between 500 and 550 nm with an average output power of greater than 40 W;



- d. Tunable pulsed single-mode dye laser oscillators having all of the following characteristics:
  - 1. Operating at wavelengths between 300 and 800 nm;
  - 2. An average output power greater than 1 W;
  - 3. A repetition rate greater than 1 kHz; and
  - 4. Pulse width less than 100 ns;
- e. Tunable pulsed dye laser amplifiers and oscillators having all of the following characteristics:
  - 1. Operating at wavelengths between 300 and 800 nm;
  - 2. An average output power greater than 30 W;
  - 3. A repetition rate greater than 1 kHz; and
  - 4. Pulse width less than 100 ns;

Note: Item 3.A.2.e. does not control single mode oscillators.

- f. Alexandrite lasers having all of the following characteristics:
  - 1. Operating at wavelengths between 720 and 800 nm;
  - 2. A bandwidth of 0.005 nm or less;
  - 3. A repetition rate greater than 125 Hz; and
  - 4. An average output power greater than 30 W;
- g. Pulsed carbon dioxide lasers having all of the following characteristics:
  - 1. Operating at wavelengths between 9000 and 11000 nm;
  - 2. A repetition rate greater than 250 Hz;
  - 3. An average output power greater than 500 W; and
  - 4. Pulse width of less than 200 ns;

Note: Item 3.A.2.g. does not control the higher power (typically 1 to 5 kW) industrial CO<sub>2</sub> lasers used in applications such as cutting and welding, as these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.

- h. Pulsed excimer lasers (XeF, XeCl, KrF) having all of the following characteristics:
  - 1. Operating at wavelengths between 240 and 360 nm;
  - 2. A repetition rate greater than 250 Hz; and
  - 3. An average output power greater than 500 W;
- i. Para-hydrogen Raman shifters designed to operate at 16 mm output wavelength and at a repetition rate greater than 250 Hz.

3.A.3. Valves having all of the following characteristics:

- a. A nominal size of 5 mm or greater;
- b. Having a bellows seal; and
- c. Wholly made of or lined with aluminum, aluminum alloy, nickel, or nickel alloy containing more than 60% nickel by weight.

**Technical Note:** *For valves with different inlet and outlet diameter, the nominal size parameter in Item 3.A.3.a. refers to the smallest diameter.*

3.A.4. Superconducting solenoidal electromagnets having all of the following characteristics:

- a. Capable of creating magnetic fields greater than 2 T;
- b. A ratio of length to inner diameter greater than 2;
- c. Inner diameter greater than 300 mm; and
- d. Magnetic field uniform to better than 1% over the central 50% of the inner volume.

**Note:** Item 3.A.4. does not control magnets specially designed for and exported *as part of* medical nuclear magnetic resonance (NMR) imaging systems.

**N.B.:** *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 the *as part of* relationship.

3.A.5. High-power direct current power supplies having both of the following characteristics:

- a. Capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater; and
- b. Current or voltage stability better than 0.1 % over a time period of 8 hours.

3.A.6. High-voltage direct current power supplies having both of the following characteristics:

- a. Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; and
- b. Current or voltage stability better than 0.1 % over a time period of 8 hours.

3.A.7. Pressure transducers capable of measuring absolute pressures at any point in the range 0 to 13 kPa and having both of the following characteristics:

- a. Pressure sensing elements made of or protected by aluminum, aluminum alloy, nickel, or nickel alloy with more than 60% nickel by weight; and
- b. Having either of the following characteristics:
  - 1. A full scale of less than 13 kPa and an "accuracy" of better than  $\pm 1\%$  of full scale; or
  - 2. A full scale of 13 kPa or greater and an "accuracy" of better than  $\pm 130$  Pa.

**Technical Notes:** 1. *In Item 3.A.7. pressure transducers are devices that convert pressure measurements into an electrical signal.*

2. In Item 3.A.7. "accuracy" includes non-linearity, hysteresis and repeatability at ambient temperature.

3.A.8. Vacuum pumps having all of the following characteristics:

- a. Input throat size equal to or greater than 380 mm;
- b. Pumping speed equal to or greater than 15 m<sup>3</sup>/s; and
- c. Capable of producing an ultimate vacuum better than 13.3 mPa.

Technical Notes: 1. The pumping speed is determined at the measurement point with nitrogen gas or air.

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

3.B. TEST AND PRODUCTION EQUIPMENT

3.B.1. Electrolytic cells for fluorine production with an output capacity greater than 250 g of fluorine per hour.

3.B.2. Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies, as follows:

- a. Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps;

Note: Item 3.B.2.a. includes precision mandrels, clamps, and shrink fit machines.

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

Technical Note: In Item 3.B.2.b. such equipment normally consists 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.

Technical Note: The bellows referred to in Item 3.B.2.c. have all of the following characteristics:

1. Inside diameter between 75 and 400 mm;
2. Length equal to or greater than 12.7 mm;
3. Single convolution depth greater than 2 mm; and
4. Made of high-strength aluminum alloys, maraging steel, or high strength "fibrous or filamentary materials".

3.B.3. 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. Swing or journal diameter greater than 75 mm;
  2. Mass capability of from 0.9 to 23 kg; and
  3. Capable of balancing speed of revolution greater than 5000 rpm;\_
- b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:
  1. Journal diameter greater than 75 mm;
  2. Mass capability of from 0.9 to 23 kg;
  3. Capable of balancing to a residual imbalance equal to or less than 0.010 kg x mm/kg per plane; and
  4. Belt drive type.

3.B.4. Filament winding machines and related equipment, as follows:

- a. Filament winding machines having all of the following characteristics:
  1. Having motions for positioning, wrapping, and winding fibers coordinated and programmed in two or more axes;
  2. Specially designed to fabricate composite structures or laminates from "fibrous or filamentary materials"; and
  3. Capable of winding cylindrical rotors of diameter between 75 and 400 mm and lengths of 600 mm or greater;
- b. Coordinating and programming controls for the filament winding machines specified in Item 3.B.4.a.;
- c. Precision mandrels for the filament winding machines specified in Item 3.B.4.a.

3.B.5. 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.

Notes: 1. Item 3.B.5. includes separators capable of enriching stable isotopes as well as those for uranium.

N.B.: A separator capable of separating the isotopes of lead with a one-mass unit difference is inherently capable of enriching the isotopes of uranium with a three-unit mass difference.

2. Item 3.B.5. includes separators with the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.

**Technical Note:** *A single 50 mA ion source cannot produce more than 3g of separated highly enriched uranium (HEU) per year from natural abundance feed.*

- 3.B.6. Mass spectrometers 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:

**N.B.:** Mass spectrometers especially designed or prepared for analyzing on-line samples of uranium hexafluoride are controlled under Section 5 Annex B of INFCIRC/254/Part 1 (as amended).

- 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 having either of the following characteristics:
  1. A source chamber constructed from, lined with or plated with stainless steel or molybdenum, and equipped with a cold trap capable of cooling to 193 K (-80 °C) or less;
  - or
  2. A source chamber constructed from, lined with or plated with materials resistant to  $UF_6$ ;
- f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

3.C. MATERIALS

None.

3.D. SOFTWARE

- 3.D.1. "Software" specially designed for the "use" of equipment specified in Item 3.B.3. or 3.B.4.

3.E. TECHNOLOGY

- 3.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 3.A. through 3.D.

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#### 4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT (Other Than Trigger List Items)

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4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 4.A.1. Specialized packings which may be used in separating heavy water from ordinary water, having both of the following characteristics:



- a. Made of phosphor bronze mesh chemically treated to improve wettability; and
- b. Designed to be used in vacuum distillation towers.

4.A.2. Pumps capable of circulating solutions of concentrated or dilute potassium amide catalyst in liquid ammonia ( $\text{KNH}_2/\text{NH}_3$ ), having all of the following characteristics:

- a. Airtight (i.e., hermetically sealed);
- b. A capacity greater than  $8.5 \text{ m}^3/\text{h}$ ; and
- c. Either of the following characteristics:
  - 1. For concentrated potassium amide solutions (1% or greater), an operating pressure of 1.5 to 60 MPa; or
  - 2. For dilute potassium amide solutions (less than 1%), an operating pressure of 20 to 60 MPa.

4.A.3. Turboexpanders or turboexpander-compressor sets having both of the following characteristics:

- a. Designed for operation with an outlet temperature of 35 K (- 238 °C) or less; and
- b. Designed for a throughput of hydrogen gas of 1000 kg/h or greater.

#### 4.B. TEST AND PRODUCTION EQUIPMENT

4.B.1. Water-hydrogen sulfide exchange tray columns and internal contactors, as follows:

N.B.: For columns which are especially designed or prepared for the production of heavy water, see Section 6 Annex B of INFCIRC/254/Part 1 (as amended).

- a. Water-hydrogen sulfide exchange tray columns, having all of the following characteristics:
  - 1. Can operate at pressures of 2 MPa or greater;
  - 2. Constructed of carbon steel having an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; and
  - 3. With a diameter of 1.8 m or greater;
- b. Internal contactors for the water-hydrogen sulfide exchange tray columns specified in Item 4.B.1.a.

**Technical Note:** *Internal contactors of the columns are segmented trays which have an effective assembled diameter of 1.8 m or greater; are designed to facilitate countercurrent contacting and are constructed of stainless steels with a carbon content of 0.03% or less. These may be sieve trays, valve trays, bubble cap trays or turbogrid trays.*

- 4.B.2. Hydrogen-cryogenic distillation columns having all of the following characteristics:
- Designed for operation at internal temperatures of 35 K (-238 °C) or less;
  - Designed for operation at internal pressures of 0.5 to 5 MPa;
  - Constructed of either:
    - Stainless steel of the 300 series with low sulfur content and with an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; or
    - Equivalent materials which are both cryogenic and H<sub>2</sub>-compatible; and
  - With internal diameters of 1 m or greater and effective lengths of 5 m or greater.
- 4.B.3. Ammonia synthesis converters or 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.
- 4.C. MATERIALS
- None.
- 4.D. SOFTWARE
- None.
- 4.E. TECHNOLOGY
- 4.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 4.A. through 4.D.

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## **5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR EXPLOSIVE DEVICES**

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- 5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
- 5.A.1. Photomultiplier tubes having both of the following characteristics:



- a. Photocathode area of greater than 20 cm<sup>2</sup>; and
- b. Anode pulse rise time of less than 1 ns.

## 5.B. TEST AND PRODUCTION EQUIPMENT

### 5.B.1. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:

- a. 1. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and
- 2. With a figure of merit (K) of 0.25 or greater; or
- b. 1. An accelerator peak electron energy of 25 MeV or greater; and
- 2. A peak power greater than 50 MW.

**Note:** Item 5.B.1. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes.

**Technical Notes:** 1. The figure of merit  $K$  is defined as:  $K = 1.7 \times 10^3 V^{2.65} Q$ .  $V$  is the peak electron energy in million electron volts. If the accelerator beam pulse duration is less than or equal to 1 ms, then  $Q$  is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 ms, then  $Q$  is the maximum accelerated charge in 1 ms.  $Q$  equals the integral of  $i$  with respect to  $t$ , over the lesser of 1 ms or the time duration of the beam pulse ( $Q = \int i dt$ ) where  $i$  is beam current in amperes and  $t$  is the time in seconds.

- 2. Peak power = (peak potential in volts) x (peak beam current in amperes).
- 3. In machines based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 ms or the duration of the bunched beam packet resulting from one microwave modulator pulse.
- 4. In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.

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

**5.B.3. Mechanical rotating mirror cameras, as follows, and specially designed components therefor:**

- a. Framing cameras with recording rates greater than 225000 frames per second;
- b. Streak cameras with writing speeds greater than 0.5 mm/ $\mu$ s.

**Note:** In Item 5.B.3. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors, and bearings.

**5.B.4. Electronic streak cameras, electronic framing cameras, tubes and devices, as follows:**

- a. Electronic streak cameras capable of 50 ns or less time resolution;
- b. Streak tubes for cameras specified in Item 5.B.4.a.;
- c. Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;
- d. Framing tubes and solid-state imaging devices for use with cameras specified in Item 5.B.4.c., as follows:
  1. Proximity focussed image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;
  2. Gate silicon intensifier target (SIT) vidicon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;
  3. Kerr or Pockels cell electro-optical shuttering;
  4. Other framing tubes and solid-state imaging devices having a fast image gating time of less than 50 ns specially designed for cameras specified in Item 5.B.4.c.

**5.B.5. Specialized instrumentation for hydrodynamic experiments, as follows:**

- a. Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 ms;
- b. Manganin gauges for pressures greater than 10 GPa;
- c. Quartz pressure transducers for pressures greater than 10 GPa.

**Note:** Item 5.B.5.a. includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLIs (Doppler laser interferometers).

**5.B.6. High-speed pulse generators having both of the following characteristics:**

- a. Output voltage greater than 6 V into a resistive load of less than 55 ohms;  
and
- b. 'Pulse transition time' less than 500 ps.

Technical Note: In Item 5.B.6.b. 'pulse transition time' is defined as the time interval between 10% and 90% voltage amplitude.

**5.C. MATERIALS**

None.

**5.D. SOFTWARE**

None.

**5.E. TECHNOLOGY**

- 5.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 5.A. through 5.D.

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**6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES**

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**6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS****6.A.1. Detonators and multipoint initiation systems, as follows:**

- a. Electrically driven explosive detonators, as follows:
  - 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 an area greater than 5000 mm<sup>2</sup> from a single firing signal with an initiation timing spread over the surface of less than 2.5  $\mu$ s.

Note: Item 6.A.1. does not control detonators using only primary explosives, such as lead azide.

Technical Note: In Item 6.A.1. the detonators of concern all utilize 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 magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator. Also, the word initiator is sometimes used in place of the word detonator.*

6.A.2. Firing sets and equivalent high-current pulse generators, as follows:

- a. Explosive detonator firing sets designed to drive multiple controlled detonators specified by Item 6.A.1. above;
- b. Modular electrical pulse generators (pulsers) having all of the following characteristics:
  1. Designed for portable, mobile, or ruggedized-use;
  2. Enclosed in a dust-tight enclosure;
  3. Capable of delivering their energy in less than 15  $\mu$ s;
  4. Having an output greater than 100 A;
  5. Having a 'rise time' of less than 10  $\mu$ s into loads of less than 40 ohms;
  6. No dimension greater than 25.4 cm;
  7. Weight less than 25 kg ; and
  8. Specified to operate over an extended temperature range of 223 to 373 K (-50 °C to 100 °C) or specified as suitable for aerospace applications.

Note: Item 6.A.2.b. includes xenon flashlamp drivers.

Technical Note: In Item 6.A.2.b.5. 'rise time' is defined as the time interval from 10% to 90% current amplitude when driving a resistive load.

6.A.3. Switching devices as follows:

- a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:
  1. Containing three or more electrodes;
  2. Anode peak voltage rating of 2.5 kV or more;
  3. Anode peak current rating of 100 A or more; and
  4. Anode delay time of 10  $\mu$ s or less;

Note: Item 6.A.3.a. includes gas krytron tubes and vacuum sprytron tubes.

- b. Triggered spark-gaps having both of the following characteristics:

1. Anode delay time of 15  $\mu$ s or less; and
  2. 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 kV;
  2. Anode peak current rating of 500 A or more; and
  3. Turn-on time of 1  $\mu$ s or less.

6.A.4. Pulse discharge capacitors having either of the following sets of characteristics:

- a.
  1. Voltage rating greater than 1.4 kV;
  2. Energy storage greater than 10 J;
  3. Capacitance greater than 0.5  $\mu$ F; and
  4. Series inductance less than 50 nH; or
- b.
  1. Voltage rating greater than 750 V;
  2. Capacitance greater than 0.25  $\mu$ F; and
  3. Series inductance less than 10 nH.

6.A.5. Neutron generator systems, including tubes, having both of the following characteristics:

- a. Designed for operation without an external vacuum system; and
- b. Utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction.

6.B. TEST AND PRODUCTION EQUIPMENT

None.

6.C. MATERIALS

6.C.1. High explosive substances or mixtures, containing more than 2 % by weight of any of the following:

- a. Cyclotetramethylenetetranitramine (HMX ) (CAS 2691-41-0);
- b. Cyclotrimethylenetrinitramine (RDX) (CAS 121-82-4);
- c. Triaminotrinitrobenzene (TATB) (CAS 3058-38-6);
- d. Hexanitrostilbene (HNS) (CAS 20062-22-0); or
- e. Any explosive with a crystal density greater than 1.8 g/cm<sup>3</sup> and having a detonation velocity greater than 8000 m/s.

6.D. SOFTWARE

None.

**6.E. TECHNOLOGY**

- 6.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 6.A. through 6.D.

**END QUOTE**



**KENNISGEWING INGEVOLGE ARTIKEL 13 VAN DIE  
WET OP DIE NIE-PROLIFERASIE VAN WAPENS  
VAN GROOTSKAALSE Vernietiging, 1993**

**VERKLARING VAN SEKERE KERNVERWANTE DUBBELDOELIGE TOERUSTING,  
MATERIALE EN VERWANTETEGNOLOGIE-ITEMS TOT BEHEERDE GOEDERE EN  
BEHEERMAATREËLS WAT OP SODANIGE GOEDERE VAN TOEPASSING IS**

1. Ek, Alec Erwin, Minister van Handel en Nywerheid, handelende op aanbeveling van die Suid-Afrikaanse Raad vir die Nie-proliferasie van Wapens van Groot skaalse Vernietiging, en kragtens artikel 13 van die Wet op die Nie-proliferasie van Wapens van Groot skaalse Vernietiging, 1993 (Wet No. 87 van 1993) -

- (a) verklaar hierby alle items gelys in die IAEA (Internasionale Atoomenergie-Agentskap)-dokument INFCIRC/254/Rev.4/Part 2, gedateer Maart 2000, soos in Bylae A van hierdie kennisgewing in Engels aangehaal, tot beheerde goedere;
  - (b) bepaal hierby dat die invoer, uitvoer en deurvoer van sodanige beheerde goedere slegs mag plaasvind kragtens 'n permit wat deur genoemde Raad, ingestel by artikel 4 van genoemde Wet, uitgereik is;
  - (c) bepaal hierby dat die plaaslike oordrag of verkoop van sodanig beheerde goedere deur 'n persoon bedoel in artikel 13(3) van genoemde Wet slegs mag plaasvind indien die ontvanger die goedere ingevolge genoemde artikel geregistreer is en genoemde Raad deur middel van 'n verklaring deur die verskaffer van die transaksie in kennis gestel is;
  - (d) verklaar hierby tot beheerde goedere enige onderdeel bedoel in "General Note 4" soos aangehaal in Bylae A, wat beskryf kan word as 'n integrerende deel van aanlegte, stelsels, samesstelle of toerusting in Bylae A gelys en waarsonder die aanlegte, stelsels, samesstelle of toerusting nie hulle beoogde funksie sal verrig of eienspappe sal vertoon of die werkverrigtingsvlak sal bereik nie wat maak dat die aanlegte, stelsels, samesstelle of toerusting ingevolge 'n inskrywing of inskrywings van Bylae A beheerde goedere is; en
  - (e) herroep hierby Goewermentskennisgewing No. R.1790 van 14 Oktober 1994.
2. Aansoekvorms vir permitte en registrasies ingevolge artikel 13(3) van genoemde Wet is verkrygbaar van:

Die Sekretariaat  
Die Suid-Afrikaanse Raad vir die Nie-proliferasie van Wapens van  
Grootsekaalse Vernietiging  
Privaat Sak X84  
**PRETORIA**

0001



**ALEC ERWIN,**  
Minister van Handel en Nywerheid.

**BYLAE A****KERNVERWANTE DUBBELDOELIGE BEHEERDE GOEDERE**

Die lys van kernverwante dubbeldoelige toerusting, materiale, programmatuur en verwantetegnologie-items, soos vervat in die Bylae by IAEA-dokument INFCIRC/254/Rev.4/Part 2, gedateer Maart 2000, word in sy geheel aangehaal.

**AANHALING BEGIN****ANNEX**

**Note:** The International System of Units (SI) is used in this Annex. In all cases the physical quantity defined in SI units should be considered the official recommended control value. However, some machine tool parameters are given in their customary units, which are not SI.

Commonly used abbreviations (and their prefixes denoting size) in this Annex are as follows:

A	—	ampere(s)
Bq	—	becquerel(s)
°C	—	degree(s) Celsius
CAS	—	chemical abstracts service
Ci	—	curie(s)
cm	—	centimeter(s)
dB	—	decibel(s)
dBm	—	decibel referred to 1 milliwatt
g	—	gram(s); also, acceleration of gravity (9.81 m/s <sup>2</sup> )
GBq	—	gigabecquerel(s)
GHz	—	gigahertz
GPa	—	gigapascal(s)
Gy	—	gray
h	—	hour(s)
Hz	—	hertz
J	—	joule(s)
K	—	kelvin
keV	—	thousand electron volt(s)
kg	—	kilogram(s)

kHz	---	kilohertz
kN	---	kilonewton(s)
kPa	---	kilopascal(s)
kV	---	kilovolt(s)
kW	---	kilowatt(s)
m	---	meter(s)
mA	---	milliampere(s)
MeV	---	million electron volt(s)
MHz	---	megahertz
ml	---	milliliter(s)
mm	---	millimeter(s)
MPa	---	megapascal(s)
mPa	---	millipascal(s)
MW	---	megawatt(s)
μF	---	microfarad(s)
μm	---	micrometer(s)
μs	---	microsecond(s)
N	---	newton(s)
nm	---	nanometer(s)
ns	---	nanosecond(s)
nH	---	nanohenry(ies)
ps	---	picosecond(s)
RMS	---	root mean square
rpm	---	revolutions per minute
s	---	second(s)
T	---	tesla(s)
TIR	---	total indicator reading
V	---	volt(s)
W	---	watt(s)

#### GENERAL NOTE

The following paragraphs are applied to the List of Nuclear-Related Dual-Use Equipment, Material, Software, and Related Technology.

1. The description of any item on the List includes that item in either new or second-hand condition.
2. When the description of any item on the List contains no qualifications or specifications, it is regarded as including all varieties of that item. Category captions are only for convenience in reference and do not affect the interpretation of item definitions.
3. The object of these controls should not be defeated by the transfer of any non-controlled item (including plants) containing one or more controlled components when the controlled component or components are the principal element of the item and can feasibly be removed or used for other purposes.

**Note:** In judging whether the controlled component or components are to be considered the principal element, governments should weigh the factors of quantity, value, and

technological know-how involved and other special circumstances which might establish the controlled component or components as the principal element of the item being procured.

4. The object of these controls should not be defeated by the transfer of component parts. Each government will take such action as it can to achieve this aim and will continue to seek a workable definition for component parts, which could be used by all the suppliers.

### TECHNOLOGY CONTROLS

The transfer of "technology" is controlled according to the Guidelines and as described in each section of the Annex. "Technology" directly associated with any item in the Annex will be subject to as great a degree of scrutiny and control as will the item itself, to the extent permitted by national legislation.

The approval of any Annex item for export also authorizes the export to the same end user of the minimum "technology" required for the installation, operation, maintenance, and repair of the item.

Note: Controls on "technology" transfer do not apply to information "in the public domain" or to "basic scientific research".

### GENERAL SOFTWARE NOTE

The transfer of "software" is controlled according to the Guidelines and as described in the Annex.

Note: Controls on "software" transfers do not apply to "software" as follows:

1. Generally available to the public by being:
  - a. Sold from stock at retail selling points without restriction;
  - and
  - b. Designed for installation by the user without further substantial support by the supplier;
  - or
2. "In the public domain".

### DEFINITIONS

"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.

"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. (Ref: VDI/VDE 2617 Draft: "Rotary table on coordinate measuring machines")

**"Basic scientific research" --**

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

**"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 2806-1980 as amended)

**"Development" --**

is related to all phases before "production" such as:

- design
- design research
- design analysis
- design concepts
- assembly and testing of prototypes
- pilot production schemes
- design data
- process of transforming design data into a product
- configuration design
- integration design
- layouts

**"Fibrous or filamentary materials" --**

means continuous 'monofilaments', 'yarns', 'rovings', 'tows' or 'tapes'.

N.B.:

1. 'Filament' or 'monofilament' --

is the smallest increment of fiber, usually several  $\mu\text{m}$  in diameter.

2. 'Roving' --

is a bundle (typically 12-120) of approximately parallel 'strands'.

N.B.:

'Strand' --

is a bundle of 'filaments' (typically over 200) arranged approximately parallel.



## 3. 'Tape' --

is a material constructed of interlaced or unidirectional 'filaments', 'strands', 'rovings', 'tows' or 'yarns', etc., usually preimpregnated with resin.

## 4. 'Tow' --

is a bundle of 'filaments', usually approximately parallel.

## 5. 'Yarn' --

is a bundle of twisted 'strands'.

## 6. 'Filament' --

See "Fibrous or filamentary materials".

"In the public domain" --

"In the public domain", as it applies herein, means "technology" or "software" that has been made available without restrictions upon its further dissemination. (Copyright restrictions do not remove "technology" or "software" from being "in the public domain".)

"Linearity" --

(Usually measured in terms of non linearity) 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.

"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/VDE 2617)

"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.

'Monofilament' --

See "Fibrous or filamentary materials".

"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)

"Positioning accuracy" --

of "numerically controlled" machine tools is to be determined and presented in accordance with Item 1.B.2., 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  $\pm 10\%$  of nominal rated voltage;
  - (ii) Frequency variation shall not be greater than  $\pm 2$  Hz of normal frequency;
  - (iii) Lineouts or interrupted service are not permitted.

(b) Test Program (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 the test results (paragraph 2):

The results of the measurements must include:

- (1) "positioning accuracy" (A) and
- (2) The mean reversal error (B).

"Production" –

means all production phases such as:

- construction
- production engineering
- manufacture
- integration
- assembly (mounting)
- inspection
- testing
- quality assurance

**"Program" --**

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

**"Resolution" --**

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

**'Roving' --**

See "Fibrous or filamentary materials".

**"Software" --**

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

**'Strand' --**

See "Fibrous or filamentary materials".

**'Tape' --**

See "Fibrous or filamentary materials".

**"Technical assistance" --**

"Technical assistance" may take forms such as: instruction, skills, training, working knowledge, consulting services.

Note: "Technical assistance" may involve transfer of "technical data".

**"Technical data" --**

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

**"Technology" --**

means specific information required for the "development", "production", or "use" of any item contained in the List. This information may take the form of "technical data" or "technical assistance".

**'Tow' --**

See "Fibrous or filamentary materials".

"Use" --

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

'Yam' --

See "Fibrous or filamentary materials".

## ANNEX CONTENTS

### 1. INDUSTRIAL EQUIPMENT

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#### 1.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 1.A.1. High-density radiation shielding windows
- 1.A.2. Radiation-hardened TV cameras, or lenses therefore
- 1.A.3. Robots, end-effectors' and control units
- 1.A.4. Remote manipulators

#### 1.B. TEST AND PRODUCTION EQUIPMENT

- 1.B.1. Flow-forming machines, spin-forming machines capable of flow-forming functions, and mandrels
- 1.B.2. Machine tools
- 1.B.3. Dimensional inspection machines, instruments, or systems
- 1.B.4. Controlled atmosphere induction furnaces, and power supplies therefore
- 1.B.5. Isostatic presses, and related equipment
- 1.B.6. Vibration test systems, equipment, and components
- 1.B.7. Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment

#### 1.C. MATERIALS

#### 1.D. SOFTWARE

#### 1.E. TECHNOLOGY

### 2. MATERIALS

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#### 2.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 2.A.1. Crucibles made of materials resistant to liquid actinide metals
- 2.A.2. Platinized catalysts
- 2.A.3. Composite structures in the forms of tubes

#### 2.B. TEST AND PRODUCTION EQUIPMENT

- 2.B.1. Tritium facilities or plants, and equipment therefore
- 2.B.2. Lithium isotope separation facilities or plants, and equipment therefore

#### 2.C. MATERIALS

- 2.C.1. Aluminium
- 2.C.2. Beryllium
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- 2.C.9. Lithium
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- 2.C.12. Radium-226
- 2.C.13. Titanium
- 2.C.14. Tungsten
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- 2.D. SOFTWARE
- 2.E. TECHNOLOGY

### **3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS (Other Than Trigger List Items)**

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- 3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS
  - 3.A.1. Frequency changers or generators
  - 3.A.2. Lasers, laser amplifiers and oscillators
  - 3.A.3. Valves
  - 3.A.4. Superconducting solenoidal electromagnets
  - 3.A.5. High-power direct current power supplies
  - 3.A.6. High-voltage direct current power supplies
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  - 3.A.8. Vacuum pumps
- 3.B. TEST AND PRODUCTION EQUIPMENT
  - 3.B.1. Electrolytic cells for fluorine production
  - 3.B.2. Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies
  - 3.B.3. Centrifugal multiplane balancing machines
  - 3.B.4. Filament winding machines and related equipment
  - 3.B.5. Electromagnetic isotope separators
  - 3.B.6. Mass spectrometers
- 3.C. MATERIALS
- 3.D. SOFTWARE
- 3.E. TECHNOLOGY

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**4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT  
(Other Than Trigger List Items)**

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**4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 4.A.1. Specialized packings
- 4.A.2. Pumps
- 4.A.3. Turboexpanders or turboexpander-compressor sets

**4.B. TEST AND PRODUCTION EQUIPMENT**

- 4.B.1. Water-hydrogen sulfide exchange tray columns and internal contactors
- 4.B.2. Hydrogen-cryogenic distillation columns
- 4.B.3. Ammonia synthesis converters or synthesis units

**4.C. MATERIALS****4.D. SOFTWARE****4.E. TECHNOLOGY**

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**5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR  
EXPLOSIVE DEVICES**

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**5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 5.A.1. Photomultiplier tubes

**5.B. TEST AND PRODUCTION EQUIPMENT**

- 5.B.1. Flash X-ray generators or pulsed electron accelerators
- 5.B.2. Multistage light gas guns or other high-velocity gun systems
- 5.B.3. Mechanical rotating mirror cameras
- 5.B.4. Electronic streak cameras, electronic framing cameras, tubes and devices
- 5.B.5. Specialized instrumentation for hydrodynamic experiments
- 5.B.6. High-speed pulse generators

**5.C. MATERIALS****5.D. SOFTWARE****5.E. TECHNOLOGY**

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**6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES**

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**6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS**

- 6.A.1. Detonators and multipoint initiation systems
- 6.A.2. Firing sets and equivalent high-current pulse generators
- 6.A.3. Switching devices
- 6.A.4. Pulse discharge capacitors
- 6.A.5. Neutron generator systems

**6.B. TEST AND PRODUCTION EQUIPMENT****6.C. MATERIALS**

- 6.C.1. High explosive substances or mixtures

**6.D. SOFTWARE****6.E. TECHNOLOGY**



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## 1. INDUSTRIAL EQUIPMENT

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### 1.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

1.A.1. High-density (lead glass or other) radiation shielding windows, having all of the following characteristics, and specially designed frames therefor:

- a. A 'cold area' greater than  $0.09 \text{ m}^2$  ;
- b. A density greater than  $3 \text{ g/cm}^3$ ; and
- c. A thickness of 100 mm or greater.

**Technical Note:** In Item 1.A.1.a. the term 'cold area' means the viewing area of the window exposed to the lowest level of radiation in the design application.

1.A.2. Radiation-hardened TV cameras, or lenses therefor, specially designed or rated as radiation hardened to withstand a total radiation dose greater than  $5 \times 10^4 \text{ Gy}$  (Silicon) without operational degradation.

**Technical Note:** The term Gy (Silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation.

1.A.3. 'Robots', 'end-effectors' and control units as follows:

- a. 'Robots' or 'end-effectors' having either of the following characteristics:
  1. Specially designed to comply with national safety standards applicable to handling high explosives (for example, meeting electrical code ratings for high explosives); or
  2. Specially designed or rated as radiation hardened to withstand a total radiation dose greater than  $5 \times 10^4 \text{ Gy}$  (Silicon) without operational degradation;

**Technical Note:** The term Gy (Silicon) refers to the energy in Joules per kilogram absorbed by an unshielded silicon sample when exposed to ionizing radiation.

- b. Control units specially designed for any of the 'robots' or 'end-effectors' specified in Item 1.A.3.a.

**Note:** Item 1.A.3. does not control 'robots' specially designed for non-nuclear industrial applications such as automobile paint-spraying booths.

**Technical Notes:**

1. 'Robots'

In Item 1.A.3. 'Robot' means a manipulation mechanism, which may be of the continuous path or of the point-to-point variety, may use 'sensors', and has all of 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.1:**

In the above definition 'sensors' means detectors of a physical phenomenon, the output of which (after conversion into a signal that can be interpreted by a control unit) 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.

**N.B.2:**

In the above definition 'user-accessible programmability' means 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.

**N.B.3:**

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 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 "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.

**2. 'End-effectors'**

In Item 1.A.3. 'end-effectors' are grippers, 'active tooling units', and any other tooling that is attached to the baseplate on the end of a 'robot' manipulator arm.

**N.B.:**

In the above definition 'active tooling units' is a device for applying motive power, process energy or sensing to the workpiece.

- 1.A.4. Remote manipulators that can be used to provide remote actions in radiochemical separation operations or hot cells, having either of the following characteristics:
- a. A capability of penetrating 0.6 m or more of hot cell wall (through-the-wall operation); or
  - b. A capability of bridging over the top of a hot cell wall with a thickness of 0.6 m or more (over-the-wall operation).

Technical Note: Remote manipulators provide translation of human operator actions to a remote operating arm and terminal fixture. They may be of a master/slave type or operated by joystick or keypad.

1.B. TEST AND PRODUCTION EQUIPMENT

- 1.B.1. Flow-forming machines, spin-forming machines capable of flow-forming functions, and mandrels, as follows:
- a. Machines having both of the following characteristics:
    1. Three or more rollers (active or guiding); and
    2. Which, according to the manufacturer's technical specification, can be equipped with "numerical control" units or a computer control;
  - b. Rotor-forming mandrels designed to form cylindrical rotors of inside diameter between 75 and 400 mm.

Note: Item 1.B.1.a. includes machines which have only a single roller designed to deform metal plus two auxiliary rollers which support the mandrel, but do not participate directly in the deformation process.

- 1.B.2. 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:

N.B.: For "numerical control" units controlled by their associated "software", see Item 1.D.3.

- a. Machine tools for turning, that have "positioning accuracies" with all compensations available better (less) than 6  $\mu\text{m}$  according to ISO 230/2 (1988) along any linear axis (overall positioning) for machines capable of machining diameters greater than 35 mm;

Note: Item 1.B.2.a. does not control bar machines (Swissturn), limited to machining only bar feed thru, if maximum bar diameter is equal to or less than 42 mm and there is no capability of mounting chucks. Machines may have drilling and/or milling capabilities for machining parts with diameters less than 42 mm.

- b. Machine tools for milling, having any of the following characteristics:
  1. "Positioning accuracies" with all compensations available better (less) than 6  $\mu\text{m}$  according to ISO 230/2 (1988) along any linear axis (overall positioning); or
  2. Two or more contouring rotary axes;

**Note:** Item 1.B.2.b. does not control milling machines having both of the following characteristics:

1. X-axis travel greater than 2 m; and
2. Overall "positioning accuracy" on the x-axis worse (more) than 30  $\mu\text{m}$  according to ISO 230/2 (1988).

c. Machine tools for grinding, having any of the following characteristics:

1. "Positioning accuracies" with all compensations available better (less) than 4  $\mu\text{m}$  according to ISO 230/2 (1988) along any linear axis (overall positioning); or
2. Two or more contouring rotary axes;

**Note:** Item 1.B.2.c. does not control grinding machines as follows:

1. Cylindrical external, internal, and external-internal grinding machines having all the following characteristics:
  - a. Limited to cylindrical grinding;
  - b. A maximum workpiece outside diameter or length of 150 mm;
  - c. Not more than two axes that can be coordinated simultaneously for "contouring control"; and
  - d. No contouring c-axis;
2. Jig grinders with axes limited to x,y,c, and a, where c-axis is used to maintain the grinding wheel normal to the work surface, and the a-axis is configured to grind barrel cams;
3. Tool or cutter grinding machines with "software" specially designed for the manufacturing of tools or cutters;
4. Crankshaft or camshaft grinding machines.

d. Non-wire type Electrical Discharge Machines (EDM) that have two or more contouring rotary axes and that can be coordinated simultaneously for "contouring control".

**Note:** Stated "positioning accuracy" levels derived from measurements made according to ISO 230/2 or national equivalents may be used for each machine tool model instead of individual machine tests.

Stated "positioning accuracy" are to be derived as follows:

1. Select five machines of a model to be evaluated;
2. Measure the linear axis accuracies according to ISO 230/2;
3. Determine the A-values for each axis of each machine. The method of calculating the A-value is described in the ISO standard;
4. Determine the mean value of the A-value of each axis. This mean value becomes the stated value of each axis for the model (Ax Ay...);
5. Since the Category 2 list refers to each linear axis there will be as many stated values as there are linear axes;
6. If any axis of a machine model not controlled by Items 1.B.1.a. to 1.B.1.c. has a stated accuracy A of 6  $\mu\text{m}$  or better (less) for grinding machines, and 8  $\mu\text{m}$  or better (less) for milling and turning machines, both according to ISO 230/2 (1988), then the builder should be

required to reaffirm the accuracy level once every eighteen months.

- Technical Notes:**
1. *Axis nomenclature shall be in accordance with International Standard ISO 841, "Numerical Control Machines - Axis and Motion Nomenclature".*
  2. *Not counted in the total number of contouring rotary axes are secondary parallel contouring rotary axes the center line of which is parallel to the primary rotary axis.*
  3. *Rotary axes do not necessarily have to rotate over 360 degrees. A rotary axis can be driven by a linear device, e.g., a screw or a rack-and-pinion.*

**1.B.3. Dimensional inspection machines, instruments, or systems, as follows:**

- a. Computer controlled or numerically 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 better (less) than  $(1.25 + L/1000) \mu\text{m}$  tested with a probe of an "accuracy" of better (less) than  $0.2 \mu\text{m}$  (L is the measured length in millimeters) (Ref: VDI/VDE 2617 parts 1 and 2);
- b. Linear displacement measuring instruments, as follows:
  1. Non-contact type measuring systems with a "resolution" equal to or better (less) than  $0.2 \mu\text{m}$  within a measuring range up to  $0.2 \text{ mm}$ ;
  2. Linear variable differential transformer (LVDT) systems having both of the following characteristics:
    - a. "Linearity" equal to or better (less) than  $0.1\%$  within a measuring range up to  $5 \text{ mm}$ :  
and
    - b. Drift equal to or better (less) than  $0.1\%$  per day at a standard ambient test room temperature  $\pm 1 \text{ K}$ ;
  3. Measuring systems having both of the following characteristics:
    - a. Contain a laser; and
    - b. Maintain for at least 12 hours, over a temperature range of  $\pm 1 \text{ K}$  around a standard temperature and a standard pressure:
      1. A "resolution" over their full scale of  $0.1 \mu\text{m}$  or better; and
      2. With a "measurement uncertainty" equal to or better (less) than  $(0.2 + L/2000) \mu\text{m}$  (L is the measured length in millimeters);

**Note:** Item 1.B.3.b.3. does not control 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.

- c. Angular displacement measuring instruments having an "angular position deviation" equal to or better (less) than  $0.00025^\circ$ ;

**Note:** Item 1.B.3.c. does not control optical instruments, such as autocollimators, using collimated light to detect angular displacement of a mirror.



- d. Systems for simultaneous linear-angular inspection of hemishells, having both of the following characteristics:
1. "Measurement uncertainty" along any linear axis equal to or better (less) than 3.5  $\mu\text{m}$  per 5 mm; and
  2. "Angular position deviation" equal to or less than 0.02°.

- Notes:**
1. Item 1.B.3. includes machine tools that can be used as measuring machines if they meet or exceed the criteria specified for the measuring machine function.
  2. Machines described in Item 1.B.3. are controlled if they exceed the threshold specified anywhere within their operating range.

- Technical Notes:**
1. *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.*
  2. *All parameters of measurement values in this item represent plus/minus, i.e., not total band.*

- 1.B.4. Controlled atmosphere (vacuum or inert gas) induction furnaces, and power supplies therefor, as follows:

- a. Furnaces having all of the following characteristics:
1. Capable of operation at temperatures above 1123 K (850 °C);
  2. Induction coils 600 mm or less in diameter; and
  3. Designed for power inputs of 5 kW or more;

**Note:** Item 1.B.4.a. does not control furnaces designed for the processing of semiconductor wafers.

- b. Power supplies, with a specified output power of 5 kW or more, specially designed for furnaces specified in Item 1.B.4.a.

- 1.B.5. 'Isostatic presses', and related equipment, as follows:

- a. 'Isostatic presses' having both of the following characteristics:
1. Capable of achieving a maximum working pressure of 69 MPa or greater; and
  2. A chamber cavity with an inside diameter in excess of 152 mm;
- b. Dies, molds, and controls specially designed for the 'isostatic presses' specified in Item 1.B.5.a.

- Technical Notes:**
1. *In Item 1.B.5. 'Isostatic presses' means equipment capable of pressurizing a closed cavity through various media (gas, liquid, solid particles, etc.) to create equal pressure in all directions within the cavity upon a workpiece or material.*
  2. *In Item 1.B.5. 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.*

1.B.6. Vibration test systems, equipment, and components as follows:

- a. Electrodynamic vibration test systems, having all of the following characteristics:
  1. Employing feedback or closed loop control techniques and incorporating a digital control unit;
  2. Capable of vibrating at 10 g RMS or more between 20 and 2000 Hz; and
  3. Capable of imparting forces of 50 kN or greater measured 'bare table';
- b. Digital control units, combined with "software" specially designed for vibration testing, with a real-time bandwidth greater than 5 kHz and being designed for a system specified in Item 1.B.6.a.;
- c. Vibration thrusters (shaker units), with or without associated amplifiers, capable of imparting a force of 50 kN or greater measured 'bare table', which are usable for the systems specified in Item 1.B.6.a.;
- d. Test piece support structures and electronic units designed to combine multiple shaker units into a complete shaker system capable of providing an effective combined force of 50 kN or greater, measured 'bare table', which are usable for the systems specified in Item 1.B.6.a.

**Technical Note:** *In Item 1.B.6. 'bare table' means a flat table, or surface, with no fixtures or fittings.*

1.B.7. Vacuum or other controlled atmosphere metallurgical melting and casting furnaces and related equipment, as follows:

- a. Arc remelt and casting furnaces having both of the following characteristics:
  1. Consumable electrode capacities between 1000 and 20000 cm<sup>3</sup>; and
  2. Capable of operating with melting temperatures above 1973 K (1700 °C);
- b. Electron beam melting furnaces and plasma atomization and melting furnaces, having both of the following characteristics:
  1. A power of 50 kW or greater; and
  2. Capable of operating with melting temperatures above 1473 K (1200 °C);
- c. Computer control and monitoring systems specially configured for any of the furnaces specified in Item 1.B.7.a. or 1.B.7.b.

1.C. MATERIALS

None.

1.D. SOFTWARE

1.D.1. "Software" specially designed for the "use" of equipment specified in Item 1.A.3, 1.B.1., 1.B.3., 1.B.5., 1.B.6.a., 1.B.6.b., 1.B.6.d. or 1.B.7.

**Note:** "Software" specially designed for systems specified in Item 1.B.3.d. includes "software" for simultaneous measurements of wall thickness and contour.

1.D.2. "Software" specially designed or modified for the "development", "production", or "use" of equipment specified in Item 1.B.2.;

- 1.D.3. "Software" for any combination of electronic devices or system enabling such device(s) to function as a "numerical control" unit capable of controlling five or more interpolating axes that can be coordinated simultaneously for "contouring control".

Notes: 1. "Software" is controlled whether exported separately or residing in a "numerical control" unit or any electronic device or system.

2. Item 1.D.3. does not control "software" specially designed or modified by the manufacturers of the control unit or machine tool to operate a machine tool that is not specified in Item 1.B.2.

1.E. TECHNOLOGY

- 1.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 1.A. through 1.D.

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## 2. MATERIALS

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2.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 2.A.1. Crucibles made of materials resistant to liquid actinide metals, as follows:
- a. Crucibles having both of the following characteristics:
    - 1. A volume of between 150 cm<sup>3</sup> (150 ml) and 8000 cm<sup>3</sup> (8 liters); and
    - 2. Made of or coated with any of the following materials, having a purity of 98% or greater by weight:
      - a. Calcium fluoride (CaF<sub>2</sub>);
      - b. Calcium zirconate (metazirconate) (CaZrO<sub>3</sub>);
      - c. Cerium sulfide (Ce<sub>2</sub>S<sub>3</sub>);
      - d. Erbium oxide (erbia) (Er<sub>2</sub>O<sub>3</sub>);
      - e. Hafnium oxide (hafnia) (HfO<sub>2</sub>);
      - f. Magnesium oxide (MgO);
      - g. Nitrided niobium-titanium-tungsten alloy (approximately 50% Nb, 30% Ti, 20% W);
      - h. Yttrium oxide (yttria) (Y<sub>2</sub>O<sub>3</sub>); or
      - i. Zirconium oxide (zirconia) (ZrO<sub>2</sub>);
  - b. Crucibles having both of the following characteristics:
    - 1. A volume of between 50 cm<sup>3</sup> (50 ml) and 2000 cm<sup>3</sup> (2 litres); and
    - 2. Made of or lined with tantalum, having a purity of 99.9% or greater by weight;
  - c. Crucibles having all of the following characteristics:
    - 1. A volume of between 50 cm<sup>3</sup> (50 ml) and 2000 cm<sup>3</sup> (2 litres);
    - 2. Made of or lined with tantalum, having a purity of 98% or greater by weight; and
    - 3. Coated with tantalum carbide, nitride, boride, or any combination thereof.
- 2.A.2. 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.

- 2.A.3. Composite structures in the form of tubes having both of the following characteristics:
- a. An inside diameter of between 75 and 400 mm; and
  - b. Made with any of the "fibrous or filamentary materials" specified in Item 2.C.7.a. or carbon prepreg materials specified in Item 2.C.7.c.

2.B. TEST AND PRODUCTION EQUIPMENT

2.B.1. Tritium facilities or plants, and equipment therefor, as follows:

- a. Facilities or plants for the production, recovery, extraction, concentration or handling of tritium;
- b. Equipment for tritium facilities or plants, as follows:
  1. Hydrogen or helium refrigeration units capable of cooling to 23 K (-250 °C) or less, with heat removal capacity greater than 150 W;
  2. Hydrogen isotope storage or purification systems using metal hydrides as the storage or purification medium.

2.B.2. Lithium isotope separation facilities or plants, and equipment therefor, as follows:

- a. Facilities or plants for the separation of lithium isotopes;
- b. Equipment for the separation of lithium isotopes, as follows:
  1. Packed liquid-liquid exchange columns specially designed for lithium amalgams;
  2. Mercury or lithium amalgam pumps;
  3. Lithium amalgam electrolysis cells;
  4. Evaporators for concentrated lithium hydroxide solution.

2.C. MATERIALS

2.C.1. Aluminium alloys having both of the following characteristics:

- a. Capable of an ultimate tensile strength of 460 MPa or more at 293 K (20 °C); and
- b. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

Technical Note: In Item 2.C.1. the phrase, capable of, encompasses aluminium alloys before or after heat treatment.

2.C.2. Beryllium metal, alloys containing more than 50% beryllium by weight, beryllium compounds, manufactures thereof, and waste or scrap of any of the foregoing.

Note: Item 2.C.2. does not control the following:

- a. Metal windows for X-ray machines or for bore-hole logging devices;
- b. Oxide shapes in fabricated or semi-fabricated forms specially designed for electronic component parts or as substrates for electronic circuits;
- c. Beryl (silicate of beryllium and aluminium) in the form of emeralds or aquamarines.

2.C.3. Bismuth having both of the following characteristics:

- a. A purity of 99.99% or greater by weight, and
- b. Containing less than 10 parts per million by weight of silver.

- 2.C.4. Boron enriched in the boron-10 ( $^{10}\text{B}$ ) isotope to greater than its natural isotopic abundance, as follows: elemental boron, compounds, mixtures containing boron, manufactures thereof, waste or scrap of any of the foregoing.

Note: In Item 2.C.4. mixtures containing boron include boron loaded materials.

Technical Note: *The natural isotopic abundance of boron-10 is approximately 18.5 weight percent (20 atom percent).*

- 2.C.5. Calcium having both of the following characteristics:

- a. Containing less than 1000 parts per million by weight of metallic impurities other than magnesium; and
- b. Containing less than 10 parts per million by weight of boron.

- 2.C.6. Chlorine trifluoride ( $\text{ClF}_3$ ).

- 2.C.7. "Fibrous or filamentary materials", and preregs, as follows:

- a. Carbon or aramid "fibrous or filamentary materials" having either of the following characteristics:

1. A 'specific modulus' of  $12.7 \times 10^6$  m or greater; or
2. A 'specific tensile strength' of  $23.5 \times 10^4$  m or greater;

Note: Item 2.C.7.a. does not control aramid "fibrous or filamentary materials" having 0.25% or more by weight of an ester based fiber surface modifier.

- b. Glass "fibrous or filamentary materials" having both of the following characteristics:

1. A 'specific modulus' of  $3.18 \times 10^6$  m or greater; and
2. A 'specific tensile strength' of  $7.62 \times 10^4$  m or greater;

- c. Thermoset resin impregnated continuous "yarns", "rovings", "tows" or "tapes" with a width of 15 mm or less (preregs), made from carbon or glass "fibrous or filamentary materials" specified in Item 2.C.7.a. or Item 2.C.7.b. .

Technical Note: *The resin forms the matrix of the composite.*

Technical Notes:

1. In Item 2.C.7. 'Specific modulus' is the Young's modulus in  $\text{N/m}^2$  divided by the specific weight in  $\text{N/m}^3$  when measured at a temperature of  $296 \pm 2$  K ( $23 \pm 2^\circ$  C) and a relative humidity of  $50 \pm 5\%$ .
2. In Item 2.C.7. 'Specific tensile strength' is the ultimate tensile strength in  $\text{N/m}^2$  divided by the specific weight in  $\text{N/m}^3$  when measured at a temperature of  $296 \pm 2$  K ( $23 \pm 2^\circ$  C) and a relative humidity of  $50 \pm 5\%$ .

- 2.C.8. Hafnium metal, alloys containing more than 60% hafnium by weight, hafnium

compounds containing more than 60% hafnium by weight, manufactures thereof, and waste or scrap of any of the foregoing.

- 2.C.9. Lithium enriched in the lithium-6 ( $^6\text{Li}$ ) isotope to greater than its natural isotopic abundance and products or devices containing enriched lithium, as follows: elemental lithium, alloys, compounds, mixtures containing lithium, manufactures thereof, waste or scrap of any of the foregoing.

Note: Item 2.C.9. does not control thermoluminescent dosimeters.

Technical Note: *The natural isotopic abundance of lithium-6 is approximately 6.5 weight percent (7.5 atom percent).*

- 2.C.10. Magnesium having both of the following characteristics:

- a. Containing less than 200 parts per million by weight of metallic impurities other than calcium; and
- b. Containing less than 10 parts per million by weight of boron.

- 2.C.11. Maraging steel 'capable of' an ultimate tensile strength of 2050 MPa or more at 293 K (20° C).

Note: Item 2.C.11. does not control forms in which all linear dimensions are 75 mm or less.

Technical Note: *In Item 2.C.11. the phrase 'capable of' encompasses maraging steel before or after heat treatment.*

- 2.C.12. Radium-226 ( $^{226}\text{Ra}$ ), radium-226 alloys, radium-226 compounds, mixtures containing radium-226, manufactures thereof, and products or devices containing any of the foregoing.

Note: Item 2.C.12. does not control the following:

- a. Medical applicators;
- b. A product or device containing less than 0.37 GBq of radium-226.

- 2.C.13. Titanium alloys having both of the following characteristics:

- a. 'Capable of' an ultimate tensile strength of 900 MPa or more at 293 K (20 °C); and
- b. In the form of tubes or cylindrical solid forms (including forgings) with an outside diameter of more than 75 mm.

Technical Note: *In Item 2.C.13. the phrase 'capable of' encompasses titanium alloys before or after heat treatment.*

- 2.C.14. Tungsten, tungsten carbide, and alloys containing more than 90% tungsten by

weight, having both of the following characteristics:

- a. In forms with a hollow cylindrical symmetry (including cylinder segments) with an inside diameter between 100 and 300 mm; and
- b. A mass greater than 20 kg.

Note: Item 2.C.14. does not control manufactures specially designed as weights or gamma-ray collimators.

- 2.C.15. Zirconium with a hafnium content of less than 1 part hafnium to 500 parts zirconium by weight, as follows: metal, alloys containing more than 50% zirconium by weight, compounds, manufactures thereof, waste or scrap of any of the foregoing.

Note: Item 2.C.15. does not control zirconium in the form of foil having a thickness of 0.10 mm or less.

- 2.C.16. Nickel powder and porous nickel metal, as follows:

N.B.: For nickel powders which are especially prepared for the manufacture of gaseous diffusion barriers see Section 5 of INFCIRC/254/Part 1 (as amended).

- a. Nickel powder having both of the following characteristics:
  1. A nickel purity content of 99.0% or greater by weight; and
  2. A mean particle size of less than 10  $\mu\text{m}$  measured by the ASTM B 330 standard;
- b. Porous nickel metal produced from materials specified in Item 2.C.16.a.

Note: Item 2.C.16. does not control the following:

- a. Filamentary nickel powders;
- b. Single porous nickel metal sheets with an area of 1000  $\text{cm}^2$  per sheet or less.

Technical Note: *Item 2.C.16.b. refers to porous metal formed by compacting and sintering the material in Item 2.C.16.a. to form a metal material with fine pores interconnected throughout the structure.*

- 2.C.17. Tritium, tritium compounds, mixtures containing tritium in which the ratio of tritium to hydrogen atoms exceeds 1 part in 1000, and products or devices containing any of the foregoing.

Note: Item 2.C.17. does not control a product or device containing less than  $1.48 \times 10^3$  GBq of tritium.

- 2.C.18. Helium-3 ( $^3\text{He}$ ), mixtures containing helium-3, and products or devices containing any of the foregoing.

Note: Item 2.C.18. does not control a product or device containing less than 1 g of helium-3.



2.C.19. Alpha-emitting radionuclides having an alpha half-life of 10 days or greater but less than 200 years, in the following forms:

- a. Elemental;
- b. Compounds having a total alpha activity of 37 GBq per kg or greater;
- c. Mixtures having a total alpha activity of 37 GBq per kg or greater;
- d. Products or devices containing any of the foregoing.

Note: Item 2.C.19. does not control a product or device containing less than 3.7 GBq of alpha activity.

2.D. SOFTWARE

None

2.E. TECHNOLOGY

2.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 2.A. through 2.D.

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### 3. URANIUM ISOTOPE SEPARATION EQUIPMENT AND COMPONENTS

(Other Than Trigger List Items)

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3.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

3.A.1. Frequency changers or generators having all of the following characteristics:

N.B.: Frequency changers and generators especially designed or prepared for the gas centrifuge process are controlled under Section 5 Annex B of INFCIRC/254/Part 1 (as amended).

- a. Multiphase output capable of providing a power of 40 W or greater;
- b. Capable of operating in the frequency range between 600 and 2000 Hz;
- c. Total harmonic distortion better (less) than 10%; and
- d. Frequency control better (less) than 0.1%.

Technical Note: Frequency changers in Item 3.A.1. are also known as converters or inverters.

3.A.2. Lasers, laser amplifiers and oscillators as follows:

- a. Copper vapour lasers having both of the following characteristics:

1. Operating at wavelengths between 500 and 600 nm; and
  2. An average output power equal to or greater than 40 W;
- b. Argon ion lasers having both of the following characteristics:
1. Operating at wavelengths between 400 and 515 nm; and
  2. An average output power greater than 40 W;
- c. Neodymium-doped (other than glass) lasers with an output wavelength between 1000 and 1100 nm having either of the following:
1. Pulse-excited and Q-switched with a pulse duration equal to or greater than 1 ns, and having either of the following:
    - a. A single-transverse mode output with an average output power greater than 40 W; or
    - b. A multiple-transverse mode output with an average output power greater than 50 W;
  - or
  2. Incorporating frequency doubling to give an output wavelength between 500 and 550 nm with an average output power of greater than 40 W;
- d. Tunable pulsed single-mode dye laser oscillators having all of the following characteristics:
1. Operating at wavelengths between 300 and 800 nm;
  2. An average output power greater than 1 W;
  3. A repetition rate greater than 1 kHz; and
  4. Pulse width less than 100 ns;
- e. Tunable pulsed dye laser amplifiers and oscillators having all of the following characteristics:
1. Operating at wavelengths between 300 and 800 nm;
  2. An average output power greater than 30 W;
  3. A repetition rate greater than 1 kHz; and
  4. Pulse width less than 100 ns;

Note: Item 3.A.2.e. does not control single mode oscillators.

- f. Alexandrite lasers having all of the following characteristics:
1. Operating at wavelengths between 720 and 800 nm;
  2. A bandwidth of 0.005 nm or less;
  3. A repetition rate greater than 125 Hz; and
  4. An average output power greater than 30 W;
- g. Pulsed carbon dioxide lasers having all of the following characteristics:
1. Operating at wavelengths between 9000 and 11000 nm;
  2. A repetition rate greater than 250 Hz;
  3. An average output power greater than 500 W; and
  4. Pulse width of less than 200 ns;

Note: Item 3.A.2.g. does not control the higher power (typically 1 to 5 kW) industrial CO<sub>2</sub> lasers used in applications such as cutting and welding, as

these latter lasers are either continuous wave or are pulsed with a pulse width greater than 200 ns.

- h. Pulsed excimer lasers (XeF, XeCl, KrF) having all of the following characteristics:
  - 1. Operating at wavelengths between 240 and 360 nm;
  - 2. A repetition rate greater than 250 Hz; and
  - 3. An average output power greater than 500 W;
- i. Para-hydrogen Raman shifters designed to operate at 16 mm output wavelength and at a repetition rate greater than 250 Hz.

3.A.3. Valves having all of the following characteristics:

- a. A nominal size of 5 mm or greater;
- b. Having a bellows seal; and
- c. Wholly made of or lined with aluminum, aluminum alloy, nickel, or nickel alloy containing more than 60% nickel by weight.

Technical Note: For valves with different inlet and outlet diameter, the nominal size parameter in Item 3.A.3.a. refers to the smallest diameter.

3.A.4. Superconducting solenoidal electromagnets having all of the following characteristics:

- a. Capable of creating magnetic fields greater than 2 T;
- b. A ratio of length to inner diameter greater than 2;
- c. Inner diameter greater than 300 mm; and
- d. Magnetic field uniform to better than 1% over the central 50% of the inner volume.

Note: Item 3.A.4. does not control magnets specially designed for and exported as part of medical nuclear magnetic resonance (NMR) imaging systems.

N.B.: 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 the as part of relationship.

3.A.5. High-power direct current power supplies having both of the following characteristics:

- a. Capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater; and
- b. Current or voltage stability better than 0.1 % over a time period of 8 hours.

3.A.6. High-voltage direct current power supplies having both of the following characteristics:

- a. Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; and

- b. Current or voltage stability better than 0.1 % over a time period of 8 hours.

- 3.A.7. Pressure transducers capable of measuring absolute pressures at any point in the range 0 to 13 kPa and having both of the following characteristics:
- Pressure sensing elements made of or protected by aluminum, aluminum alloy, nickel, or nickel alloy with more than 60% nickel by weight; and
  - Having either of the following characteristics:
    - A full scale of less than 13 kPa and an "accuracy" of better than  $\pm 1\%$  of full scale; or
    - A full scale of 13 kPa or greater and an "accuracy" of better than  $\pm 130$  Pa.

Technical Notes: 1. In Item 3.A.7. pressure transducers are devices that convert pressure measurements into an electrical signal.

2. In Item 3.A.7. "accuracy" includes non-linearity, hysteresis and repeatability at ambient temperature.

- 3.A.8. Vacuum pumps having all of the following characteristics:
- Input throat size equal to or greater than 380 mm;
  - Pumping speed equal to or greater than  $15 \text{ m}^3/\text{s}$ ; and
  - Capable of producing an ultimate vacuum better than 13.3 mPa.

Technical Notes: 1. The pumping speed is determined at the measurement point with nitrogen gas or air.

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

### 3.B. TEST AND PRODUCTION EQUIPMENT

- 3.B.1. Electrolytic cells for fluorine production with an output capacity greater than 250 g of fluorine per hour.

- 3.B.2. Rotor fabrication or assembly equipment, rotor straightening equipment, bellows-forming mandrels and dies, as follows:

- Rotor assembly equipment for assembly of gas centrifuge rotor tube sections, baffles, and end caps;

Note: Item 3.B.2.a. includes precision mandrels, clamps, and shrink fit machines.

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

Technical Note: In Item 3.B.2.b. such equipment normally consists 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.

**Technical Note:** *The bellows referred to in Item 3.B.2.c. have all of the following characteristics:*

1. *Inside diameter between 75 and 400 mm;*
2. *Length equal to or greater than 12.7 mm;*
3. *Single convolution depth greater than 2 mm; and*
4. *Made of high-strength aluminum alloys, maraging steel, or high strength "fibrous or filamentary materials".*

- 3.B.3. 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. Swing or journal diameter greater than 75 mm;
  2. Mass capability of from 0.9 to 23 kg; and
  3. Capable of balancing speed of revolution greater than 5000 rpm;
- b. Centrifugal balancing machines designed for balancing hollow cylindrical rotor components and having all of the following characteristics:
  1. Journal diameter greater than 75 mm;
  2. Mass capability of from 0.9 to 23 kg;
  3. Capable of balancing to a residual imbalance equal to or less than 0.010 kg x mm/kg per plane; and
  4. Belt drive type.

- 3.B.4. Filament winding machines and related equipment, as follows:

- a. Filament winding machines having all of the following characteristics:
  1. Having motions for positioning, wrapping, and winding fibers coordinated and programmed in two or more axes;
  2. Specially designed to fabricate composite structures or laminates from "fibrous or filamentary materials"; and
  3. Capable of winding cylindrical rotors of diameter between 75 and 400 mm and lengths of 600 mm or greater;
- b. Coordinating and programming controls for the filament winding machines specified in Item 3.B.4.a.;
- c. Precision mandrels for the filament winding machines specified in Item 3.B.4.a.

- 3.B.5. 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.

**Notes:** 1. Item 3.B.5. includes separators capable of enriching stable isotopes as well as those for uranium.

**N.B.:** A separator capable of separating the isotopes of lead with a one-

mass unit difference is inherently capable of enriching the isotopes of uranium with a three-unit mass difference.

2. Item 3.B.5. includes separators with the ion sources and collectors both in the magnetic field and those configurations in which they are external to the field.

**Technical Note:** *A single 50 mA ion source cannot produce more than 3g of separated highly enriched uranium (HEU) per year from natural abundance feed.*

- 3.B.6. Mass spectrometers 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:

**N.B.:** Mass spectrometers especially designed or prepared for analyzing on-line samples of uranium hexafluoride are controlled under Section 5 Annex B of INFCIRC/254/Part 1 (as amended).

- 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  $\text{UF}_6$ ;
- e. Molecular beam mass spectrometers having either of the following characteristics:
  1. A source chamber constructed from, lined with or plated with stainless steel or molybdenum, and equipped with a cold trap capable of cooling to 193 K (-80 °C) or less;
  - or
  2. A source chamber constructed from, lined with or plated with materials resistant to  $\text{UF}_6$ ;
- f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

3.C. MATERIALS

None.

3.D. SOFTWARE

- 3.D.1. "Software" specially designed for the "use" of equipment specified in Item 3.B.3. or 3.B.4.

3.E. TECHNOLOGY

- 3.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 3.A. through 3.D.



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## 4. HEAVY WATER PRODUCTION PLANT RELATED EQUIPMENT

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### (Other Than Trigger List Items)

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#### 4.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

##### 4.A.1. Specialized packings which may be used in separating heavy water from ordinary water, having both of the following characteristics:

- a. Made of phosphor bronze mesh chemically treated to improve wettability; and
- b. Designed to be used in vacuum distillation towers.

##### 4.A.2. Pumps capable of circulating solutions of concentrated or dilute potassium amide catalyst in liquid ammonia ( $\text{KNH}_2/\text{NH}_3$ ), having all of the following characteristics:

- a. Airtight (i.e., hermetically sealed);
- b. A capacity greater than  $8.5 \text{ m}^3/\text{h}$ ; and
- c. Either of the following characteristics:
  1. For concentrated potassium amide solutions (1% or greater), an operating pressure of 1.5 to 60 MPa; or
  2. For dilute potassium amide solutions (less than 1%), an operating pressure of 20 to 60 MPa.

##### 4.A.3. Turboexpanders or turboexpander-compressor sets having both of the following characteristics:

- a. Designed for operation with an outlet temperature of 35 K (- 238 °C) or less; and
- b. Designed for a throughput of hydrogen gas of 1000 kg/h or greater.

#### 4.B. TEST AND PRODUCTION EQUIPMENT

##### 4.B.1. Water-hydrogen sulfide exchange tray columns and internal contactors, as follows:

N.B.: For columns which are especially designed or prepared for the production of heavy water, see Section 6 Annex B of INFCIRC/254/Part 1 (as amended).

- a. Water-hydrogen sulfide exchange tray columns, having all of the following characteristics:
  1. Can operate at pressures of 2 MPa or greater;
  2. Constructed of carbon steel having an austenitic ASTM (or equivalent standard) grain size number of 5 or greater; and
  3. With a diameter of 1.8 m or greater;
- b. Internal contactors for the water-hydrogen sulfide exchange tray columns specified in Item 4.B.1.a.

**Technical Note:** *Internal contactors of the columns are segmented trays which have an effective assembled diameter of 1.8 m or greater; are designed to facilitate countercurrent contacting and are constructed of stainless steels with a carbon content of 0.03% or less. These may be sieve trays, valve trays, bubble cap trays or turbogrid trays.*

4.B.2. Hydrogen-cryogenic distillation columns having all of the following characteristics:

- a. Designed for operation at internal temperatures of 35 K (-238 °C) or less;
- b. Designed for operation at internal pressures of 0.5 to 5 MPa;
- c. Constructed of either:
  1. Stainless steel of the 300 series with low sulfur content and with an austenitic ASTM (or equivalent standard) grain size number of 5 or greater;  
or
  2. Equivalent materials which are both cryogenic and H<sub>2</sub>-compatible; and
- d. With internal diameters of 1 m or greater and effective lengths of 5 m or greater.

4.B.3. Ammonia synthesis converters or 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.

4.C. MATERIALS

None.

4.D. SOFTWARE

None.

4.E. TECHNOLOGY

4.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 4.A. through 4.D.

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## 5. TEST AND MEASUREMENT EQUIPMENT FOR THE DEVELOPMENT OF NUCLEAR EXPLOSIVE DEVICES

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5.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

5.A.1. Photomultiplier tubes having both of the following characteristics:

- a. Photocathode area of greater than 20 cm<sup>2</sup>; and
- b. Anode pulse rise time of less than 1 ns.

**5.B. TEST AND PRODUCTION EQUIPMENT****5.B.1. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:**

- a. 1. An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; and
2. With a figure of merit (K) of 0.25 or greater; or
- b. 1. An accelerator peak electron energy of 25 MeV or greater; and
2. A peak power greater than 50 MW.

**Note:** Item 5.B.1. does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes.

**Technical Notes:** 1. *The figure of merit K is defined as:  $K = 1.7 \times 10^3 V^{2.65} Q$ . V is the peak electron energy in million electron volts. If the accelerator beam pulse duration is less than or equal to 1 ms, then Q is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 ms, then Q is the maximum accelerated charge in 1 ms. Q equals the integral of i with respect to t, over the lesser of 1 ms or the time duration of the beam pulse ( $Q = \int i dt$ ) where i is beam current in amperes and t is the time in seconds.*

2. *Peak power = (peak potential in volts) x (peak beam current in amperes).*

3. *In machines based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 ms or the duration of the bunched beam packet resulting from one microwave modulator pulse.*

4. *In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.*

**5.B.2. Multistage light gas guns or other high-velocity gun systems (coil, electromagnetic, and electrothermal types, and other advanced systems) capable of accelerating projectiles to 2 km/s or greater.****5.B.3. Mechanical rotating mirror cameras, as follows, and specially designed components therefor:**

- a. Framing cameras with recording rates greater than 225000 frames per second;

- b. Streak cameras with writing speeds greater than 0.5 mm/ $\mu$ s.

**Note:** In Item 5.B.3. components of such cameras include their synchronizing electronics units and rotor assemblies consisting of turbines, mirrors, and bearings.

- 5.B.4. Electronic streak cameras, electronic framing cameras, tubes and devices, as follows:

- a. Electronic streak cameras capable of 50 ns or less time resolution;
- b. Streak tubes for cameras specified in Item 5.B.4.a.;
- c. Electronic (or electronically shuttered) framing cameras capable of 50 ns or less frame exposure time;
- d. Framing tubes and solid-state imaging devices for use with cameras specified in Item 5.B.4.c., as follows:
  - 1. Proximity focussed image intensifier tubes having the photocathode deposited on a transparent conductive coating to decrease photocathode sheet resistance;
  - 2. Gate silicon intensifier target (SIT) vidicon tubes, where a fast system allows gating the photoelectrons from the photocathode before they impinge on the SIT plate;
  - 3. Kerr or Pockels cell electro-optical shuttering;
  - 4. Other framing tubes and solid-state imaging devices having a fast image gating time of less than 50 ns specially designed for cameras specified in Item 5.B.4.c.

- 5.B.5. Specialized instrumentation for hydrodynamic experiments, as follows:

- a. Velocity interferometers for measuring velocities exceeding 1 km/s during time intervals of less than 10 ms;
- b. Manganin gauges for pressures greater than 10 GPa;
- c. Quartz pressure transducers for pressures greater than 10 GPa.

**Note:** Item 5.B.5.a. includes velocity interferometers such as VISARs (Velocity interferometer systems for any reflector) and DLIs (Doppler laser interferometers).

- 5.B.6. High-speed pulse generators having both of the following characteristics:

- a. Output voltage greater than 6 V into a resistive load of less than 55 ohms; and

- b. 'Pulse transition time' less than 500 ps.

**Technical Note:** In Item 5.B.6.b. 'pulse transition time' is defined as the time interval between 10% and 90% voltage amplitude.

5.C. MATERIALS

None.

5.D. SOFTWARE

None.

5.E. TECHNOLOGY

- 5.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 5.A. through 5.D.

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## 6. COMPONENTS FOR NUCLEAR EXPLOSIVE DEVICES

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6.A. EQUIPMENT, ASSEMBLIES AND COMPONENTS

- 6.A.1. Detonators and multipoint initiation systems, as follows:

- a. Electrically driven explosive detonators, as follows:

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 an area greater than 5000 mm<sup>2</sup> from a single firing signal with an initiation timing spread over the surface of less than 2.5 µs.

**Note:** Item 6.A.1. does not control detonators using only primary explosives, such as lead azide.

**Technical Note:** In Item 6.A.1. the detonators of concern all utilize 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 magnetic force. The term exploding foil detonator may refer to either an EB or a slapper-type detonator. Also, the word initiator is sometimes used in place of the word detonator.*

**6.A.2. Firing sets and equivalent high-current pulse generators, as follows:**

- a. Explosive detonator firing sets designed to drive multiple controlled detonators specified by Item 6.A.1. above;
- b. Modular electrical pulse generators (pulsers) having all of the following characteristics:
  1. Designed for portable, mobile, or ruggedized-use;
  2. Enclosed in a dust-tight enclosure;
  3. Capable of delivering their energy in less than 15  $\mu$ s;
  4. Having an output greater than 100 A;
  5. Having a 'rise time' of less than 10  $\mu$ s into loads of less than 40 ohms;
  6. No dimension greater than 25.4 cm;
  7. Weight less than 25 kg ; and
  8. Specified to operate over an extended temperature range of 223 to 373 K (-50 °C to 100 °C) or specified as suitable for aerospace applications.

Note: Item 6.A.2.b. includes xenon flashlamp drivers.

Technical Note: In Item 6.A.2.b.5. 'rise time' is defined as the time interval from 10% to 90% current amplitude when driving a resistive load.

**6.A.3. Switching devices as follows:**

- a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:
  1. Containing three or more electrodes;
  2. Anode peak voltage rating of 2.5 kV or more;
  3. Anode peak current rating of 100 A or more; and
  4. Anode delay time of 10  $\mu$ s or less;

Note: Item 6.A.3.a. includes gas krytron tubes and vacuum sprytron tubes.

- b. Triggered spark-gaps having both of the following characteristics:
  1. Anode delay time of 15  $\mu$ s or less; and
  2. 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 kV;
  2. Anode peak current rating of 500 A or more; and
  3. Turn-on time of 1  $\mu$ s or less.



**6.A.4. Pulse discharge capacitors having either of the following sets of characteristics:**

- a.
  - 1. Voltage rating greater than 1.4 kV;
  - 2. Energy storage greater than 10 J;
  - 3. Capacitance greater than 0.5  $\mu\text{F}$ ; and
  - 4. Series inductance less than 50 nH; or
- b.
  - 1. Voltage rating greater than 750 V;
  - 2. Capacitance greater than 0.25  $\mu\text{F}$ ; and
  - 3. Series inductance less than 10 nH.

**6.A.5. Neutron generator systems, including tubes, having both of the following characteristics:**

- a. Designed for operation without an external vacuum system; and
- b. Utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction.

**6.B. TEST AND PRODUCTION EQUIPMENT**

None.

**6.C. MATERIALS****6.C.1. High explosive substances or mixtures, containing more than 2 % by weight of any of the following:**

- a. Cyclotetramethylenetetranitramine (HMX) (CAS 2691-41-0);
- b. Cyclotrimethylenetrinitramine (RDX) (CAS 121-82-4);
- c. Triaminotrinitrobenzene (TATB) (CAS 3058-38-6);
- d. Hexanitrostilbene (HNS) (CAS 20062-22-0); or
- e. Any explosive with a crystal density greater than 1.8 g/cm<sup>3</sup> and having a detonation velocity greater than 8000 m/s.

**6.D. SOFTWARE**

None.

**6.E. TECHNOLOGY****6.E.1. "Technology" according to the Technology Controls for the "development", "production" or "use" of equipment, material or "software" specified in 6.A. through 6.D.**

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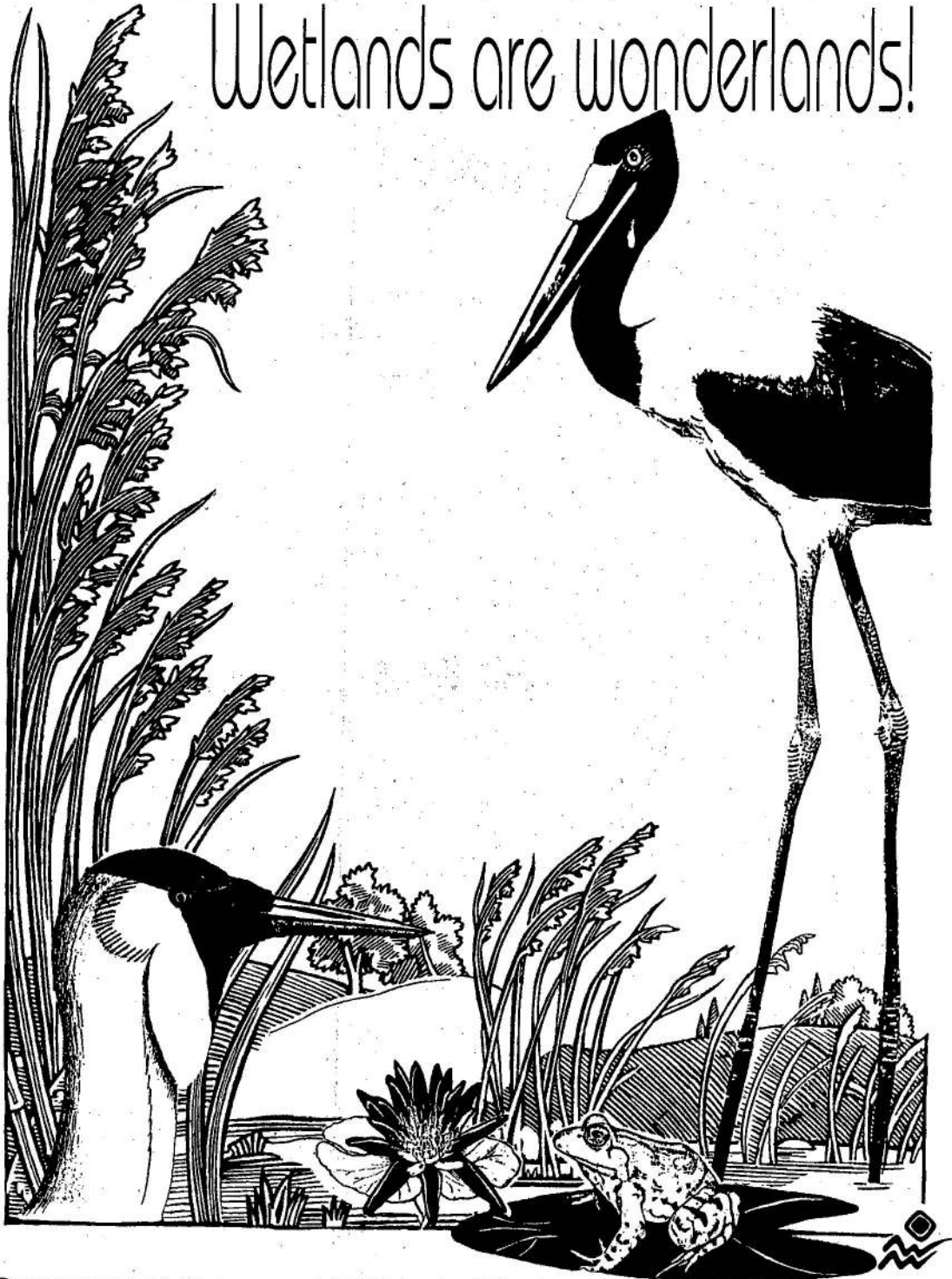
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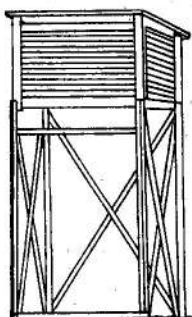
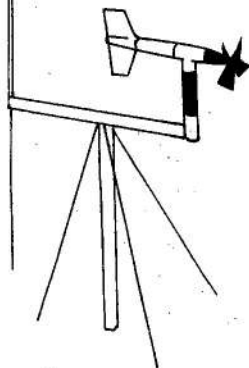
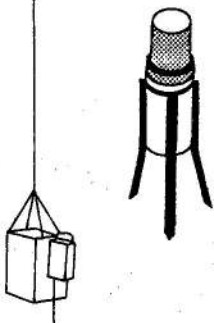
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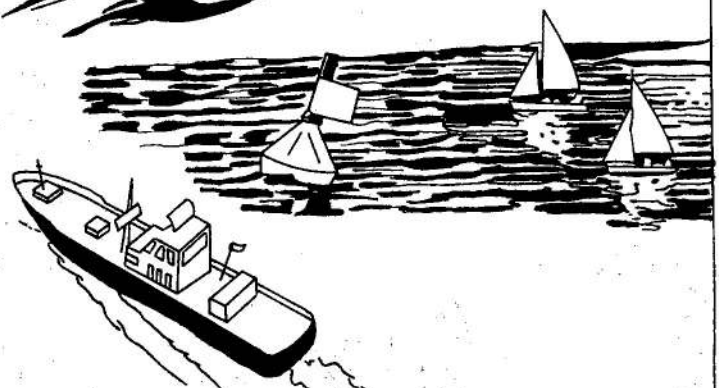
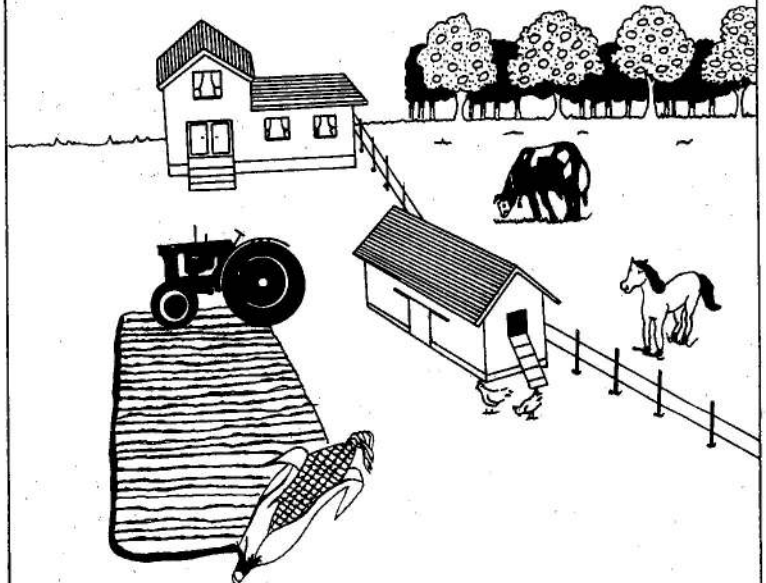
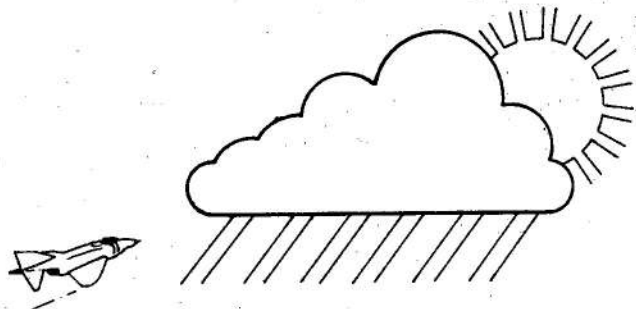


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