

4506. EXPLOSIVES AND RELATED EQUIPMENT

4506. 1. Detonators and multipoint initiation systems (exploding bridge wire, slapper, etc.)
- Electrically driven explosive detonators as follows:
 - exploding bridge (EB);
 - exploding bridge wire (EBW);
 - slapper; and
 - exploding foil initiators (EFI).
 - Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface (over greater than 5000 mm²) from a single firing signal (with an initiation timing spread over the surface of less than 2.5 s).

TECHNICAL NOTE:

The detonators described in Item 4506.1 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 (pentaerythritoltrinitrate). 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."

NOTE:

Item 4506.1 does not include detonators using only primary explosives, such as lead azide.

4506. 2. Electronic components for firing sets (switching devices and pulse discharge capacitors)
- Switching devices
 - Cold-cathode tubes (including gas krytron tubes and vacuum sprayon tubes), whether gas filled or not, operating similarly to a spark gap, containing three or more electrodes, and having all of the following characteristics:
 - Anode peak voltage rating of 2500 V or more,
 - Anode peak current rating of 100 A or more,
 - Anode delay time of 10 s or less, and
 - Triggered spark-gaps having an anode delay time of 15 s or less and rated for a peak current of 500 A or more;
 - Modules or assemblies with a fast switching function having all of the following characteristics:
 - Anode peak voltage rating greater than 2000 V;
 - Anode peak current rating of 500 A or more; and
 - turn-on time of 1 s or less.
 - Capacitors with the following characteristics:
 - Voltage rating greater than 1.4 kV, energy storage greater than 10 J, capacitance greater than 0.5 F, and series inductance less than 50 nH, or
 - Voltage rating greater than 750 V, capacitance greater than 0.25 F, and series inductance less than 10 nH.
 - Firing sets and equivalent high-current pulse generators (for controlled detonators), as follows:
 - Explosive detonator firing sets designed to drive multiple controlled detonators covered under item 4506.1. above;
 - Modular electrical pulse generators (pulsers) designed for portable, mobile, or ruggedized use (including xenon flash-lamp drivers) having all the following characteristics:
 - capable of delivering their energy in less than 15 s;
 - having an output greater than 100 A;
 - having a rise time of less than 10 s into loads of less than 40 ohms. (Rise time is defined as the time interval from 10% to 90% current amplitude when driving a resistive load);
 - enclosed in a dust-tight enclosure;
 - no dimension greater than 25.4 cm (10 in.);
 - weight less than 25 kg (55 lb.); and
 - specified for use over an extended temperature range (-50°C to 100°C) or specified as suitable for aerospace use.
 - High explosives or substances or mixtures containing more than 2% of any of the following:
 - Cyclotetramethylenetetranitramine (HMX);
 - Cyclotrimethylenetrinitramine (RDX);

- Triaminotrinitrobenzene (TATB);
- Any explosive with a crystal density greater than 1.8 g/cm³ and having a detonation velocity greater than 8000 m/s; or
- Hexanitrostilbene (HNS).

4507. NUCLEAR TESTING EQUIPMENT AND COMPONENTS

4507. 1. Oscilloscopes and transient recorders and specially designed components as follows: plug-in units, external amplifiers, pre-amplifiers, sampling devices, and cathode ray tubes for analog oscilloscopes.
- Non-modular analog oscilloscopes having a "bandwidth" of 1 GHz or greater;
 - Modular analog oscilloscope systems having either of the following characteristics:
 - a mainframe with a "bandwidth" of 1 GHz or greater; or
 - Plug-in modules with an individual "bandwidth" of 4 GHz or greater;
 - Analog sampling oscilloscopes for the analysis of recurring phenomena with an effective "bandwidth" greater than 4 GHz;
 - Digital oscilloscopes and transient recorders, using analog-to-digital conversion techniques, capable of storing transients by sequentially sampling single-shot inputs at successive intervals of less than 1 ns (greater than 1 giga-sample per second), digitizing to 8 bits or greater resolution and storing 256 or more samples.

TECHNICAL NOTE:

"Bandwidth" is defined as the band of frequencies over which the deflection on the cathode ray tube does not fall below 70.7% of that at the maximum point measured with a constant input voltage to the oscilloscope amplifier.

4507. 2. Photomultiplier tubes with a photocathode area of greater than 20 cm² having an anode pulse rise time of less than 1 ns.
4507. 3. High-speed pulse generators with output voltages greater than 6 V into a less than 55-ohm resistive load, and with pulse transition times less than 500 ps (defined as the time interval between 10% and 90% voltage amplitude).

4508. OTHER

4508. 1. Neutron generator systems, including tubes, designed for operation without an external vacuum system and utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction.
4508. 2. Equipment related to nuclear material handling and processing and to nuclear reactors as follows:
 - Remote manipulators that provide mechanical translation of human operator actions by electrical, hydraulic, or mechanical means to an operating arm and terminal fixture that can be used to provide remote actions in radiochemical separation operations and "hot cells." The manipulators have a capability to penetrate 0.6 m or more (2 ft. or more) of cell wall or, alternatively, bridge over the top of a cell wall with a thickness of 0.6 m or more (2 ft. or more);
 - High-density (lead glass or other) radiation shielding windows greater than 0.3 m (1 ft.) on a side and with a density greater than 3 g/cm³ and a thickness of 100 mm or greater, and specially designed frames therefor;
 - Radiation-hardened TV cameras specially designed or rated as radiation hardened to withstand greater than 5 X 10⁴ grays (Si) (5 X 10⁶ rad (Si)) without operational degradation and specially designed lenses used therein.
4508. 3. Tritium. See also 4012.
Tritium, tritium compounds, and mixtures containing tritium in which the ratio of tritium to hydrogen by atoms exceeds 1 part in 1000 except a product or device containing not more than 40 Ci of tritium in any chemical or physical form.
4508. 4. Facilities or plants for the production, recovery, extraction, concentration, or handling of tritium, and equipment as follows (see also 4205.):
 - Hydrogen or helium refrigeration units capable of cooling to -250°C (23 K) or less, with heat removal capacity greater than 150 watts or