KODAK INDUSTREX Digital Imaging Plates

KODAK INDUSTREX Flex GP and HR Digital Imaging Plates (IPs) are designed for computed radiography in non-destructive testing applications. These plates employ storage phosphors which capture and retain a latent image in direct proportion to an exposure of ionizing radiation. This latent image is subsequently read out by scanning with a red laser, which stimulates the emission of blue light, in a phenomenon known as photostimulated luminescence.

The imaging plate can be loaded into a flexible cassette and used with metal screens of appropriate thickness. They offer the flexibility of film without the need for wet processing, so you can capture and read images quickly and easily, both in the field and in the lab.

You can manipulate the images if needed and store or share them digitally, and they work with KODAK CR Systems including the KODAK INDUSTREX ACR-2000 and ACR-2000i Digital Systems.

KODAK INDUSTREX Flex GP and HR Digital imaging Plates are:

- **Flexible**—Wrap around most shapes.
- **Sharp**—Better resolution than high-speed films, and a suitable replacement for many applications.
- **Available in Multiple Sizes**—To cover a wide range of applications.
- **Portable**—With a KODAK INDUSTREX Digital System, image capture in remote areas is easier than ever.
- **Versatile**—Use in a rigid or flexible cassette.
- **Efficient**—Phosphor plates can be erased and reused thousands of times, require less exposure than film, and provide faster image access.
- **Certified**—When used with KODAK INDUSTREX ACR-2000 and ACR-2000i Digital Systems, both plates meet requirements for the highest system class: IP 1/100 according to EN 14784-1 and IP Special/100 according to ASTM E 2446.

Recommended Uses:

KODAK INDUSTREX Digital Imaging Plates are available in many sizes, and are designed for a wide variety of NDT applications, including:

- Castings
- Erosion and corrosion
- Pipeline inspection
- Welded fabrication
- Ordnance

STORAGE AND HANDLING

The lifetime of the plates is hundreds or thousands of exposure/readout/erase cycles, determined primarily by the care in handling and environmental conditions. Careless handling and very dirty environments can shorten the useful lifetime of an imaging plate.

Important

Inspect phosphor plates every week and replace when wear is evident. Clean every 200 exposures, every 30 days, or as necessary as directed in the “Cleaning” section below.

Handling

Handling the IP and operating the ACR-2000/ACR-2000i reader must be done in a darkened room that is free of light contamination. It is not necessary to have complete darkness, but the light source must be a low wattage incandescent bulb. Fluorescent, sodium vapor, mercury vapor, safelights and sunlight must not be allowed in the processing room during handling or scanning of the imaging plates.

Under normal use conditions, phosphor plates will eventually show wear. Plate wear can result in artifacts on radiographs. This may occur from abrasion of the protective overcoat or inadvertent physical damage to the surface or edge. Certain chemical agents, such as non-approved plate cleaners, hand lotions, topical medications, food, etc., may also damage the plates.

Handle flexible phosphor plates with care. Hold plates by the edges and by the black side. Avoid contact with the plate’s white (phosphor) side. Make sure hands are clean and dry. For best results, wear clean, soft, lint-free fabric gloves.

Cutting

Cutting the plates is not recommended, as this will compromise the edge seal and make the plates prone to moisture damage at the edges.

Temperature Range

The normal temperature operating range is -5 to 25° C (23 to 77° F), although lower temperatures for short periods (several hours) will have no detrimental effect on the performance or physical integrity of the plates. In very hot environments, care should be exercised in bending or flexing the plates, as the phosphor layer of the HR plate could crack if flexed at temperatures exceeding 65° C (149° F). Between 65 and 100° C (149 and 212° F), minor distortions of the polyester support may occur, and over 100° C (212° F), damage to the phosphor layer (blistering/buckling) can occur. When radiography of very hot objects (such as hot welds) is necessary, a thin fire-resistant insulating layer may be placed between the cassette and the object, if experimentation shows it does not negatively affect image quality. Again, as a practical matter, the upper temperature limit will be determined by the point at which the cassette begins to burn or the lead identification letters begin to melt.

Cleaning Plates

KODAK INDUSTREX Digital Imaging Plates employ a phosphor that is moisture sensitive. When exposed to water (either liquid or vapor form), the phosphor breaks down and liberates iodine. The iodine can become trapped within the phosphor layer at the interface between the overcoat and phosphor layer. The yellow-brown color in the iodine strongly absorbs the blue light emitted by the phosphor. This results in a loss in plate speed, which causes image quality problems.

The plates are over-coated with a highly moisture-resistant polymer blend. However, the overcoat is very thin (less than 0.001 inch) and has limited resistance to mechanical abrasion that may occur during cleaning. Thus, it is possible to lower the resistance to water during use or cleaning. This can result in the degradation of the plate.

Caution

Moisture can cause immediate or future screen damage and image artifacts. Minimize contact with moisture and ALWAYS DRY PLATES IMMEDIATELY.

Use a clean, dry, soft, lint-free cloth to remove dust. Use one of the following approved liquid cleaners to remove other dirt.

- KODAK Intensifying Screen Cleaner and Antistatic Solution
- KODAK MIN-R Screen Cleaner
- KODAK MIN-R Screen Cleaner Wipes

Precautionary: Read and follow instructions in Material Safety Data Sheets (MSDS) for KODAK Intensifying Screen Cleaner and Antistatic Solution, KODAK MIN-R Screen Cleaner, and KODAK MIN-R Screen Cleaner Wipes.

Caution

Water, isopropyl alcohol (Isopropanol, rubbing alcohol), and plate cleaners containing isopropyl alcohol are not recommended.

Cleaning Method

When using a cleaning solution, apply the solution to a clean, soft, lint-free cloth. Do not pour the cleaning solution directly onto the plate. Cleaning solutions other than those recommended can contain chemicals that cause visible or hidden damage to the plate and could result in immediate or future image artifacts.

1. Place the plate with the black (non-phosphor) side down on a clean, dry, non-abrasive surface, such as the cassette's cleaned Tube Side.
2. Wipe the plate gently to remove dust. Remove other dirt by following the directions for the cleaning product being used. Clean and dry the plate's entire phosphor side.

Note: It is also a good practice to clean the interior of flexible cassettes to avoid transfer of dirt or dust to the plate.

CHARACTERISTICS

Physical Properties

Thickness

	Total Thickness (microns [mils])	Phosphor layer (microns [mils])	Overcoat (microns [mils])	Backing Layer (microns [mils])
HR	444 (17.5)	150 (5.9)	6 (0.24)	25.4 (1)
GP	605 (23.8)	300 (11.8)	12 (0.47)	38.1 (1.5)

KODAK INDUSTREX Digital Imaging Plates are comprised of a layer of bariumfluorobromoiodide doped with divalent Europium (BaFBr/I:Eu2+), coated on a 10-mil polyester support.

A polymer overcoat provides protection against normal handling such as fingerprints and moisture.

A black polycarbonate backing layer provides anti-halation protection and curl control, and also contains slip agents for optimum transport through the CR reader hardware.

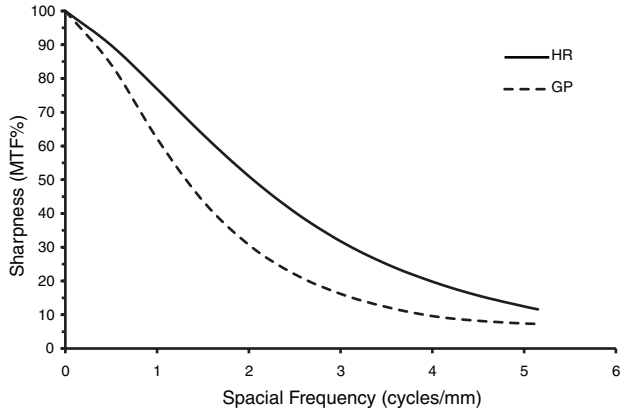
Flexibility

The plates can be bent around pipes and other curved surfaces down to a radius of one inch, although as a practical matter, the bend radius will be much more limited by the configuration of the cassette and the lead screens, when used.

Sharpness

Sharpness is typically characterized by Modulation Transfer Function, a measure of signal or image modulation as a function of spatial frequency. The figure below shows the MTF curves for both imaging plates, and highlights the improved sharpness of the HR plate.

Modulation Transfer Function



Signal Retention

The stored energy in the imaging plate phosphors will decay over time, resulting in some signal loss. This effect is known as image fading. This loss is also a function of temperature, and will be greater at elevated temperatures.

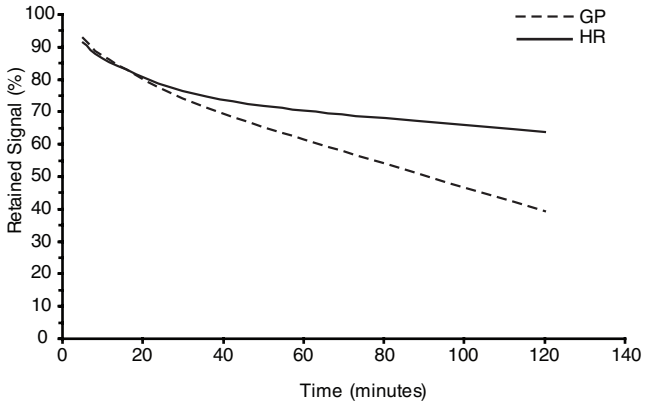
In most applications this signal decay will be of little importance, given the very wide latitude of storage phosphor imaging plates.

In critical applications, there are a couple of measures that can be taken; when the interval between exposing and readout is more than a couple of hours, the plates can be exposed with a higher radiation dose (greater milliamp-seconds) to compensate for signal decay.

For shorter intervals, simply keeping the time between exposing and readout constant will eliminate any decay-induced variability.

The figure below shows the percent signal retention in the first two hours at ambient temperatures after an exposure of 80 kV.

Signal Retention



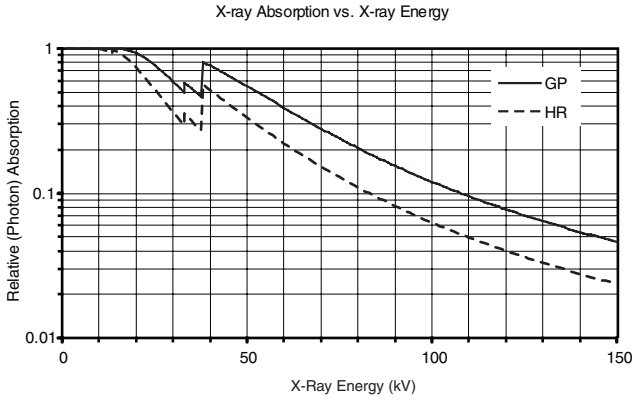
Absorption

Imaging plates are quite prone to low energy scatter, as shown by their x-ray energy absorption curves below.

For this reason, the use of lead screens, especially at energies greater than 100 kV, is important in controlling scatter to produce optimum image quality.

The thickness of the screens is determined by experimentation, however it will generally be two to three times the thickness of a comparable film application.

Absorption

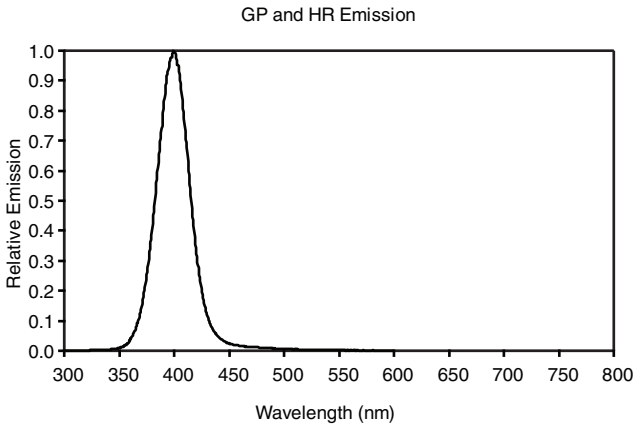


Emission

The wavelength of light needed to stimulate phosphor luminescence is different from the wavelength of light released by the phosphors. This enables the stimulating light to be filtered from the phosphor luminescence.

The emission is typically stimulated with a laser diode of approximately 550nm to 560nm, while the photostimulated emission of both the GP and HR imaging plates is a narrow band of blue light at 400 nanometers.

Emission



CR System Classification

The CR System Classification, as defined in industry standards ASTM E2446 and EN 14784-1, is a function of many factors including exposure conditions, the CR reader hardware, and the imaging plates themselves. The classification is based on the basic spatial resolution (BSR) and the signal-to-noise ratio (SNR) as a function of exposure (dose). When used with the KODAK INDUSTREX ACR-2000 or ACR-2000i Digital Systems, or other ACR-based systems, both the GP and HR imaging plates are capable of achieving the highest system classes, as shown in the tables below.

Classification of KODAK INDUSTREX ACR-2000 / ACR-2000i Digital System with KODAK INDUSTREX Flex GP Digital Imaging Plate SO-170

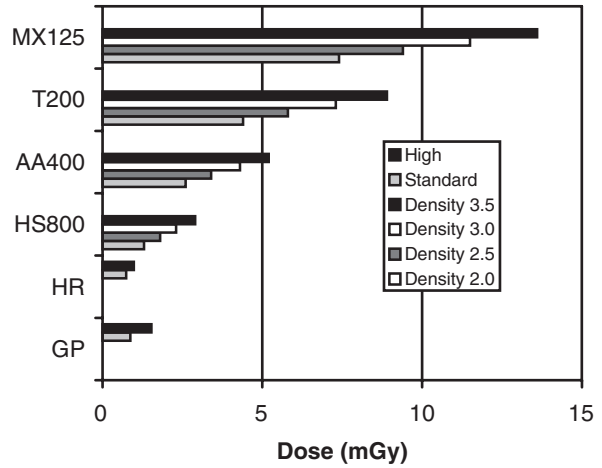
ASTM System Class ASTM E 2446	CEN System Class EN 14784-1	Minimum SNR	Minimum (INDUSTREX) Pixel Intensity	ISO/CEN Speed	System Parameters
ASTM IP Special/100	IP 1/100	130	2139	640	High dose setting, Gain 128 Resolution 365 PPI BSR = 100 microns Exposure per ASTM E 2446
	IP 2/100	117	1938	1000	
	IP 3/100	78	1337	4000	
ASTM IP I/100	IP 4/100	65	1136	6300	
ASTM IP II/100	IP 5/100	52	936	10000	
ASTM IP III/100	IP 6/100	43	797	12500	

Classification of KODAK INDUSTREX ACR-2000 / ACR-2000i Digital System with KODAK INDUSTREX Flex HR Digital Imaging Plate 2174

ASTM System Class ASTM E 2446	CEN System Class EN 14784-1	Minimum SNR	Minimum (INDUSTREX) Pixel Intensity	ISO/CEN Speed	System Parameters
ASTM IP Special/100	IP 1/100	130	1770	1000	High dose setting, Gain 128 Resolution 365 PPI BSR = 100 microns Exposure per ASTM E 2446
	IP 2/100	117	1632	1250	
	IP 3/100	78	1218	3200	
ASTM IP I/100	IP 4/100	65	1080	5000	
ASTM IP II/100	IP 5/100	52	842	6300	
ASTM IP III/100	IP 6/100	43	846	8000	

Because of the relatively high ISO/CEN speeds of INDUSTREX Flex GP and HR Digital Imaging Plates, they require far less exposure than a corresponding industrial x-ray film. To the right is an illustration of the relatively low exposure (dose) required for the GP and HR imaging plates compared to the family of INDUSTREX films. Note that the speed of the HR plate is actually higher than that of the GP plate, as it is based on the exposure required to reach a SNR corresponding to the highest CR system class.

Relative Speeds of INDUSTREX Digital Imaging Plates* vs. INDUSTREX FIlms Used in Similar Applications**



* Flex GP and Flex HR Imaging Plates: dose required to reach highest ASTM and CEN System Classes at standard and high dose settings on ACR-2000/2000i readers.

** INDUSTREX Films: dose required to reach indicated densities in automatic, 8 minute, 26° C (79° F) processing cycle.

DISPOSAL

These plates, when discarded, are a hazardous waste (EPA waste code D005) under the Resource Conservation and Recovery Act (RCRA) due to the leachability of barium. An Article Information Sheet (AIS) for each plate can be found in the Health, Safety, and Environment section at www.kodak/com/go/ndtproducts. Hazardous waste must be managed and transported in accordance with federal, state, and local regulations. Please contact your local authorities for more information.

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