TI2497 Issued 11-99

KODAK Black-and-White Print Film 2302 / ESTAR Base

1) Description

KODAK Black-and-White Print Film 2302 / ESTAR Base is a low speed, high-resolution print film. This blue-sensitive black-and-white film is designed for general release printing. It is also useful for making both positive and negative titles and RGB separations from electron beam recorders. 2302 is coated on a proprietary ESTAR base which offers improved physical performance throughout the entire motion picture system.

Please refer to Section 6 for processing information on 2302

Laboratory benefits include:

- Polyester base—greater tear strength, durability, dimensional stability, and archival keeping.
- Process surviving anti-static layer—protection from static marks prior to printing.
- Process surviving anti-static layer—reduced dirt attraction to processed prints and static protection prior to processing.
- Process surviving lubricant—better transport characteristics for processed film.
- Patented antihalation dye technology—superior halation protection (no fringes in titles).

Benefits for distributors and exhibitors include:

- Polyester base, process surviving anti-static layer, scratch resistant backing layer, and process surviving lubricant—cleaner, more durable prints.
- Patented anti-halation dye technology—no fringes in titles and sharper projected image.
- Improved transport throughout the entire system.

Benefits for the archivist include:

- Polyester base—better archival keeping properties than current 5302.

2) Base

KODAK Black-and-White Print Film 2302 / ESTAR Base is coated on thin 0.0048 inch (120 micrometers) ESTAR (polyethylene terephthalate) base, featuring a proprietary electrically conductive anti-static layer, a scratch resistant backing layer, and a process surviving backside lubricant which remains with the film after processing, eliminating the electrostatic attraction of dirt particles to the processed print even at very low relative humidity. A very thick polymeric backing layer coated on top of the anti-static layer provides improved resistance to backside scratches, cinch marks, and abrasion of both raw stock and processed film. The backing layer also contains a process surviving lubricant and matte to optimize winding and transport characteristics.

3) Photographic Properties

Sensitometry

SO-302 sensitometry (characteristic curve) is different than 5302/SO-434. The gamma is slightly lower resulting from an efficient anti-halation layer which reduces light scatter. This antihalation layer is located under the emulsion layers, using a patented solid particle dye that decolorizes and is removed during processing. This dye offers superior protection against halation (exposure by light reflected back from the support surfaces), minimizing fringing in very high contrast scenes such as white titles or night scenes with automobile headlights. In addition to cleaner titles and credits, the film has improved image sharpness.

As a result of the sensitometric changes in 2302, process development time and printer setups may need to be modified slightly to achieve a "look" that is similar to 5302/SO-434. Since 2302 maintains the same degree of process sensitivity as current product, a desired "look" is easily achieved.

4) Darkroom Recommendations

Use a KODAK OA Safelight Filter / green-yellow, with a 15-watt bulb, no closer to the film than 1.2 meters (4 feet).

5) Storage of Raw Stock

Film is perishable and changes with prolonged storage or adverse storage conditions. After packaging, Kodak stores print film raw stock at 13°C (55°F) or lower. Transportation and distribution warehousing are refrigerated. Print film is not adversely affected by short-term storage at room temperatures (less than 25°C/77°F). For extended-term storage, store at -18°C (0°F) or lower. Avoid unconditioned storage, as sensitometric and physical changes occur more rapidly at high temperatures, and may degrade film quality. If refrigerated storage is used, allow the sealed can or foil bag to equilibrate to room temperature before opening to avoid moisture condensation. Unused raw stock should be rebagged and put into sealed film cans before being put back in refrigerated storage. Process exposed film promptly.

6) Printer Conditions

Negative film of average density will produce satisfactory prints if run on a continuous additive printer (such as the Bell & Howell Model C) run at 180 ft/min., equipped with a 1200-watt lamp operated at 85 volts and a 1.0 neutral density filter in the beam for 35 mm. Typical starting-point printer settings are as follows:

Beam	Trim Setting	Tape Setting
Red	17	21
Green	17	21
Blue	17	21

7) Processing

KODAK Black-and-White Print Film 2302 / ESTAR Base may be processed along with other D97 processed black-and-white films using Kodak recommended D97 Process. No change in process sequence is required. Complete process specifications, formulae, and procedures are contained in KODAK Publication No. H-24-15, "Manual for Processing EASTMAN Motion Picture Films, Module 15". The processing times may require modification depending upon the process.

Notice: Observe precautionary information on product labels and on the Material Safety Data Sheets.

Processing Step	Temperature	Time	Replenishment Rate (mL per 100 ft)
			35 mm
KODAK Developer D-97 [1]	70°F (21°C)	—[2]	650 (D-97R)
Stop Rinse [3]	70°F (21°C)	50 sec	12,000
KODAK Fixing Bath F-5 [1]	70°F (21°C)	6 min	600
Wash (counter-current)	70°F (21°C)	10 min	12,000
Dry	95 °F(35 C)	—[4]	

[1] Agitation in the developer and fixing bath should be by recirculation through submerged spray jets that impinge on the film strands.

[2] Develop to recommended control gamma of 2.4 to 2.6 (Status A). Calculation to obtain control gamma is Dmin + 0.95 density to + 0.50 log E.

[3] Countercurrent flow of fixer-laden water overflow from the wash tank, pH about 6.

[4] Many factors affect the drying: air temperature, relative humidity (RH); volume, rate and distribution of the airflow; final squeegeeing, etc.

SO-302 has a slightly higher wet load. Since processor dryer conditions vary, please monitor the film as it goes through the dryer the first time to assure that the film is being adequately dried. Adjust drier accordingly.

In a conventional convection-type drying cabinet with air at about 95°F (35°C) and 40 to 50 percent RH, drying will take 15 to 20 minutes. With an impingement type drying cabinet (with a higher temperature and lower RH), drying time is greatly reduced. With either type of dryer, the film should be dry without tackiness 1/2 to 2/3 of the way through. Upon cooling to room temperature after leaving the dryer, the film should be in equilibrium with the room air at approximately 50 percent RH.

Print film occasionally exhibits "static cling" during projection, where several laps of the film may stick together as they feed to the control arm on a platter, causing erratic platter behavior and possible film jam or "brain wrap". This behavior is affected by the design of the platter, the ambient conditions in the projection room, the winding orientation and curl of the film, and a variety of other factors. Kodak recommends maintaining a relative humidity of 50-60 percent RH in the projection room.

Staticide 3000G, a process additive available from ACL Staticide, may be added to the final wash (tank and replenisher) of the D97 Process at a concentration of 0.01% (0.1 ml per liter) to reduce the incidence of "static cling". Kodak testing and trade experience have shown that films having a process-surviving conductive anti-static backings will be much less

prone to "static cling" when processed with Staticide process additive. Other similar quaternary ammonium compounds may also be effective as final rinse anti-static additives, but have not been certified for use in the D97 Process.

Staticide 3000G is available from ACL Staticide, 1960 East Devon Avenue, Elk Grove Village, Illinois 60007, USA (Telephone: 847-981-9212, Fax: 847-981-9278), who can supply the chemical through distributors worldwide.

8) Lubrication

The scratch-resistant polymeric backing offers improved resistance to backside abrasions and scratching. Process-surviving lubricants are incorporated into both the backing and the top layer (SOC) of the emulsion side, to optimize transport characteristics and improve abrasion resistance. However, post-process lubrication of prints is still recommended to optimize print performance, reduce "dusting", and extend print life. Edge-waxing is especially important for reducing the wear and extending the life of digital soundtrack information printed on 35 mm film in areas of severe projector abrasion, such as along the edges or between the perforations. The additional lubrication helps reduce abrasion of the film, much as wax protects the surface of fine furniture or an automobile. The reduced friction afforded by proper lubrication also reduces perforation wear, improves steadiness, and results in quieter transport of the film through the projector. Edge waxing is specified by SMPTE Recommended Practice RP 151, "Lubrication of 35 mm Motion-Picture Prints for Projection" and specified in KODAK Publication No. H24-02, "Manual for Processing EASTMAN Color Films, Module 2, Equipment and Procedures".

The use of oils, or other non-volatile materials (e.g., WD-40) as film lubricants is NOT recommended. These materials may cause the film convolutions to stick together, or make rolls difficult to handle. Oil deposits may be visible as mottle, or hold dirt particles on the film.

9) Sound Track Printing

ANALOG—A variable-area positive silver sound track can be printed on 2302 Film from a negative sound record on KODAK Panchromatic Sound Recording Film 2374, KODAK Panchromatic Sound Recording Film 2376 and EASTMAN EXR Sound Recording Film 2378. The optimum variable-area sound track density for the print lies between 1.0 and 1.8 measured visually. This print density is chosen to provide a good compromise between signal to noise ratio and frequency response. The densities of the sound-track negatives required to produce optimal print densities are determined by using recognized cross-modulation test procedures.

KODAK recommends using an infrared (IR) reader for reading analog sound track.

DIGITAL (e.g. Dolby Digital and SONY SDDS)—Each system vendor provides exposure recommendations and control procedures for optimum performance.

Kodak digital optimization tests for Dolby Digital indicate that the print density should fall between 1.0 and 1.7.

Kodak digital optimization tests for SONY SDDS indicate that the print density should fall between 0.5 and 2.0.

Order SO-302 without edge code (print) if SDDS is being recorded.

10) Storage of Processed Prints

KODAK Black-and-White Print Film 2302 / ESTAR Base has excellent image stability characteristics, very similar to 5302/ SO-434 Film. Store processed film according to the recommendations in ANSI/PIMA IT9.11-1998: for medium-term storage (minimum of ten years), store at 25°C (77°F) or lower at a relative humidity of 20 to 50 percent; for extended-term storage (for preservation of material having permanent value), store at 21°C (70°F) or lower at a relative humidity of 20 to 30 percent. For active use, store at 25°C (77°F) or lower, at a relative humidity of 50 +/- 5 percent; this relates to optimized film handling rather than preservation. Static, dust-attraction and curl-related problems are generally minimized at the higher relative humidity. After usage, the film should be returned to the appropriate medium- or long-term storage conditions as soon as possible.

For more information about medium- and extended-term storage, see ANSI/PIMA IT9.11-1998, SMPTE RP131-1998, and KODAK Publications No. H-1, "KODAK Motion Picture Film", and No. H-23, "The Book of Film Care".

11) Image Structure

The modulation-transfer curves and the diffuse rms granularity data were generated from samples of SO-302 Film exposed with tungsten light and processed as recommended in KODAK Developer D-97 at 70°F (21°C) to the recommended control gamma. For more information on image-structure characteristics, see KODAK Publication No. H-1, "KODAK Motion Picture Film".

12) Projection

KODAK Black-and-White Print Film 2302 / ESTAR Base offers superior performance during projection. The permanent humidity-independent anti-stat greatly reduces static charging of the film and annoying "shocks" and static discharge, even at the high transport speeds during rewinding and make-up onto platters. The anti-stat also helps reduce static attraction of dirt to the processed film during projection, resulting in longer print runs with less build-up of black dirt and cinch marks.

Process-surviving lubricants are incorporated into both the backing and the top layer (SOC) of the emulsion side to optimize transport characteristics and improve abrasion resistance. However, post-process lubrication is still recommended to achieve optimum print life and performance for extended runs and special-venue applications. Contact your Kodak technical representative for recommendations.

Although prints made on 2302 Film will perform well under a wide range of ambient conditions, projection facilities should try to maintain constant levels of temperature and humidity. Recommended conditions are 20 to 25°C (68 to 77°F), and 50 to 60 percent relative humidity. For optimum projection focus performance, processed prints should always be wound emulsion-in, in accordance with SMPTE Recommended Practice RP-39-1993. Normal 35 mm and 70 mm print orientation is with the emulsion-side toward the lamp, and the base-side toward the projection lens, per standard SMPTE 194-1991.

Because of the high tensile strength and tear resistance of polyester film, Kodak has always recommended the use of tension-sensor fail-safes (not just film-break detectors) to protect equipment and reduce film damage in the event of tension build-up due to a mis-thread or projector malfunction. A variety of fail-safes are available from theatre equipment dealers.

13) Splicing

KODAK Black-and-White Print Film 2302 / ESTAR Base is manufactured on ESTAR base. Since ESTAR base is impervious to most solvents, solvent-based "cement" splicing CANNOT be used.

Thermal-weld ultrasonic splicers may be used on both raw stock and processed film. After cutting, the two pieces of film are overlapped slightly and brought into contact with a horn that focuses acoustic energy from an ultrasonic transducer to the film overlap. A pressure roller brings the film into intimate contact with the horn, causing localized heating and fusion of the polyester support, creating a strong weld and reliable splice. Key splicing parameters are the acoustic frequency and power output, roller pressure, and roller transit time. Although the emulsion and backside layers become part of the polyester weld, there is usually no need to scrape them off prior to ultrasonic splicing.

Adhesive tape splicing is often used in splicing rolls of printed raw stock prior to processing. Clear adhesive splicing tape is the most frequently used method of splicing processed prints in theaters, producing reliable splices on relatively inexpensive splicers that are simple to use. Current splicing procedures using high-quality splicing tapes will work equally well on 5302, SO-434 and 2302.

14) Available Roll Lengths

For information on available roll lengths and formats of KODAK Black-and-White Print Film SO-302 / ESTAR Base contact your Kodak Professional Motion Imaging sales representative.

For prints released with SDDS, please specify on your order NO edge code (print).

15) Graphs[1]

Data for each of the following characteristics was obtained for film processed in Process D97:

MTF

A) (11-99)

Note: These photographic modulation-transfer values were determined by using a method similar to the one described in ANSI Standard PH2.39-1977(R1992). The film was exposed with the specified illuminant to spatially varying sinusoidal test patterns having an aerial image modulation of a nominal 35 percent at the image plane, with processing as indicated. In most cases, the photographic modulation-transfer values are influenced by development-adjacency effects and are not equivalent to the true optical modulation-transfer curve of the emulsion layer in the particular photographic product.

Characteristic

B) (11-99)

Spectral Sensitivity

C) (11-99)

Gamma

D) (11-99)

Gamma is a measure of the film contrast. Gamma is the slope of the straight-line portion of the characteristic curve. Slope refers to the steepness of a straight line determined by taking the change in density from two points on the curve and dividing that by the change in log exposure for the same two points. The formula for calculating gamma is *D-min + 0.95 density to + 0.50 LogE.*

Net Fog

E) KODAK Developer D-97 (HQ) at 70°F (8-99)

The minimum density or smallest amount of density in a film is known as D-min; it is the density of the clear ESTAR base plus a little bit of "fog" in the emulsion. In the graph identified as TI2497E, *"NET FOG" is defined as D-min minus base density.* The graph shows emulsion "fog" in density versus increasing development times through the hydroquinone (HQ) based D97 Developer.

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[1]NOTICE: The sensitometric curves and data in this publication represent product tested under the conditions of exposure and processing specified. They are representative of production coatings, and therefore do not apply to a particular box or roll of photographic material. They do not represent standards or specifications that must be met by Eastman Kodak Company. The company reserves the right to change and improve product characteristics at any time.

Net Fog

F) KODAK Developer D-97 (AA) at 70°F (10-99)

The minimum density or smallest amount of density a film has is known as the D-min; it is the density of the clear ESTAR base plus a little bit of "fog" in the emulsion. In the graph identified as TI2497F, *"NET FOG" is defined as D-min minus base density.* The graph shows emulsion "fog" in density versus increasing development times through the ascorbic acid (AA) based D97 Developer.

Note: The Kodak materials described in this publication for use with KODAK Black-and-White Print Film 2302 / ESTAR Base are available from dealers who supply Kodak products. You can use other materials, but you may not obtain similar results.

rms Granularity

G) (11-99)

The contents of this publication are subject to change without notice.

Professional Motion Imaging
EASTMAN KODAK COMPANY - Rochester, NY 14650