

# Overview of Export Controls

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# This presentation provides an overview of international export control regimes.

Development of international nonproliferation regimes

Nuclear Suppliers Group

- Trigger List
- Dual-Use List

Controlled technology, commodities, and materials

Correlation to US export control laws/regulations

Similar export control regimes

- chemical and biological weapons
- missiles
- conventional arms

# The “*Treaty on the Non-Proliferation of Nuclear Weapons*” (NPT) Became Effective in 1970.

Prompted by China’s 1964 nuclear weapon test

- becoming the 5<sup>th</sup> nuclear armed nation
  - previous four:
    - United States (1945)
    - Soviet Union (1949)
    - United Kingdom (1952)
    - France (1960)
- worldwide concern over expanding number of nuclear armed nations

# The NPT sought to halt the expansion in the number of nuclear armed nations.

Limited which nations could have nuclear weapons

- five official “Weapon States”
  - allowed to retain nuclear weapon programs
  - agreed to *not* assist other nations acquire nuclear weapons
- all other signatory nations deemed to be “Non-weapon States”
  - not allowed to pursue nuclear weapon programs
  - agreed to *not* seek nuclear weapons
  - allowed to pursue peaceful nuclear programs
- eventually signed by all but 3 countries
  - Israel
  - Pakistan
  - India

# NPT *(continued)*

Did not provide export controls

- nuclear-related commodities
- nuclear-related technology

Lacked punitive measures for Non-weapon States that pursued nuclear weapons programs

India's 1974 nuclear weapon test

- recognized need to control nuclear equipment

# Several nations have proliferated nuclear weapons since India's nuclear weapon test.

- Pakistan (*not an NPT signatory*)
  - 1998 nuclear weapon tests
  - alleged to have nuclear weapons
- Democratic People's Republic of Korea (*withdrew from NPT in 2003*)
  - publicly acknowledged its nuclear weapons program
  - 2006 “event”
    - possibly a nuclear weapon test
- Israel (*not an NPT signatory*)
  - alleged to have nuclear weapons
- South Africa
  - nuclear weapons program abandoned in 1991
- Iraq
  - clandestine nuclear weapons program discovered in 1991

# Nuclear export control regimes started in 1974 with the NPT Exporters' Committee.

a.k.a. “Zangger Committee”

Developed a “Trigger List” of strategic nuclear material and equipment

- controls exports of *“especially designed or prepared equipment or material for the processing, use or production of special fissionable material”*
  - includes weapon-grade fissile material
- exports to Non-weapon States subject to International Atomic Energy Agency (IAEA) safeguards agreement
- illustrative list of equipment
  - descriptive criteria for determinations

# The Nuclear Suppliers Group (NSG) publishes guidelines to control nuclear related exports.

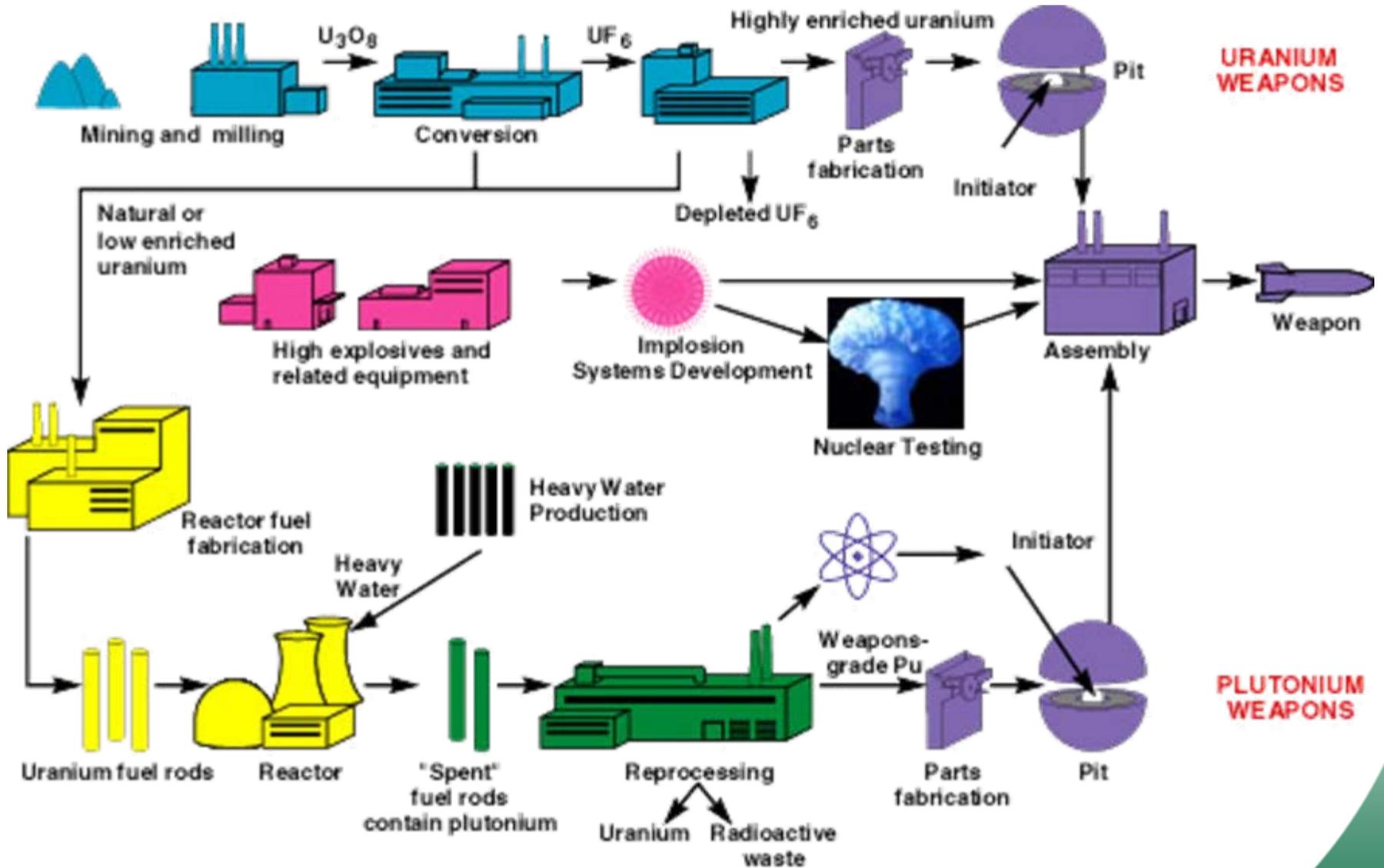
## NSG participation

- currently 45 member states
  - includes all five Weapon States

## Controls

- focused on the nuclear fuel cycle
  - peaceful end uses
  - useful to weaponization
- not focused on production or use of other radiological materials
  - useful in Radiological Dispersal Devices (RDDs)
    - $^{137}\text{Cs}$

# The nuclear fuel cycle



# NSG published its “Trigger List” in 1978.

## More comprehensive than the Zangger Committee’s “Trigger List”

- also an illustrative list of equipment
  - expanded to cover heavy water production
- exports to Non-weapon States require “full-scope” IAEA safeguards agreement
- published as an IAEA document
  - INFCIRC/254/Part 1
    - currently in its 8<sup>th</sup> revision
      - March 2006

# NSG Trigger List *(continued)*

- later expansions/modifications
  - added the control of strategic nuclear “technology”
  - restricted retransfers
  - added a “Non-proliferation Principle”
    - allows for subjective denial of export over doubt of recipient's peaceful-use intentions
      - closed an important loophole

# NSG Trigger List *(continued)*

## Scope of controls

- *production* of special fissionable material
  - creation/production of these
    - including weapon-capable grades
  - encompasses chemical reduction to raw metal
    - necessary for eventual weapon component fabrication
  - no control of subsequent weaponization activities

# NSG Trigger List *(continued)*

- two major categories of control
  - Annex A — source and special fissionable material
  - Annex B — equipment and non-nuclear materials
    - reactors
    - fuel reprocessing
    - enrichment
    - heavy water production
    - processing and chemical conversion
      - uranium
      - plutonium

# NSG Trigger List *(continued)*

## Annex A — source material

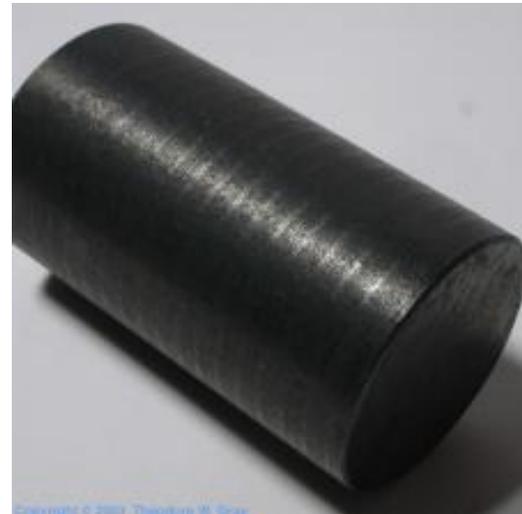
- natural uranium



natural uranium  
“yellowcake”  
(shown in  
shipping drum)

- depleted uranium

depleted  
uranium  
metal



- thorium

# NSG Trigger List *(continued)*

## Annex A — special fissionable material

- enriched uranium ( $^{235}\text{U}$  above natural levels)
  - low-enriched
    - reactor grade
  - highly enriched
    - weapon grade



highly  
enriched  
uranium  
metal

- $^{233}\text{U}$ 
  - non-natural isotope

# NSG Trigger List *(continued)*

## Annex A — *more* special fissionable material

- $^{239}\text{Pu}$ 
  - exception for high concentrations of  $^{238}\text{Pu}$



plutonium  
dioxide  
powder

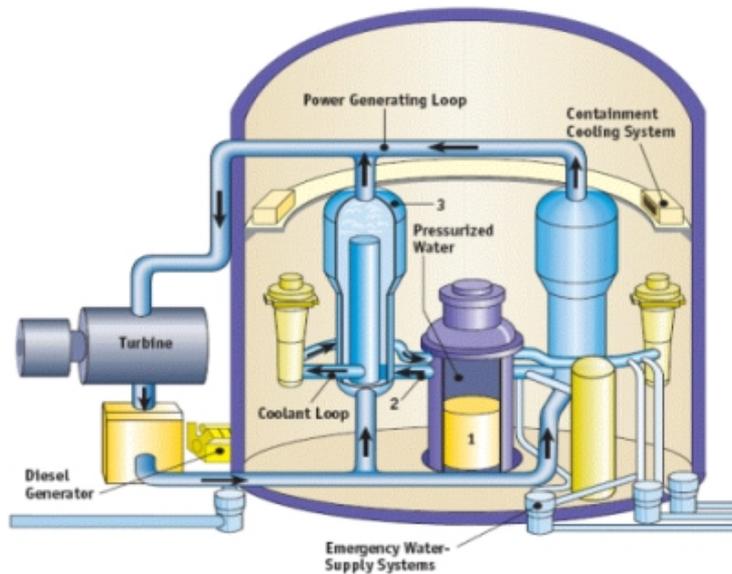


plutonium  
metal

# NSG Trigger List *(continued)*

## Annex B — reactors & related commodities

- complete nuclear reactors



pressurized water  
reactor (PWR)



TVA's Sequoyah Nuclear  
Plant (PWR)

Soddy-Daisy, TN

# NSG Trigger List *(continued)*

## Annex B — *more* reactors & related commodities

- reactor vessels



PWR reactor vessel

# NSG Trigger List *(continued)*

## Annex B — *more* reactors & related commodities

- primary coolant pumps

reactor  
coolant  
pump



- heat exchangers

steam generator  
(a type of  
heat exchanger)



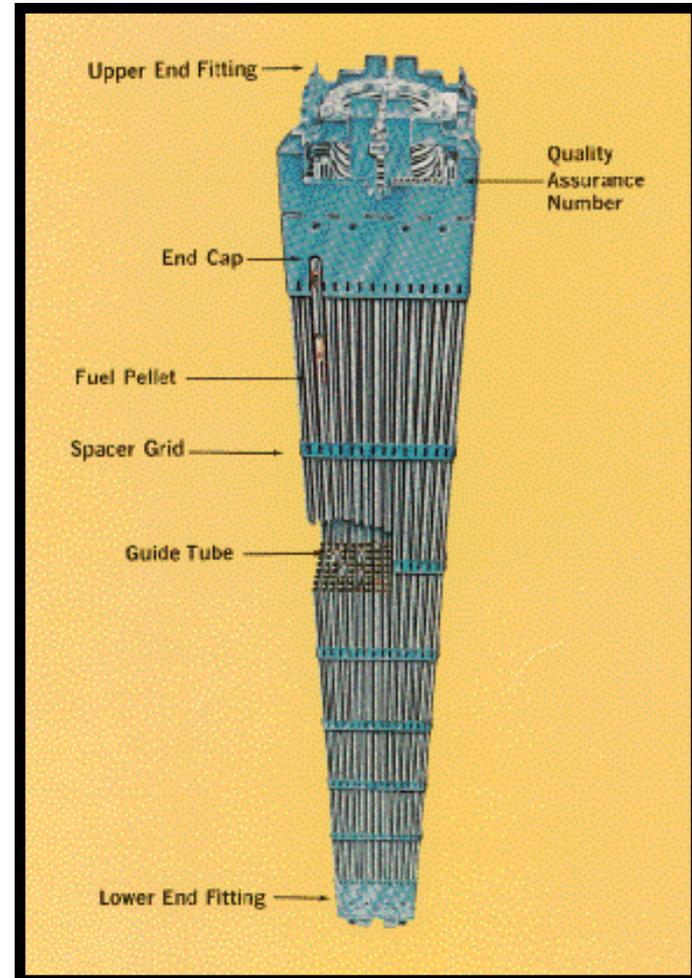
# NSG Trigger List *(continued)*

## Annex B — *more* reactors & related commodities

- reactor fuel



zirconium  
tubes used  
for  
reactor fuel  
cladding



PWR  
fuel  
assembly

# NSG Trigger List *(continued)*

## Annex B — non-nuclear reactor materials

- heavy water (deuterium dioxide [D<sub>2</sub>O])



stainless steel  
drums of  
heavy water

# NSG Trigger List *(continued)*

## Annex B — *more* non-nuclear reactor materials

- nuclear grade graphite

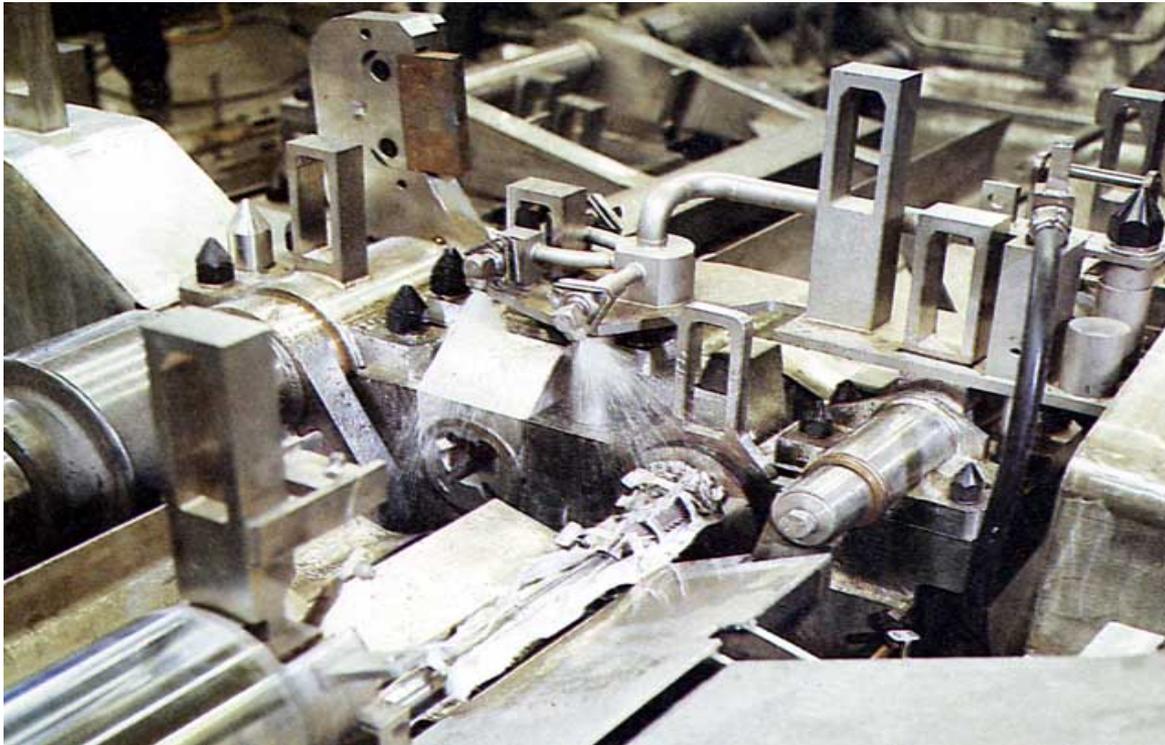


graphite blocks  
used in  
Manhattan Project  
N-reactor,  
Hanford, WA

# NSG Trigger List *(continued)*

## Annex B — fuel reprocessing plants & equipment

- fuel element chopping machines



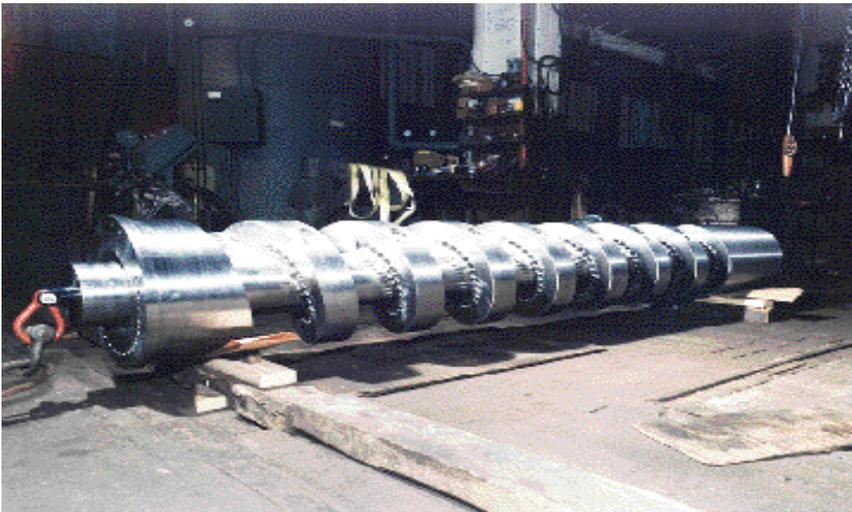
fuel element  
decladding  
equipment

# NSG Trigger List *(continued)*

## Annex B — *more* fuel reprocessing plants & equipment

- fuel dissolvers

internal  
dissolver  
screw



continuous  
fuel  
dissolver  
(remotely  
operated  
facility)

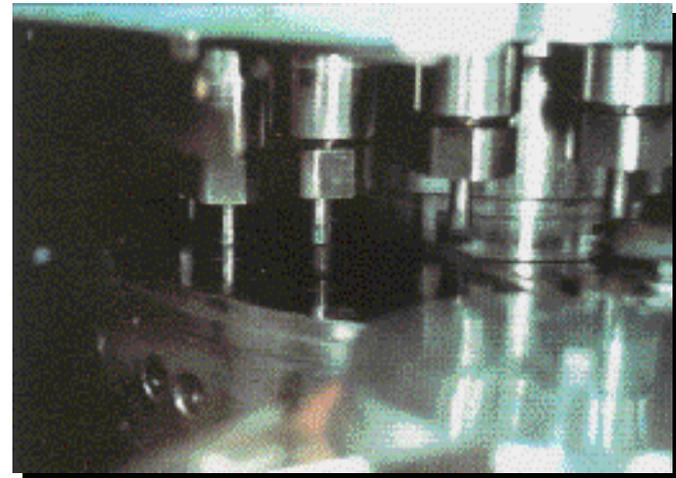


# NSG Trigger List *(continued)*

## Annex B — fuel fabrication plants & equipment



UO<sub>2</sub> fuel pellets  
(low-enriched)  
for  
civilian power  
reactor



fuel  
pellet  
press

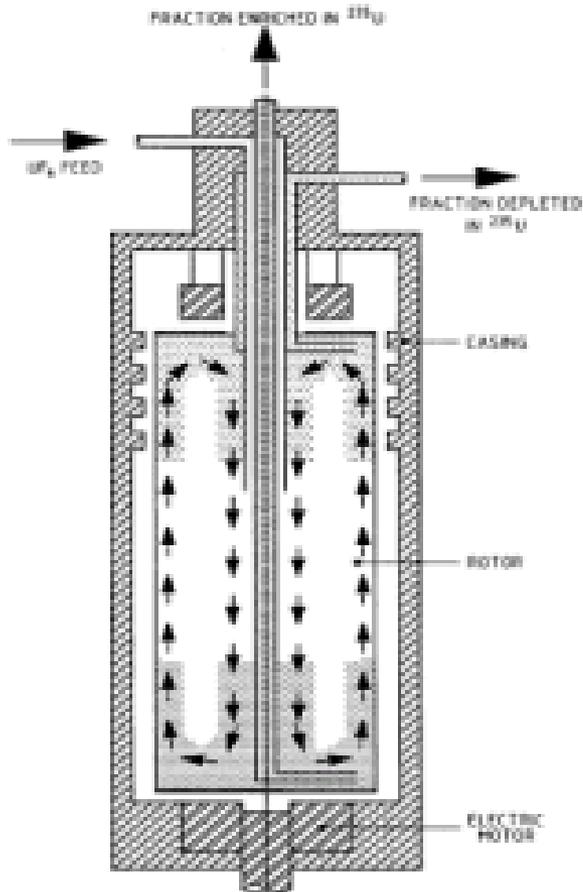
# NSG Trigger List *(continued)*

## Annex B — uranium enrichment plants & equipment

- gas centrifuge
- gaseous diffusion
- electromagnetic
- aerodynamic
- other types
  - laser-based
    - atomic vapor laser (AVLIS) or molecular laser (MLIS)
  - plasma separation
  - chemical or ion exchange
- some auxiliary systems
  - uranium feed/withdrawal systems, process piping & control systems, vacuum systems, analytical instrumentation

# NSG Trigger List *(continued)*

## Annex B — gas centrifuge enrichment



# NSG Trigger List *(continued)*

## Annex B — *more* gas centrifuge enrichment



US Gas  
Centrifuge  
Enrichment  
Program

Oak Ridge, TN



Urenco Enrichment  
Company, Ltd  
Almelo, Netherlands

# NSG Trigger List *(continued)*

## Annex B — *more* gas centrifuge enrichment

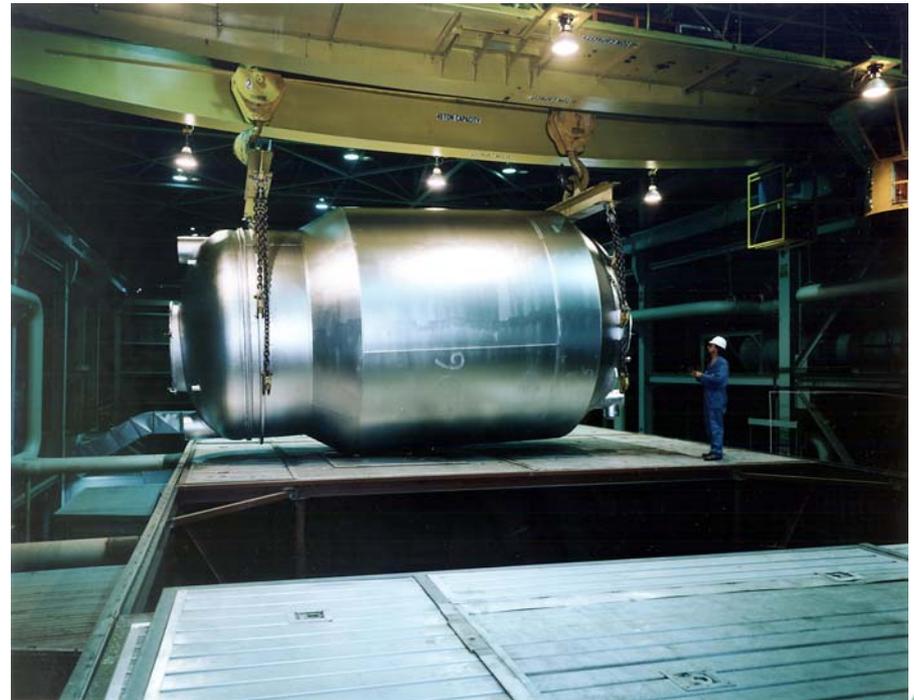
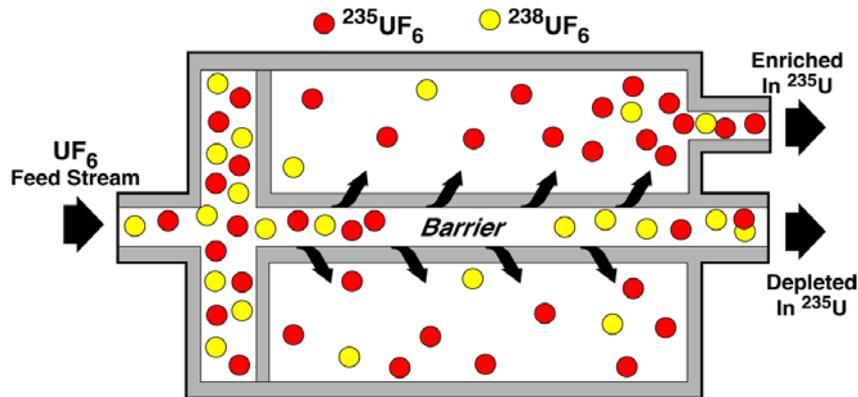


Pakistani gas  
centrifuge equipment

Press conference,  
Oak Ridge, TN

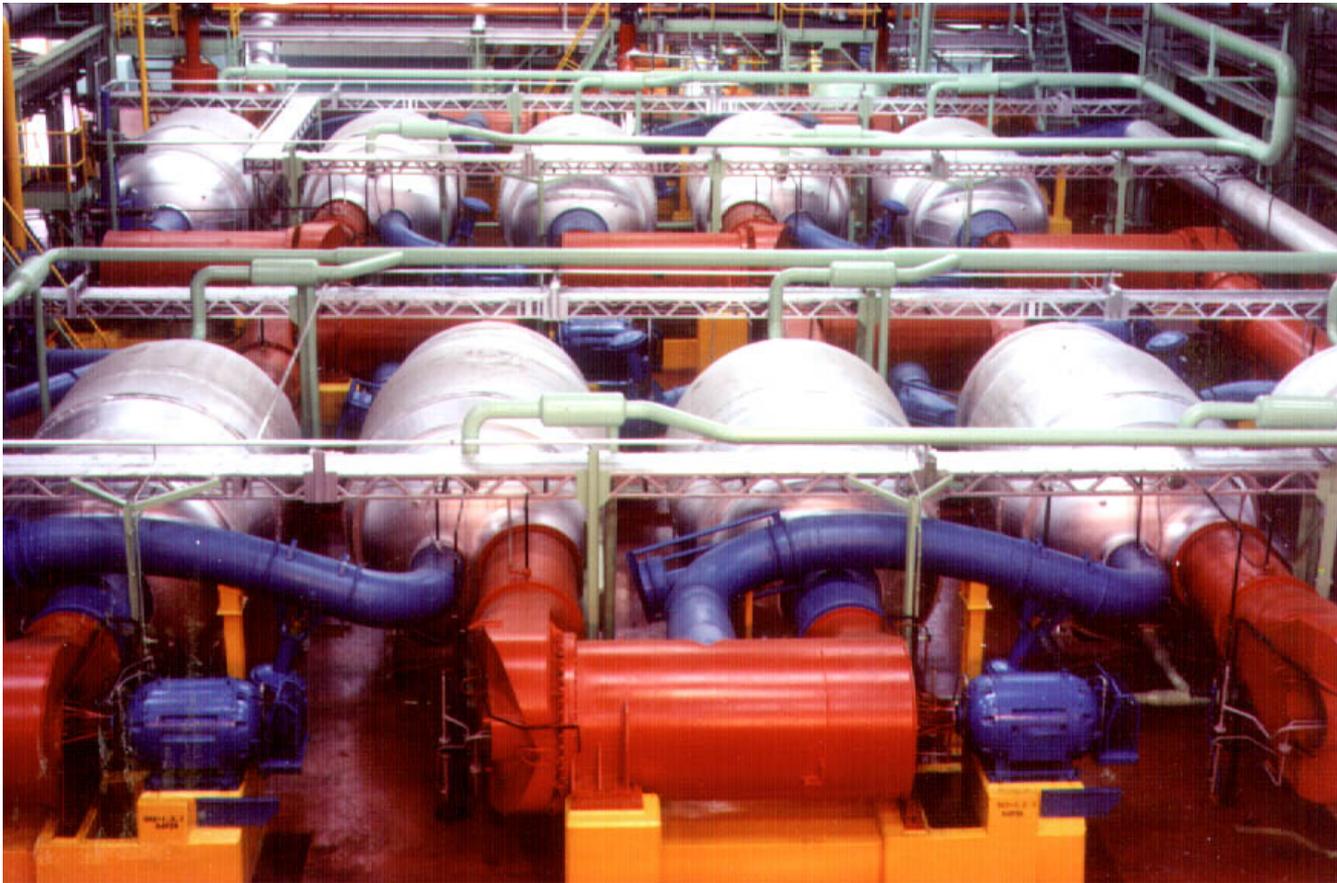
# NSG Trigger List *(continued)*

## Annex B — gaseous diffusion enrichment



# NSG Trigger List *(continued)*

Annex B — *more* gaseous diffusion enrichment



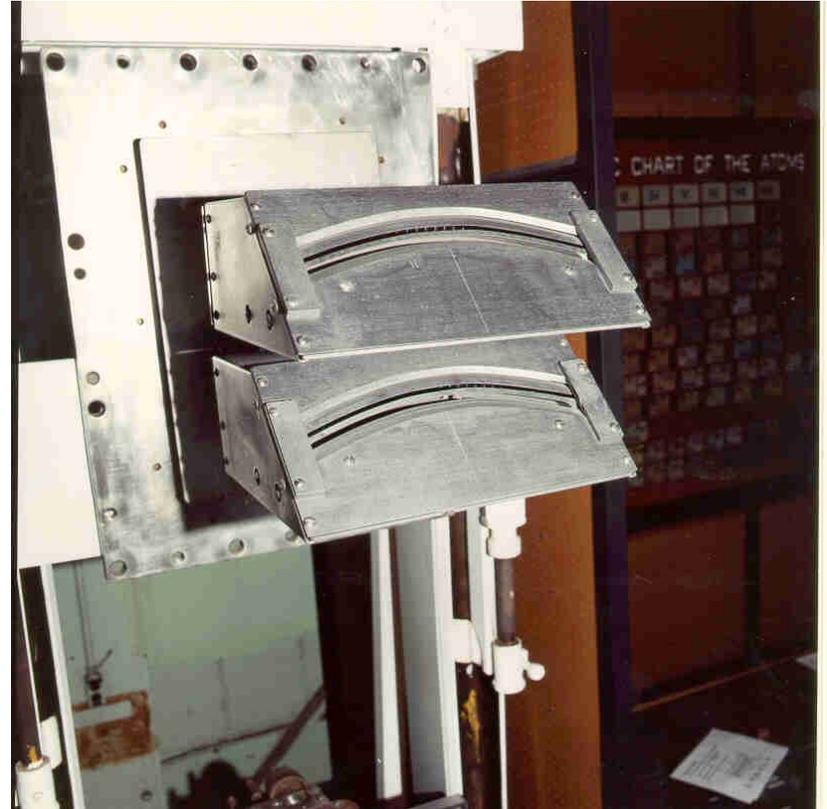
# NSG Trigger List *(continued)*

## Annex B — electromagnetic enrichment



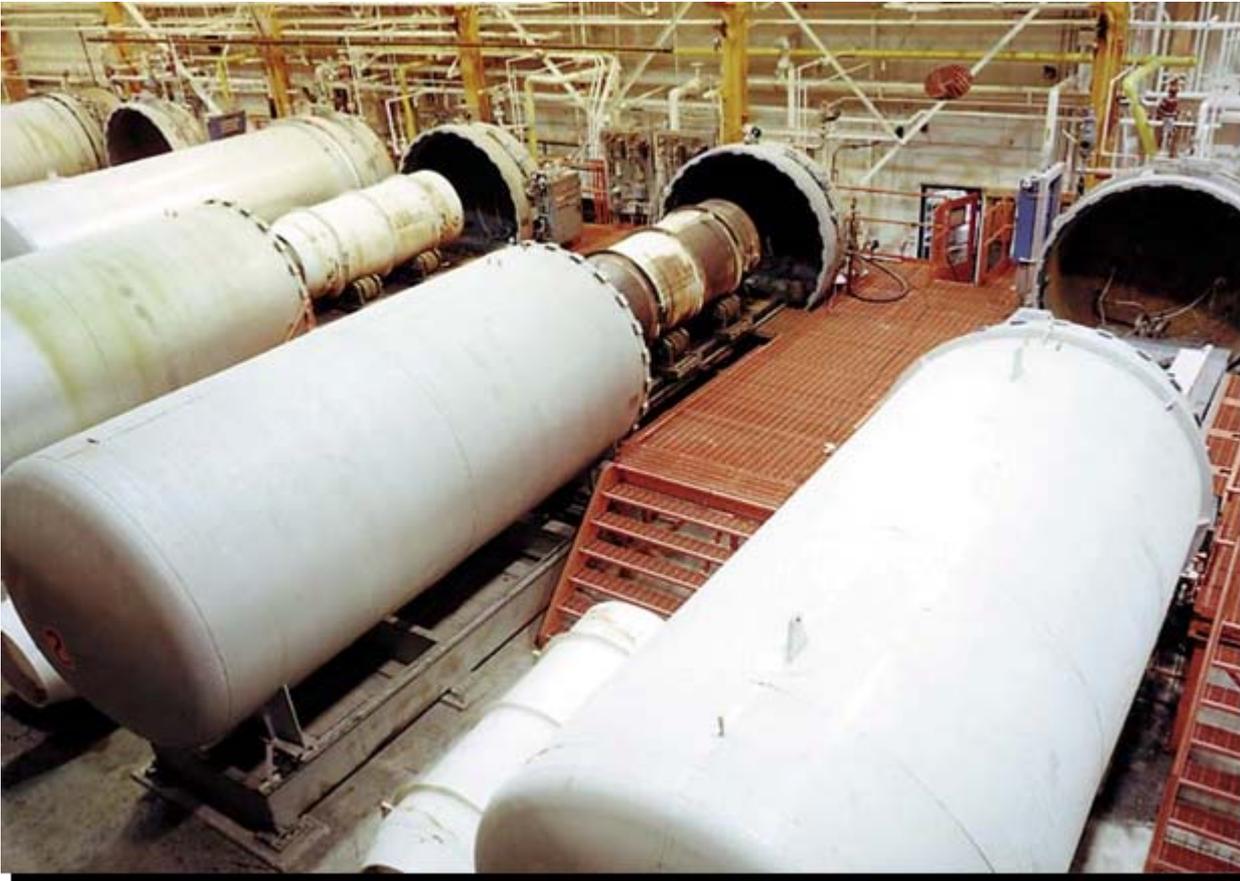
# NSG Trigger List *(continued)*

## Annex B — *more* electromagnetic enrichment



# NSG Trigger List *(continued)*

## Annex B — auxiliary systems (enrichment)



uranium ( $UF_6$ )  
feed system

gaseous  
diffusion  
enrichment plant

# NSG Trigger List *(continued)*

## Annex B — *more* auxiliary systems (enrichment)

large gate valve  
gaseous diffusion  
enrichment plant



# NSG Trigger List *(continued)*

## Annex B — heavy water production plants



Bruce  
Heavy Water  
Plant  
Lake Huron  
Canada

# NSG Trigger List *(continued)*

## Annex B — uranium and plutonium processing and chemical conversion

### Uranium processing and conversion

Uranium ore to  $\text{UO}_3$

$\text{UO}_3$  to  $\text{UF}_6$ ,  $\text{UO}_2$

$\text{UO}_2$  to  $\text{UF}_4$ ,  $\text{UCl}_4$

$\text{UF}_4$  to  $\text{UF}_6$ , metal

$\text{UF}_6$  to  $\text{UO}_2$ ,  $\text{UF}_4$

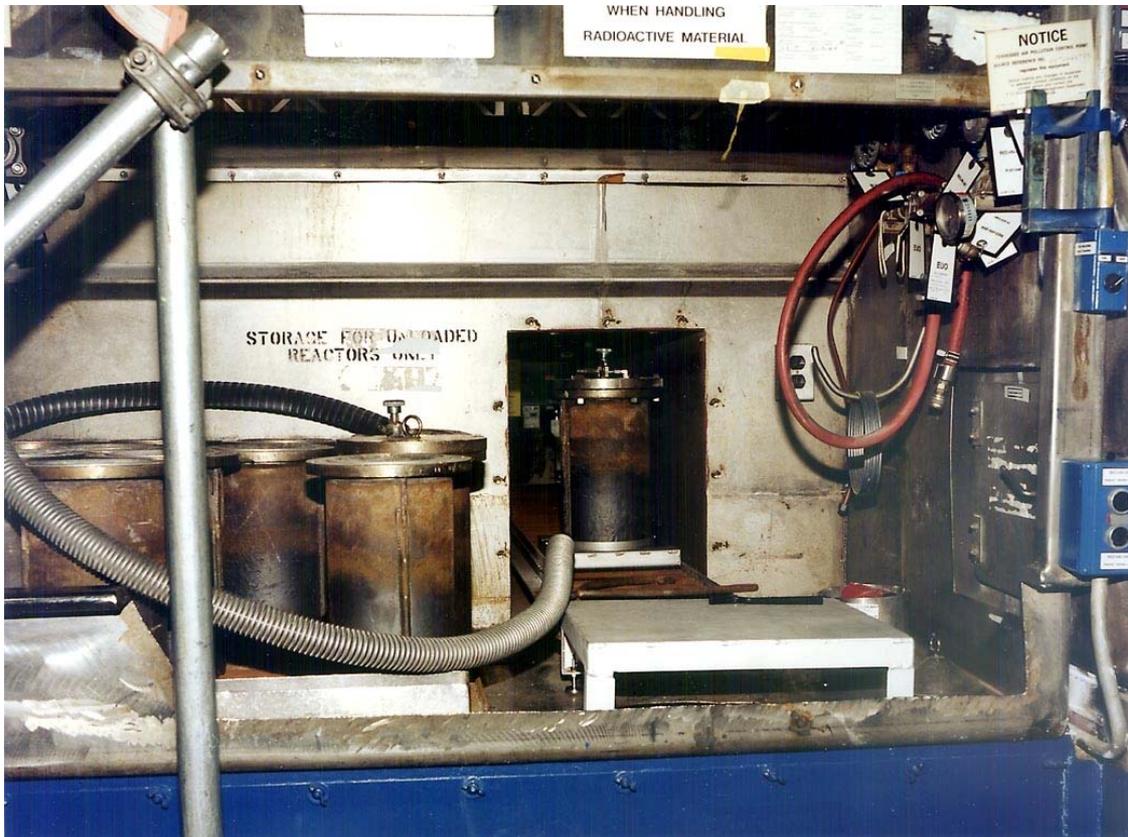
### Plutonium processing and conversion

Plutonium nitrate to oxide

Plutonium metal production

# NSG Trigger List *(continued)*

## Annex B — *more* uranium and plutonium processing and chemical conversion



Stainless steel reactor vessels for reduction of highly enriched  $UF_4$  to U metal

# Two Federal agencies license the export of Trigger List materials, components, equipment, facilities, and technology.

## US Nuclear Regulatory Commission (NRC)

- equipment, material, and embedded technology
  - 10 CFR PART 110, *Export and Import of Nuclear Equipment and Material*

## US Department of Energy (DOE)

- stand-alone nuclear technology
  - 10 CFR Part 810, *Assistance to Foreign Atomic Energy Activities*

# Most of 10 CFR Part 110 regulations are closely based on the NSG Trigger List.

## Trigger List entry for valves for use in gaseous diffusion\*

*Especially designed or prepared manual or automated shut-off and control bellows valves made of UF6 -resistant materials with a diameter of 40 to 1500 mm (1.5 to 59 in.) for installation in main and auxiliary systems of gaseous diffusion enrichment plants.*

## Corresponding export control language in 10 CFR Part 110\*

*Especially designed or prepared manual or automated shut-off and control bellows valves made of UF6 -resistant materials with a diameter of 4 cm to 1.5 m for installation in main and auxiliary systems of gaseous diffusion enrichment plants.*

- \* The differences between the Trigger List and 10 CFR Part 110 entries are highlighted in red.

# The N-stamp is an international designation of Trigger List commodities.



N-stamps on nameplates  
affixed to pumps  
controlled by the  
NSG Trigger List

# N-stamp (continued)

## American Society of Mechanical Engineers (ASME)

- authorizing entity in the United States

**NUCLEAR COMPONENTS**  
(N-type Certificates)

- **Stamps**

	Nuclear vessels, pumps, valves, piping systems, storage tanks, core support structures, concrete containments, and transport packaging
	Field installation and shop assembly
	Fabrication, with or without design responsibility, for nuclear appurtenances and supports
	Pressure relief valves

ASME C&S Training Module B9

(cont'd)  
.....→  
Slide 67



# N-stamp (continued)

- <http://cstools.asme.org/holdersearch/>

**NUCLEAR COMPONENTS  
(N-type Certificates)**

- **Stamps (cont'd)**

	Nuclear supports
	Containments for spent nuclear fuel and high level radioactive waste

ASME C&S Training Module B9

ASME

Slide 68

# The IAEA and NSG recently granted an exception on U.S. nuclear transfers to India.

## *“U.S.-India Agreement for Cooperation Concerning Peaceful Uses of Nuclear Energy (123 Agreement)”*

- executed on 10 October 2008
- allows U.S. nuclear transfers
  - to India’s civilian nuclear programs and facilities
    - still restricts certain equipment and technology
      - uranium enrichment
      - fuel reprocessing
  - contingent upon IAEA Safeguards at these same civilian facilities
    - 1 August 2008 of IAEA Safeguards agreement
    - does not apply to India’s nuclear weapon facilities
- no direct changes to NPT or NSG Trigger List

# The NSG published the Dual-Use List in 1992 after events in Iraq and South Africa.

Controls exports of dual-use equipment, material, software, and technology which could make a significant contribution to unsafeguarded nuclear fuel cycle or nuclear explosive activities

- specific list of controlled items
  - exacting technical criteria for determinations
- no export to certain activities in “Non-weapon States”
  - nuclear explosives
  - unsafeguarded nuclear fuel cycle facilities
- published as an IAEA document
  - INFCIRC/254/Part 2
    - currently in its 7th revision
    - March 2006

# NSG Dual-Use List *(continued)*

## Scope of controls

- nuclear fuel cycle
  - some items or materials-of-construction used in Trigger List equipment/facilities
- nuclear weaponization

# NSG Dual-Use List *(continued)*

- six broad categories
  - 1) industrial equipment
  - 2) materials
  - 3) uranium isotope separation equipment
  - 4) heavy water production equipment
  - 5) test and measurement equipment for the development of nuclear explosive devices (NEDs)
  - 6) components for NEDs

# NSG Dual-Use List examples

## Category 1 — industrial equipment

- machine tools

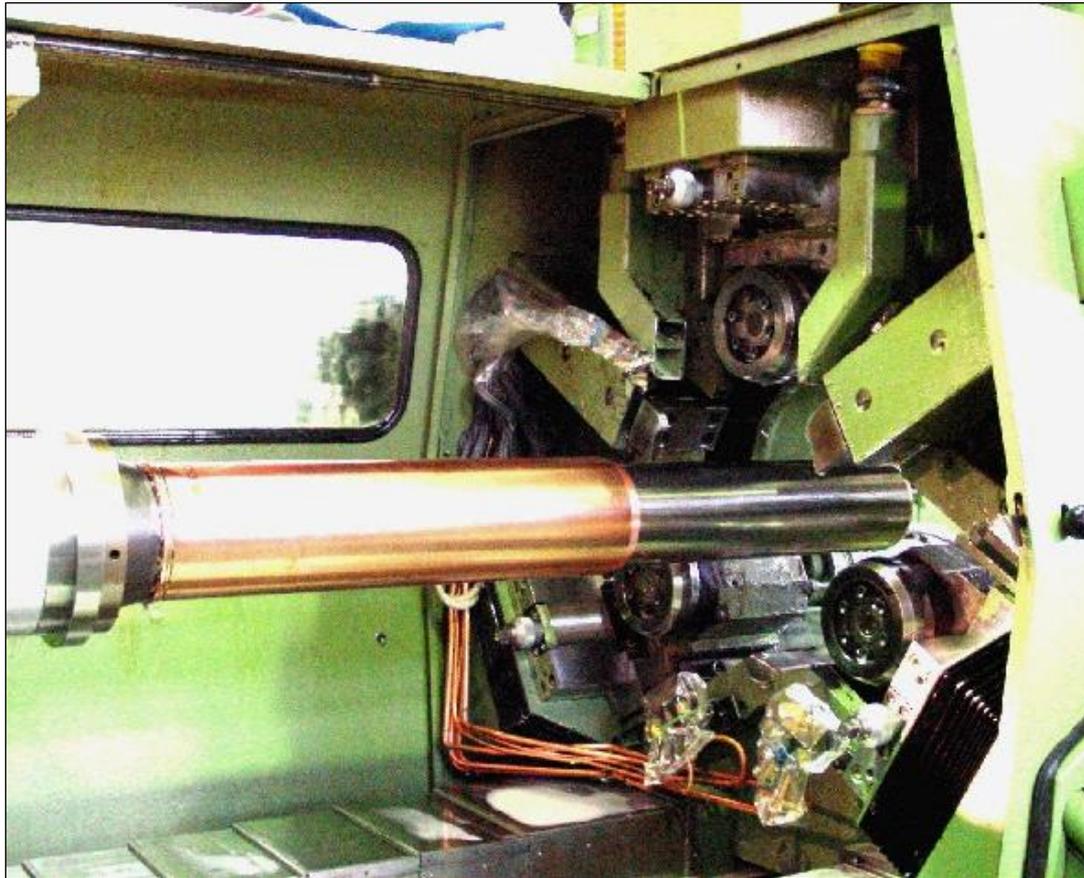
High accuracy,  
multiple axes  
machine tool



# NSG Dual-Use List examples *(continued)*

## Category 1 — *more* industrial equipment

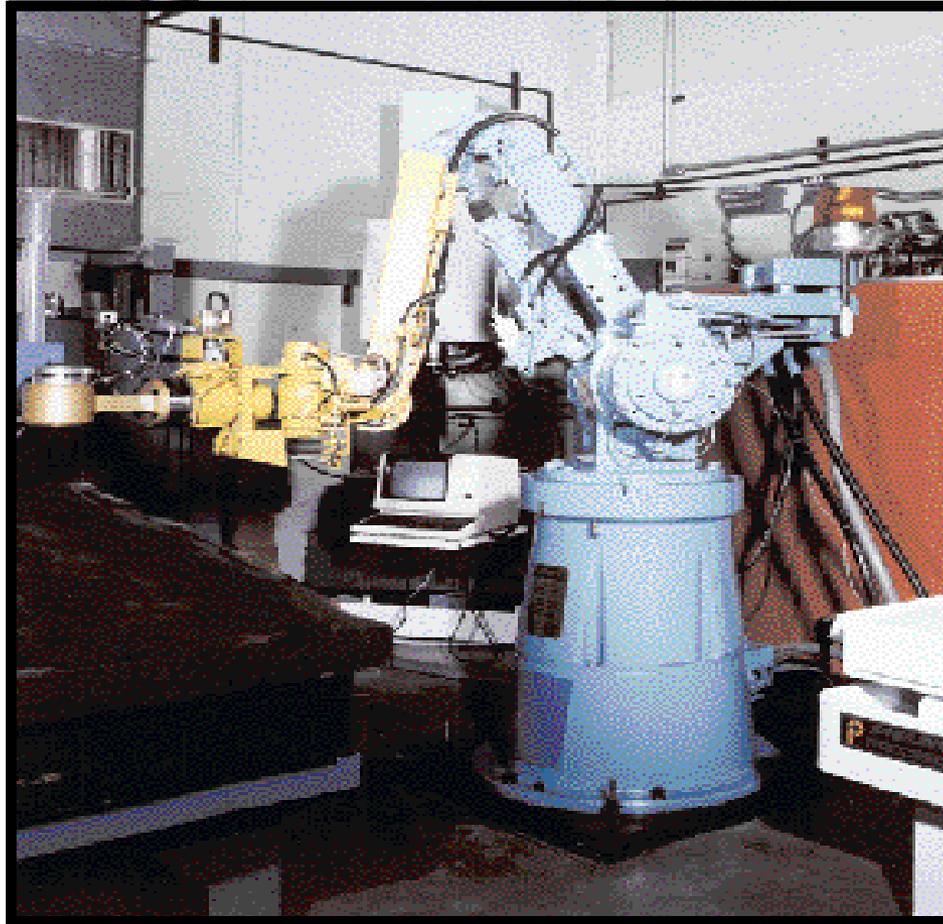
- flow- and spin-forming machines



# NSG Dual-Use List examples *(continued)*

## Category 1 — *more* industrial equipment

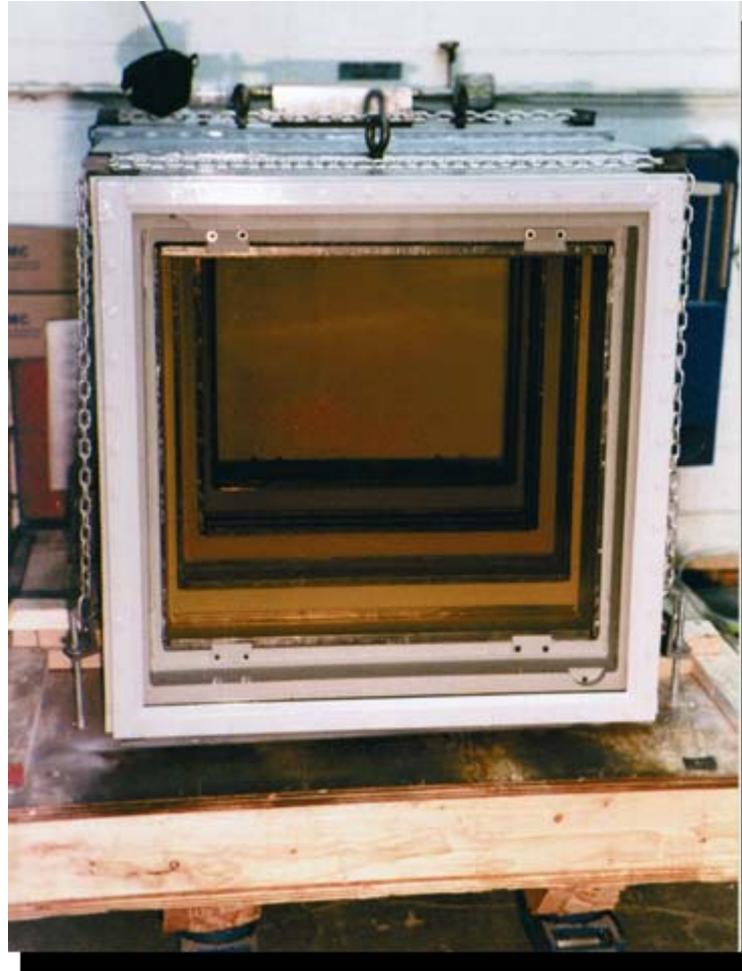
- robots



# NSG Dual-Use List examples *(continued)*

## Category 1 — *more* industrial equipment

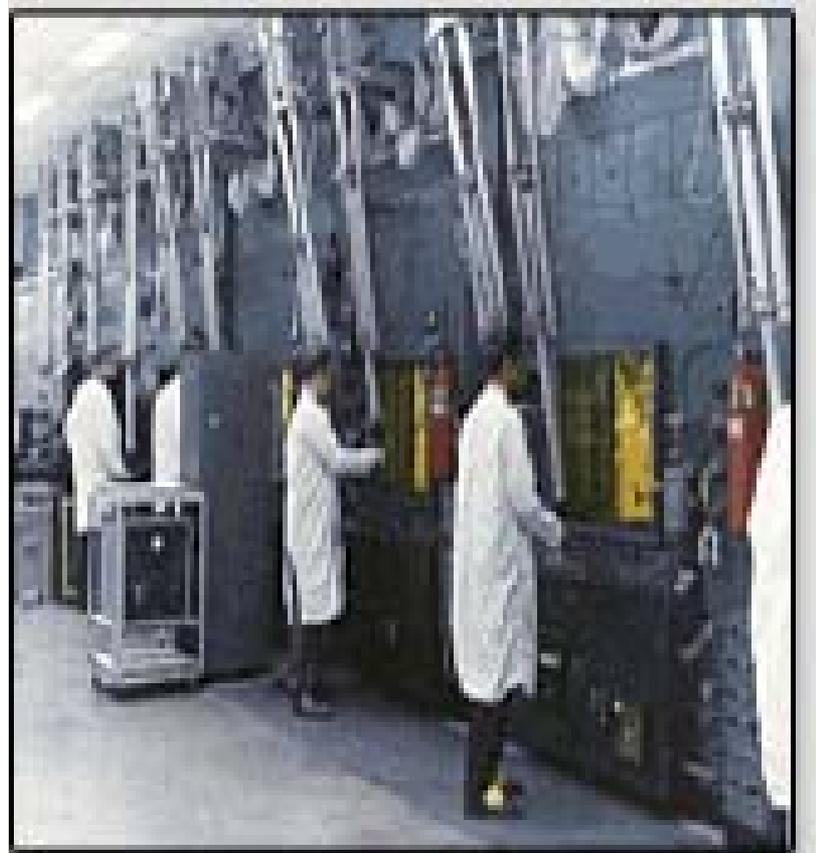
- radiation shielding windows



# NSG Dual-Use List examples *(continued)*

## Category 1 — *more* industrial equipment

- remote manipulators



Reprocessing at Savannah River

# NSG Dual-Use List examples *(continued)*

## Category 1 — *more* industrial equipment

- vacuum induction furnaces



# NSG Dual-Use List examples *(continued)*

## Category 2 — materials

- high strength aluminum (round stock, solid or hollow)



# NSG Dual-Use List examples (continued)

## Category 2 — *more* materials

- maraging steel





# NSG Dual-Use List examples (continued)

## Category 2 — *more* materials

- composite structures (tubular)



# NSG Dual-Use List examples (continued)

## Category 2 — *more* materials

- crucibles made of materials resistant to liquid actinide metals



various crucibles

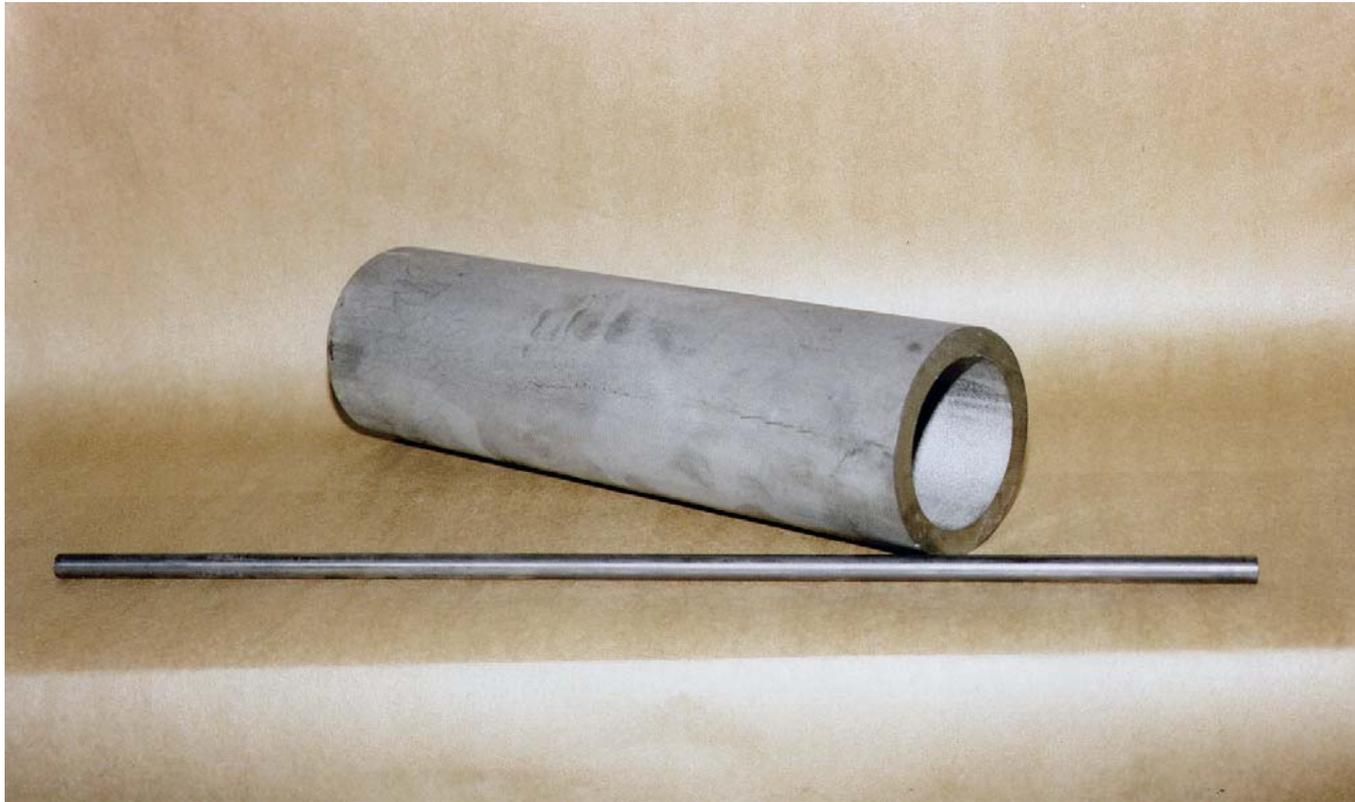


MgO  
crucible

# NSG Dual-Use List examples *(continued)*

## Category 2 — *more materials*

- zirconium having low concentrations of hafnium



# NSG Dual-Use List examples (continued)

## Category 3 — uranium enrichment equipment

- frequency changers



# NSG Dual-Use List examples *(continued)*

## Category 3 — *more* uranium enrichment equipment

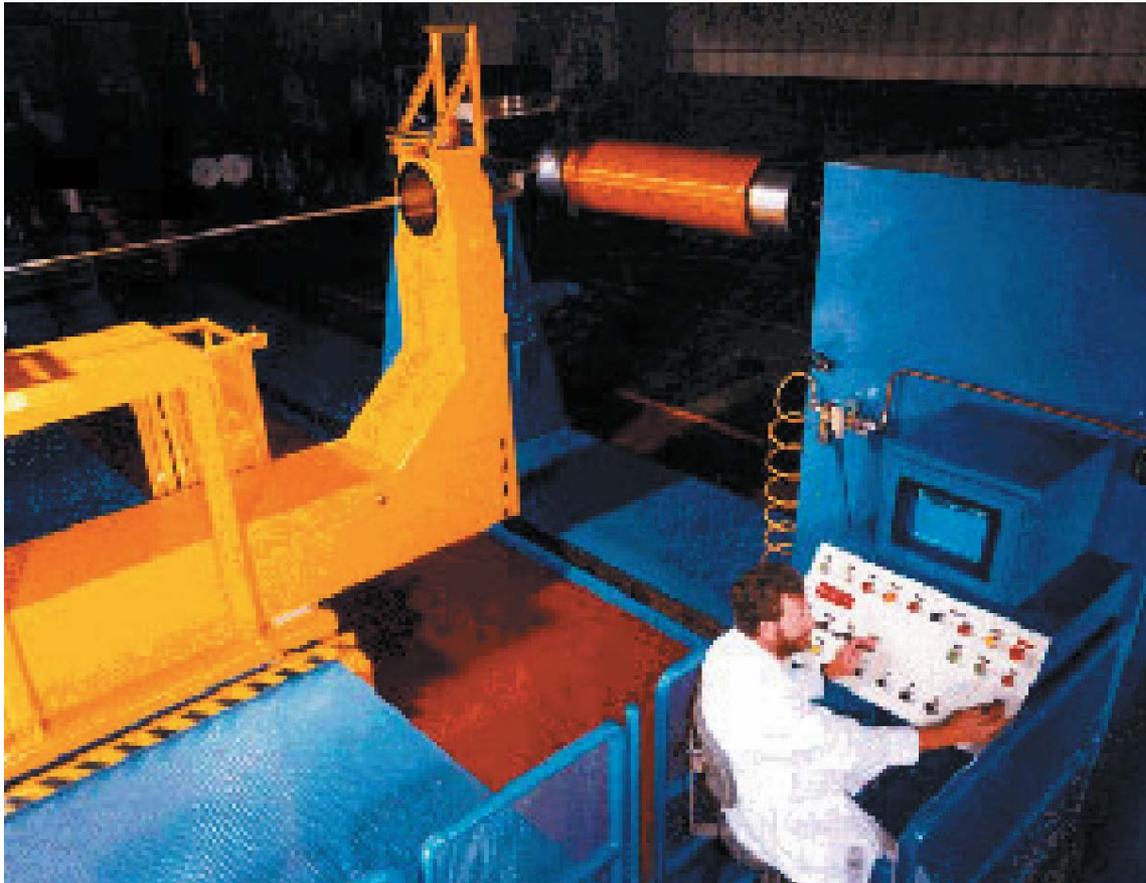
- corrosion resistant valves, with a bellows seal



# NSG Dual-Use List examples *(continued)*

## Category 3 — *more* uranium enrichment equipment

- filament winding machines



# NSG Dual-Use List examples *(continued)*

## Category 3 — *more* uranium enrichment equipment

- electrolytic cells for fluorine production



# NSG Dual-Use List examples *(continued)*

## Category 4 — heavy water production plant equipment

- ammonia synthesis converters
- specialized packings



# NSG Dual-Use List examples *(continued)*

Category 5 — test and measurement equipment (for development of NEDs)

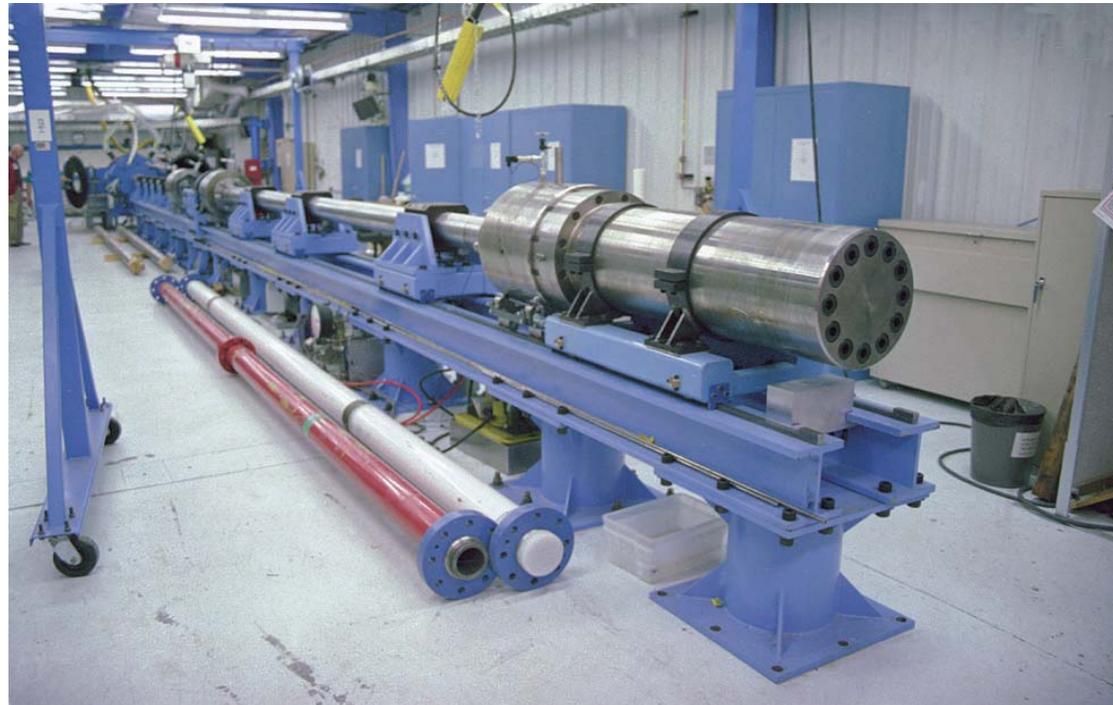
- photomultiplier tubes



# NSG Dual-Use List examples *(continued)*

Category 5 — *more* test and measurement equipment (for development of NEDs)

- multistage light gas guns or other high-velocity gun systems



# NSG Dual-Use List examples (continued)

Category 5 — *more* test and measurement equipment (for development of NEDs)

- mechanical rotating mirror cameras



# NSG Dual-Use List examples *(continued)*

Category 5 — *more* test and measurement equipment (for development of NEDs)

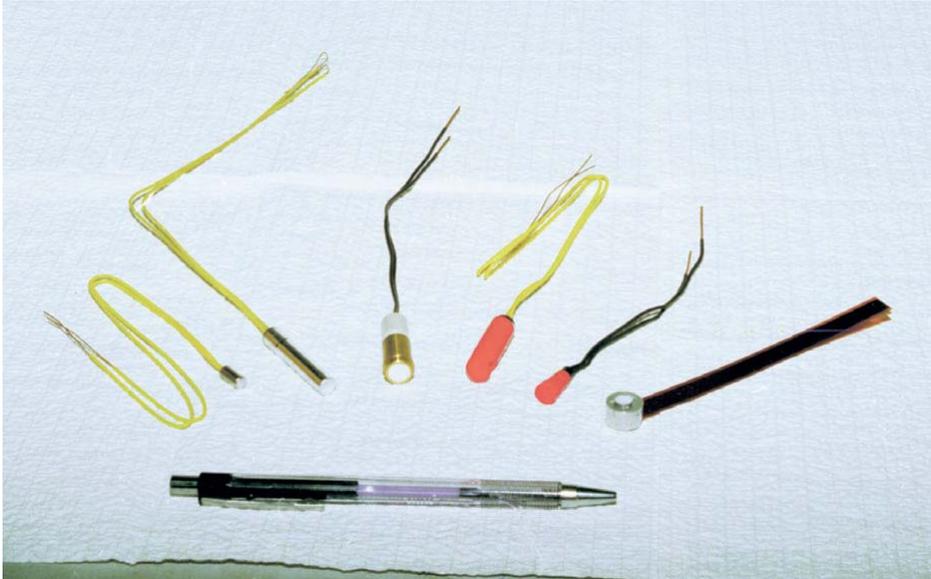
- pulse generators



# NSG Dual-Use List examples (continued)

## Category 6 — components for NEDs

- detonators and multipoint initiation systems

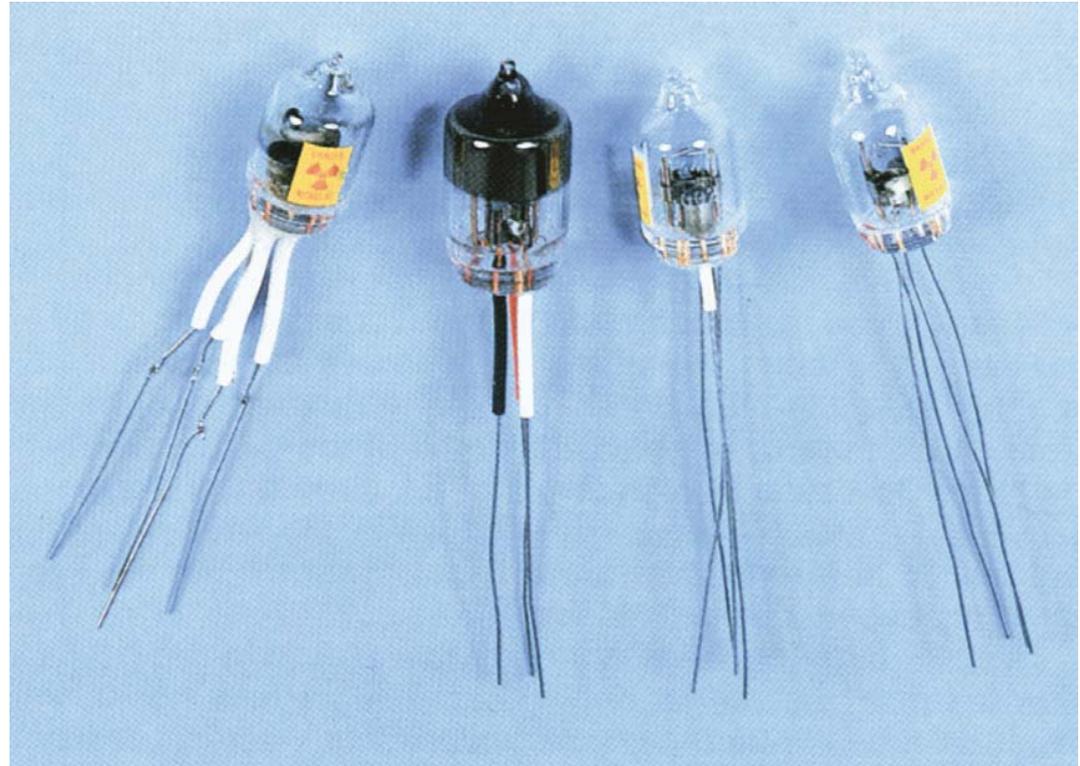


# NSG Dual-Use List examples *(continued)*

## Category 6 — *more* components for NEDs

- switching devices

three Krytrons  
and one Sprytron  
(2<sup>nd</sup> from left)



# NSG Dual-Use List examples (continued)

## Category 6 — *more* components for NEDs

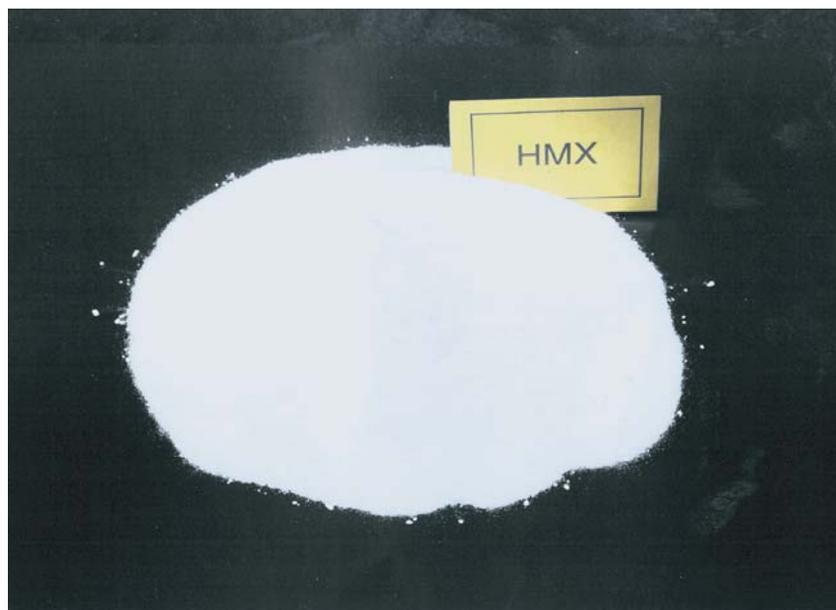
- capacitors



# NSG Dual-Use List examples (continued)

## Category 6 — *more* components for NEDs

- high explosive substances



HMX



TATB

# The US Department of Commerce (DOC) licenses the export of dual-use equipment, material, software, and technology.

## 15 CFR Parts 730 – 774, *Export Administration Regulations (EAR)*

- listing of export control items
  - Commerce Control List (CCL)
    - Supplement No. 1 to 15 CFR 774
- jurisdiction authority over items on the CCL
  - DOC's Bureau of Industry and Security (BIS)

# How do Trigger List definitions differ from Dual-Use definitions?

## Trigger List's illustrative definitions

- Plants and equipment “*especially designed or prepared systems for the conversion of  $UF_4$  to  $UF_6$* ”
  - NSG Trigger List Annex B, Section 7.1.5
  - Controls such equipment, regardless of size, capacity, chemical process involved, or quality of product

## Dual-Use List's specific definitions

- “*Magnesium containing less than 200 parts per million by weight of metallic impurities other than calcium, and containing less than 10 parts per million by weight of boron.*”
  - NSG Dual-Use List, Section 2.C.10
  - Controls precisely this type of high-purity magnesium, *not* to other types of high-purity magnesium

# Similar export control regimes aim to control other weaponization technology.

## Chemical and biological weapons

- Australia Group
  - started in 1985
    - response to chemical weapon use during Iran-Iraq War
      - violation of the 1925 Geneva Protocol
  - currently 41 member states
  - controls
    - chemical weapon precursors
    - select biological agents
      - including plant and animal pathogens
    - dual-use manufacturing facilities, equipment, and related technology

# Similar weaponization export control regimes *(continued)*

## Missile delivery systems

- Missile Technology Control Regime (MTCR)
  - started in 1987
  - currently 34 member states
  - two broad categories of control
    - 1) complete rocket, missile, and unmanned air vehicle systems
      - $\geq 500$  kg payload with  $\geq 300$  km range
      - major subsystems
    - 2) dual-use facilities, equipment, and related technology
      - used to develop, test, and build Category 1 systems
      - also captures delivery systems smaller than Category 1

# Similar weaponization export control regimes (*continued*)

## Conventional arms

- Wassenaar Arrangement
  - started in 1995
  - currently 40 member states
  - controls goods and technology
    - nine broad categories
      - e.g., Advanced Materials; Electronics; Material Processing
    - additional “Sensitive”, “Very Sensitive”, and “Munitions” lists
    - some overlap with or supplement to other control regimes
      - military nuclear reactors
      - nuclear/chemical/biological weapon effects software and protective equipment
      - weaponized chemical and biological agents
      - machine tools applicable for missile production
      - missile detection systems; certain missiles components

# Here is a list of useful internet links.

## NPT

- <http://disarmament2.un.org/wmd/npt/index.html>

## NSG

- <http://www.nuclearsuppliersgroup.org/default.htm>

## IAEA

- <http://www.iaea.org/>

## Australia Group

- <http://www.australiagroup.net/en/index.html>

## MTCR

- <http://www.mtcr.info/english/index.html>

## Wassenaar Arrangement

- <http://www.wassenaar.org/>

# Useful Internet Links *(continued)*

## U.S. Nuclear Regulatory Commission

- <http://www.nrc.gov/>

## U.S. Department of Commerce

- <http://www.commerce.gov/>

## U.S. Department of Energy

- <http://www.energy.gov/>

## U.S. National Nuclear Security Administration (NNSA)

- <http://www.nnsa.doe.gov/>

## NNSA NA-24 Nuclear Supply and Transfers Team

- <http://www.nnsa.doe.gov/na-20/nstt.shtml>