HRP Job Aid

Cameras

Description	ECCN
Cameras and components	6A003 or 6A203 or 6A993
Cinema recording cameras	6A003.a.1
Electronic cameras	6A003.a.5
Electronic streak cameras and streak tubes	6A003.a.3 or 6A203.b.1
Fingerprint analyzers, cameras and equipment	3A981
Framing cameras, electronic type	6A003.a.4 or 6A203.b.2
Framing cameras, mechanical	6A203.a.1
High-speed cameras	6A003 or 6A203
Imaging cameras with focal plane arrays of	6A002.a.3 6A003.b.4
Imaging cameras with image intensifiers of	6A002a.2.a 6A003.b.3
Imaging cameras w/solid-state detectors specified by	6A002.a.1 6A003.b.5
Instrumentation cameras	6A003.a
Mechanical cameras, framing	6A003.a.1, a.2, or a.3
Photo-optical step and repeat cameras	3B991.b.2.d.1
Photographic still cameras, for underwater use	8A001.e or 8A992.b
Radiation hardened TV cameras or lenses therefor	6A203.d or 6A999.b
Scanning cameras and systems	6A003.b.2
Solid state cameras	6A003.b.1
Streak cameras, mechanical type	6A203.a.2
Streak cameras, mechanical or electronic	6A003.a.3
Streak tubes, electronic streak cameras	6A203.b.1
Streak cameras, electronic type	6A203.b.1
Television cameras, underwater	8A002.d.1.a or d.1.b
Television cameras, remote operation with submersible vehicle	8A992.a.1
Underwater cameras, photographic	8A002.d, e, or f
Underwater camera equipment, n.e.s.	8A992.d
Underwater television cameras	8A992.a.2

Do not worry about the following cameras

- Cameras for general-purpose video and photography applications lacking any unique features outlined in this training aid (e.g., fast framing rate, radiation hardened, night vision capability)
- Television or video cameras designed for television broadcasting
- Scanning cameras and camera scanning systems for industrial or civilian photocopiers
- Image scanners for civil, stationary, close proximity scanning (e.g., reproduction of images or prints contained in documents or photographs)
- Imaging cameras for the following applications:
  - Industrial or civilian intrusion alarm, traffic, or industrial movement control
  - Inspection or monitoring of heat flows in buildings, equipment, or industrial processes
  - Industrial equipment used for inspection, sorting, or analysis of the properties of materials
  - Medical equipment
  - Financial fraud detection equipment

Features of Cameras of Concern

- High speed (video frame rate, measured in hertz [Hz] or frames per second [fps])
- Infrared/thermal imaging/night vision capability
- Radiation-hardened
- Incorporating lasers to enhance capability
- Applications with drones or submersible vehicles

Major Manufacturers of Export-Controlled Cameras

- Teledyne FLIR (world leader in thermal imaging infrared [IR] cameras)
  - Both EAR and ITAR XII(c) controlled cameras
- Sierra-Olympic Technologies Inc.
- Xenics Infrared Solutions
- Vision Research (a business unit of AMETEK Inc.)
- Tech Imaging Services
- Andor (part of the Oxford Instruments Group)
- Cordin (world leader in high-speed electronic streak and framing cameras)
- Princeton Instruments

Technical Information to Investigate

- Video frame rate, especially if less than or greater than 9 Hz
- Camera resolution (e.g., 640 × 480 or 1920 × 1200)
- The terms *FPA, IIT, LLL, LWIR, MWIR, FLIR* on any paperwork or nameplate

Thermal Imaging Cameras

Definitions and Notes

- A *thermal camera* is a device that has the capability to detect very small changes in temperature differences. These temperature differences are sensed by a detector and are generated in an image on a screen.
- A major benefit of a thermal camera is that it has the ability to "see" in complete darkness. The infrared detector can go through intense smoke, dust, fog, and even haze.
- First only used by the military, thermal cameras are now routinely used in commercial applications, especially since the development and commercialization of high-definition sensors.
- Some are fixed, others are portable. Modern thermal cameras have sophisticated software that enables image storage capacity and wireless transmission.
- Forward-looking infrared (FLIR) cameras are thermal imaging cameras that detect infrared radiation directly from objects such as people or vehicles with no external illumination required; these are also called *passive thermal imaging cameras*.

Two Types of Thermal Imaging Cameras

- Mid-wave infrared (MWIR) cameras usually require heavy, bulky, and expensive cooling systems.
- Long-wave infrared (LWIR) cameras are smaller, lighter, and cheaper than cooled MWIR cameras and are ideal for use in airborne reconnaissance using drones.

Cameras and Components for ECCN 6A002, 6A003, 6A993

ECCNs 6A002 and 6A003: Items Controlled

- Focal plane arrays (FPAs), image intensifier tubes (IITs), and low light level (LLL) sensors
- Cameras and direct view equipment incorporating these FPAs, IITs, and sensors for the purposes of cooled and uncooled IR or near-IR imaging
- Full frame rate (fast video): LWIR thermal video cameras >9 Hz (e.g., 30 or 60 Hz)

ECCN 6A993: Items Controlled

- Slow frame rate (slow video): LWIR thermal video cameras ≤9 Hz
- These cameras may be exported under No License Required to all countries except terrorist-supporting countries (i.e., Cuba, Iran, Libya, North Korea, Sudan, and Syria)

Notes

- **Fast video/slow video—**Many manufacturers offer thermal cameras with "fast video" (ECCN 6A002, 6A003) and "slow video" (ECCN 6A993) options for a given camera model.
- Export of thermal imaging cameras is prohibited, regardless of camera resolution or video rate, to terrorist-supporting countries.

ITAR Controlled Items under USML Category XII(c)

- Image intensification and other night sighting equipment or systems especially designed, modified, or configured for military use
- Items typically use high-resolution (HD) thermal IR technology and fast video rates for uncooled LWIR cameras and cooled MWIR cameras and sensors

Examples of Thermal Imaging Cameras

Teledyne FLIR Tau 2 640 × 512 19 mm—LWIR Thermal Imaging Camera Core 30 Hz

- Price: $6,000
- **ECCN 6A003.b.4.b**

FLIR FC-369-ID 320 × 240 9 MM—LWIR Thermal Analytics Security Camera

- Frame rate: NTSC: 30 Hz
- sPAL: 25 Hz/8.3 Hz
- Array: 320 × 240
- Lens: 9 mm
- Best-in-class perimeter protection
- Weight: 5 lb
- Price: $5,400
- **ECCN 6A003.b.4.b**

FLIR Scout III 240 Thermal Imaging Monocular

- Creates crisp, clear thermal imagery in all lighting conditions
- Reveals the heat signatures of animals up to 3,740 ft away
- Submersible
- Weight: 4 lb
- Price: $1,499
- **ECCN 6A003.b.4.b**

FLIR M332 Marine Thermal Camera with Active Gyro-Stabilization

- Detector: 320 × 256 VOx microbolometer
- Field of view: 24° (H) × 18° (V)
- Pan/tilt adjustment range: 360° continuous pan, ±90° tilt
- Power requirements: 12–24 VDC
- Range performance for a person in the water: 2,700 ft (823 m)
- Range performance for a small vessel: 1.2 nm (2.2 km)
- Weight: 15 lb
- $8,495
- **ECCN 6A003.b.4.b**

Sierra-Olympic Technologies Vayu HD Long Wave Infrared (LWIR) Camera

- 60 Hz frame rate
- State-of-the-art
- Highest resolution (1,920 × 1,200 × 12 µm) uncooled LWIR camera on the market
- Applications: Navigation, surveying, wide area surveillance, driver vision, aerial mapping, unmanned vehicles, wildlife, wildfire, search and rescue, film production
- **ECCN 6A003.b.4.b**

High Speed Streak and Framing Cameras (ECCN 6A003, 6A203)

Key Points

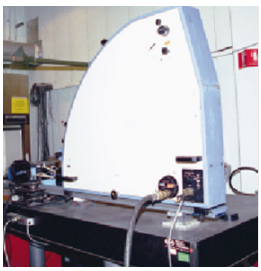
- Two types of high-speed streak and framing cameras—mechanical and electronic
- 6A003 covers the same types of cameras as 6A203 but with different specifications

Mechanical Rotating Mirror (RM) Cameras

- Specialized cameras capable of recording multiple, very-high–time resolution images called *frame records* or *streak records* (i.e., the format of the optical output)
- Uses a multifaceted, highly polished RM (rather than a conventional shutter) to capture images
- Nuclear uses include developing high explosive (HE) components and initiation systems for nuclear explosive devices; dynamic materials properties studies
- Technical information to investigate for export control:
  - Streak cameras with writing speeds greater than 0.5 mm/µs
  - Framing cameras with recording rates >225,000 fps
- Specially designed components of such cameras are also controlled (e.g., synchronizing electronic units and rotor assemblies consisting of turbines, mirrors, and bearings)
- Most new RM cameras sold are charged coupled device (CCD)-based, though film cameras are still supported and commonly used

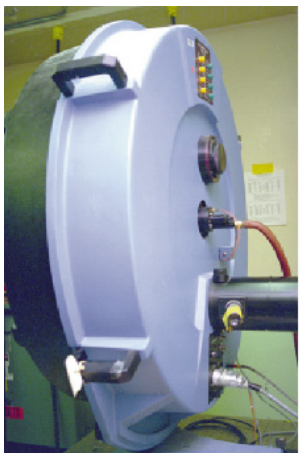
Appearance and Notable Features

- Outer metal housing, typically aluminum; heavy and sturdily engineered
- Essentially all internal components except for the actual optical elements will be black
- Many varieties will be circular (or partially circular) when viewed from the side, with the RM bearing at the center; connector for a gas hose at the center of the circle



Typical film-based RM framing camera

Charge coupled device–based RM streak/framing cameras do not have the distinctive circular shape



Modern state-of-the-art combined RM streak/framing camera. (Left) Outside. This camera shape is a complete circle, with the mirror turbine and connecting gas hose at right center. (Right) Inside. The RM is at the center, with beam-turning optics at the bottom.

Electronic Streak and Framing Cameras

- Specialized cameras capable of recording very-high–time resolution images
- Use an electronic means of producing images (i.e., beam splitters or sweep tubes combined with image intensifiers to both amplify and shutter the image)
- Nuclear uses include the study of dynamic materials properties and to provide information about the performance of nuclear explosive device components driven by high explosives
- Commercial non–weapons of mass destruction applications include spectroscopy, optoelectronics, aerosol studies, aerodynamics, materials science research, and military and defense research
- Technical information to investigate for export control:
  - Electronic streak cameras capable of ≤50 ns time resolution
  - Electronic framing cameras capable of ≤50 ns frame exposure time
- Specially designed components of such cameras are also controlled (e.g., streak tubes, framing tubes, solid state imaging devices, plug-ins, synchronizing electronic units)

Appearance and Notable Features

- Resembles ordinary video cameras
- Lighter and more compact than their mechanical RM counterparts
- Basic enclosure approximately rectilinear and may be plastic or aluminum
- The lens and recording electronics are on opposite ends
- Output coupled to a computer or a second camera (older analog output)
- A panel of control buttons and switches on the outside of the camera enclosure
- Key characteristics are on the inside, including highly specialized optical imaging and electronic components
- Typical price (new): Framing cameras cost $20,000–$350,000, and streak cameras start at about $150,000

Electronic camera capable of both streak and framing operation (measures 37 in. long and weighs 59 lb).

Manufacturer-supplied packaging for a modern streak/framing camera. The camera is contained in a metal box (latches visible), which is then covered with an assembly of wood and foam panels that is inserted into a cardboard box (not shown)

Modern electronic streak camera by Hamamtsu Photonic Division, Japan (Model C5860)

Phantom Model v2512. The fastest 1 MP digital high-speed camera on the market; capable of reaching up to 1,000,000 fps. Starting at $150,000. Manufactured by Vision Research (a business unit of Ametek Inc.) **ECCN 6A003**

Radiation Hardened Cameras (ECCN 6A203.d)

- Specially designed or rated as radiation-hardened to withstand a total dose of greater than 5×10^4 Gy (5×10^6 rad) without operational degradation
- Vacuum type or shielded solid state camera designed to operate in a high-radiation environment
- Lens for such cameras are also controlled

Applications

Nuclear

- Remote observation in hot cells during reprocessing or for monitoring waste processing
- May be used in high radiation areas, both underwater and in air, at nuclear power plants

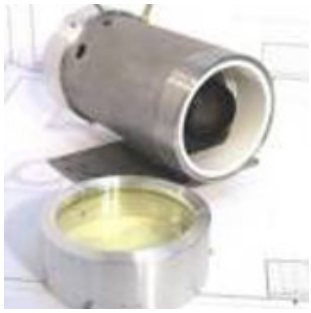
Commercial

- Used in response to bombings when conditions are unknown;
- Satellites and space missions
- Industrial applications (e.g., food irradiation) generally <5,000 Gy not requiring radiation-hardened equipment

Appearance

- **Components:** Lens cover (often removable); lens; house containing electronics; connector for signal going to monitor
- **Solid state camera:** Requires lead shielding to protect electronics from radiation
  - Lens protector typically made of removable lead glass (yellowish tint)
  - Solid state cameras are the most widely manufactured
- **Vacuum tube camera:** Not as susceptible to radiation; no lens protector

Ahlberg Electronics Model N65HR radiation hardened camera (vacuum type)



Removable lead-glass to protect the lens

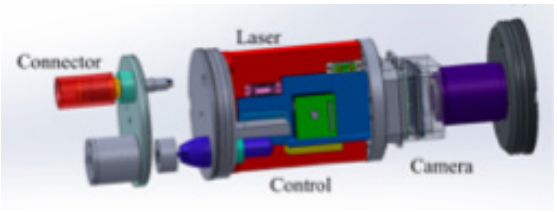
Underwater Cameras (ECCN 8A002, 8A992)

Notes

- Underwater optical imaging provides much higher resolution than traditional sonar
- The clarity of these images, however, depends on the water quality
- In turbid (cloudy or opaque) water, active illumination causes *backscatter*, which is the reflection of light back toward the camera and the same phenomenon that makes it difficult to drive in fog

ECCN 8A002

- Underwater cameras especially designed or modified for remote operation with an underwater vehicle and
- Using either a range-gated illuminator or range-gated laser system to minimize backscatter



Underwater time-of-flight imaging acquisition camera system. Shown are the topside box, control computer, laser camera, and connecting cable. Technical drawing shows the internal range-gated laser. Housing has a diameter of 6.1 in. and a length of 14.6 in. Designed to withstand pressures up to a depth of 300 m. **ECCN 8A002**

ECCN 8A992

Certain underwater cameras are controlled under ECCN 8A992 only if especially designed or modified for either of the following:

- Camera is part of a television system for remote operation with a submersible vehicle
- Photographic still cameras with a film format of ≥35 mm with autofocusing or remote focusing for underwater use

DOE/NNSA High Risk Property

https://hrp.doe.gov

https://ecap.doe.gov

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