since 1921

X RAY FILMS FOR NDT

www.foma.eu

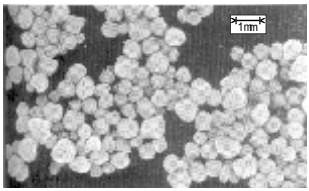
FILMS FOR INDUSTRIAL RADIOGRAPHY

Tradition and present

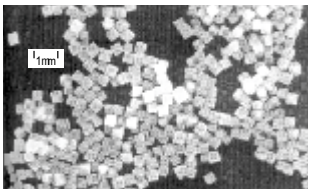
In 1986, FOMA BOHEMIA spol. s r.o. (Ltd.) began manufacturing of new generation films for non-destructive material testing (NDT) - INDUX and FOMADUX. The manufacturing of film in two speed classes, R4 and R7, began by implementing changes in the production formula of the original NDT film, which had been manufactured since the sixties.

In 1995, a radical modification of the technological process took place. The utilization of controlled precipitation resulted in uniform cubic crystals (grains) of silver halides with a narrow distribution of sizes. The composition of emulsion microcrystals and their narrow size-distribution curve has become prerequisite for high speed and contrast of the film, its high resolving power and low graininess.

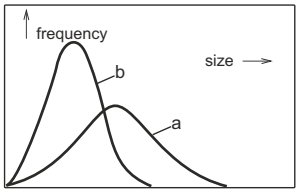
Simultaneously the processing of the industrial X-ray films has been speeded up. The controlled precipitation has become the basic precondition for the stable quality of INDUX line films.
Originally manufactured films R4 and R7 speed class were completed by R2, R3, R5 and R8 speed classes to become an integral line.



a) silver halide microcrystals in the previous emulsion



b) silver halide microcrystals in the new-type emulsion



c) comparison of size-distribution of microcrystals frequency size

Programme of industrial radiography (FOMA NDT SYSTEM)

The FOMA NDT SYSTEM includes complete speed series of X-ray films INDUX and FOMADUX. Processing chemicals FOMADUX for manual and automatic processing and additional accessories. The wide range of speed classes enables the user to find a film suitable for practically any type of radiographic work, using X-ray appliances and radionuclides.

Specification and use of INDUX and FOMADUX

INDUX R4	A very fine-grain, high-contrast, medium-speed film designed for the detection of small critical defects.	Application: Light metal and steel castings, aircraft industry, nuclear energetics.
INDUX R5	A fine-grain, high-contrast, standard-speed film. A standard film for most applications.	Inspection of welds and castings, general engineering, shipbuilding industry.
INDUX R7	A fine-grain, high-contrast, high-speed film for most standard applications.	Inspection of welds and castings, general engineering, building industry.

Image quality and classification of film system

NDT films suitable for a specific type of application/work are subdivided by the EN ISO 11699-1 Standard according to minimally guaranteed parameters into six groups, denominated C1 to C6. To include a film into a group, four parameters specifying ability of the film to differenciate details in the radiograph are relevant:

– local gradient at optical density D_{min} +2
– local gradient at optical density D_{min} +4
– film granularity at optical density D_{min} +2
– system parameter G/s, which is defined as the ratio of gradient and granularity at optical density D_{min} +2, and represents the useful-to-disturbing ratio.

Requirements of the EN 11699-1 Standard on a radiographic film system

Class according to EN 11699-1	G $D_{min.}$+2	G $D_{min.}$+4	s	G/s
C1	ł 4,5	ł 7,5	Ł 0,018	ł 300
C2	ł 4,3	ł 7,4	Ł 0,020	ł 230
C3	ł 4,1	ł 6,8	Ł 0,023	ł 180
C4	ł 4,1	ł 6,8	Ł 0,028	ł 150
C5	ł 3,8	ł 6,4	Ł 0,032	ł 120
C6	ł 3,5	ł 5,0	Ł 0,039	ł 100

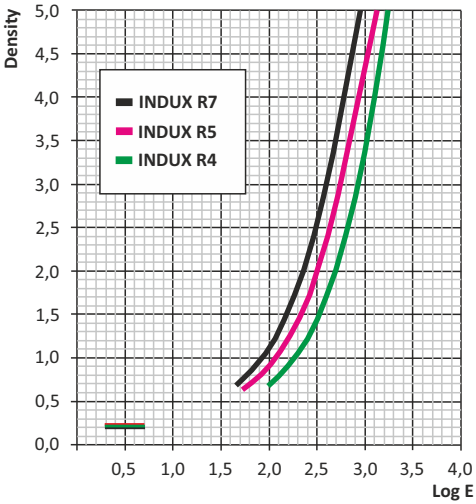
Guaranteed parameters of INDUX line films according to EN 11699-1 and other corresponding Standards

Film type / Characteristic	INDUX R4	INDUX R5	INDUX R7
EN ISO 11699-1 class	C3	C4	C5
ASTM E1815 class	I.	I.	II.
JIS K 7627	T2	T2	T3

Characteristics curves of INDUX line films

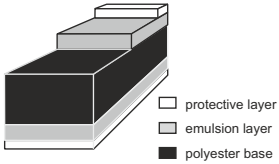
Exposure parameters
X-rays 200 kV
Cu 8 mm
Pb screens 0,025 mm

Processing parameters
FOMADUX LP-D developer
developer immersion time 2 minutes at 28°C
Colenta INDX 432.0b



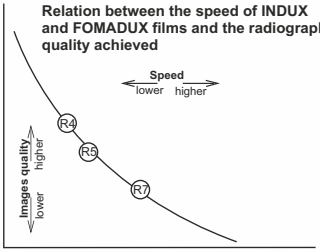
Film composition

INDUX and FOMADUX films are manufactured by coating of a light-sensitive silver bromo-iodide emulsion on both sides of a bluish polyester base, that is 0,175 mm thick. The emulsion layers are protected against mechanical impacts by effective protective gelatine layers featuring anti-static properties. The sensitivity of film to visible light is reduced by means of a desensitization dye being added to the emulsion layers.



Optimum image quality

As it is applicable to photographic materials, the same applies to films for industrial radiography, the lower the film speed, the lower granularity, and the higher the resolving power. Therefore, the correct choice of film is important in view of exposure time, size of the inspected part , and required resolution of presented defects.



Packaging forms of INDUX and FOMADUX industrial X-ray films

- Daylight packaging (FOMAPAK) – one-sheet vacuum-sealed packaging with lead screens of 0,025 mm thickness; sizes: 6x10, 6x12, 6x16, 6x20, 6x24, 6x30, 6x40, 6x48, 10x10, 10x12, 10x16, 10x20, 10x24, 10x30, 10x40, 10x48, 18x24 and 30x40 cm. The vacuum-sealed packaging FOMAPAK ensures optimum contact of film surface with lead screens, simple handling, and is light-tight, air-tight and waterproof.
- Darkroom packaging (KB) – sizes: 6x24, 6x40, 6x48, 10x12, 10x20, 10x24, 10x40, 10x48, 10x72, 18x24, 24x30 and 30x40.
- FOMADUX ROLLFILM – a daylight roll film packaging sized 60, 70 or 100 mm x 90 m with lead screens 0,025 mm thick or without lead screens as bare rollfilm (BLR) of length of 150 m, wound on a paper core and packed in a cardboard dispenser box.
- Packaging forms with lead screens are suitable for use with voltages above 100 kV.
- Packaging forms without lead screens are suitable for use with voltages below 100 kV.

Sensitivity to safelight illumination

General sensitivity to visible light has been reduced in INDUX and FOMADUX films by adding a filter dye into the emulsion layers. The reduction of sensitivity to visible light does not influence the sensitivity to ionizing radiation. Therefore INDUX and FOMADUX films may be processed under brighter safelight illumination in darkroom. The danger of unwanted film fog is lower and the operator´s fatigue is limited.
The film is processed at yellow-orange safety illumination with wavelength of 590 nm. Length of exposure and a distance of the processed material from the illumination source should be tested.

Processing chemicals

INDUX and FOMADUX films are designed for manual and automatic processing with using FOMA chemicals. The liquid concentrates Fomadux LP-T developer and Fomadux Mix fixer is intended for manual processing. The chemicals intended for automatic processing are supplied as liquid concentrates Fomadux LP-D developer and hardening fixer Fomadux Mix.

Liquid concetrate of Fomadux LP- ECO, Fomadux Fix Eco are intended for both automatic and manual proccessing of industrial X-ray films.

The pre-exposed test film Fomatest SC 981 enables to monitor the stability of processing procedure as rendered by EN 11699. This test discovers any deviation in the quality of processing in comparison with the standard conditions and helps to determine the replacement time for the baths and make the processing procedure more cost-effective.

ELEKTROTECHNICKÝ ZKUŠEBNÍ ÚSTAV

ELECTROTECHNICAL TESTING INSTITUTE - CZECH REPUBLIC
ELEKTROTECHNISCHE PRÜFANSTALT TSCHECHISCHE REPUBLIK
INSTITUT ELECTROTECHNIQUE D'ESSAIS REPUBLIQUE TCHEQUE
ЭЛЕКТРОТЕХНИЧЕСКИЙ ИСПЫТАТЕЛЬНЫЙ ИНСТИТУТ - ЧЕШСКАЯ РЕСПУБЛИКА

Pod lisem 129/2, 171 02 Praha 8 Troja

Elektrotechnický zkušební ústav, s. p., Certification Body No. 3004 for certification of management systems, accredited by the Czech Accreditation Institute, o.p.s. in accordance with ČSN EN ISO/IEC 17021-1, grants the

CERTIFICATE

No.: 8210085

for the Quality Management System in accordance with

EN ISO 9001:2015

to the Firm

FOMA BOHEMIA spol. s r.o.

Jana Krušinky 1737/6, 500 02 Hradec Králové - Pražské Předměstí, Czech Republic

in localities:

because it ascertained that the Quality Management System of the Firm in localities and processes:

Development, production and sale of imaging and recording materials (photographic films and papers, NDT X-ray films, graphic arts and technical films and papers, recording materials, processing baths).

complies with all requirements of the above mentioned Standard documented by the Report No.: 211454-02 of 13.09.2021

First certification granted: 14.09.2021
The validity of the Certificate is limited till: 13.09.2024

The Certified Organization is subject to annual check-ups carried out by the Certification Body. Any change within the organization concerning the certification shall be followed up and approved by the Electrotechnical Testing Institute. The validity of this Certificate may be suspended or cancelled in the event of non-compliance with the Standard on the basis of which the Certificate was issued.

Certification decision: 14.09.2021
Date of issue: 14.09.2021

Ing. Radek Teuff
Head of Certification Body

elektrotechnický zkušební ústav
ezú
Pod lisem 129/2, 171 02 Praha 8 - Troja
Stamp

211454-02

DECLARATION OF CONFORMITY

Manufacturer:	**FOMA BOHEMIA Ltd.** **Jana Krušinky 1737/6** **500 02 Hradec Králové – Pražské Předměstí** **Czech Republic**
Products:	**INDUX R4, INDUX R5, INDUX R7**
Product type:	industrial radiography films.
Identification:	batch number on a packaging unit.
Conformity with technical standards:	ISO 5655:2000 (dimensions), ISO 7004:2002 (sensitometry), EN ISO 11699-1:2011 (classification of film systems), ASTM E1815 rev.8 (classification of film systems), JIS K 7627:1998 (classification of film systems), standard of manufacturer PND 6-035 (dimensions, method of testing, technical requirements).
Standards Applied:	EN ISO 9001:2015.

Following the provisions of law of Czech Republic No. 22/1997 Coll., FOMA BOHEMIA Ltd. confirms that quality and parameters of the above listed products fulfill all relevant requirements for the product and correspond with present conditions of scientific and technical knowledge.

Manufacturer ensures, according to quality management system in compliance with EN ISO 9001:2015, the conformity of all products on the market with basic rules and requirements on the safety of the product. Certificate for the Quality System issued by Electrotechnical Testing Institute, Czech Republic, Certificate Body No. 3004, Certificate No. 8180109.

Jindřich Puhlovský, Dipl. Ing.
CEO

Hradec Králové, April 15th 2019

FOMA BOHEMIA spol. s r.o. Hradec Králové Czech Republic

INDUX R4, R5 and R7

INDUSTRIAL X-RAY FILMS

General information

INDUX R4, R5 and R7 are the industrial radiographic films intended for non-destructive material testing using X- or gamma radiation.

INDUX R4 is a medium-speed, high-contrast, extremely fine-grain film, corresponds with the class C3 classification according to EN ISO 11699-1 standard and according to ASTM E1815 standard with class I.

INDUX R5 is a standard-speed, high-contrast, very fine-grain film, corresponds with the class C4 classification according to EN ISO 11699-1 standard and according to ASTM E1815 standard with class I.

INDUX R7 is a high-speed, high contrast, fine-grain film, corresponds with the class C5 classification according to EN ISO 11699-1 standard and according to ASTM E1815 standard with class II.

All films are suitable for radiography with or without lead screens and meet requirements for the most standard applications.

Applications

INDUX R4 should be used at low voltages for the radiography of thin-to-medium thick-walled light metal parts/ products. At higher voltages the film is suitable for the testing of thick-walled light metal or thin-walled steel parts/products. With high-energy gamma rays the film is suitable for the radiography of thick-walled dense metal parts/products.

INDUX R 5 is suitable for the radiography of medium-walled steel or thick-walled light metal parts/products.

INDUX R7 should be used at low voltages for the radiography of medium-walled light metal or thin-walled steel parts/products. At higher voltages the film is suitable for the testing of thick-walled light metal or medium-walled steel parts/products. With high-energy gamma rays the film is suitable for the radiography of thicker-to-thickest dense metal parts/products.

Packaging forms

daylight packaging (FOMAPAK) – one-sheet vacuum-sealed packaging with lead screens of 0,025 mm thickness

Sizes: 6x10, 6x12, 6x16, 6x20, 6x24, 6x30, 6x40, 6x48, 10x10, 10x12, 10x16, 10x20, 10x24, 10x30, 10x40, 10x48, 18x24, 30x40 cm in boxes and other sizes according to an agreement with manufacturer.

The vacuum-sealed packaging FOMAPAK ensures optimum contact of film surface with lead screens, simple handling, and is light-tight, air-tight and waterproof.

darkroom packaging (KB)

Sizes: 6x24, 6x40, 6x48, 10x12, 10x20, 10x24, 10x40, 10x48, 10x72, 18x24, 30x40 cm in boxes and other sizes according to an agreement with manufacturer.

Rollfilm packaging

– rollfilm with lead screen

– bare rollfilm (BLR)

for more details see the technical data sheet of ROLLFILM

Other sizes are subject to an agreement with the manufacturer.

Film base

INDUX R4, R5 nad R7 are manufactured on a dimensionally stable bluish polyester base of 0,175 mm thickness.

Screens

Screens-packed kinds (FOMAPAK) content lead screens 0,025 mm thick, backed by a paper of 70 - 90 g/sq. m of basis weight, on both film sides.

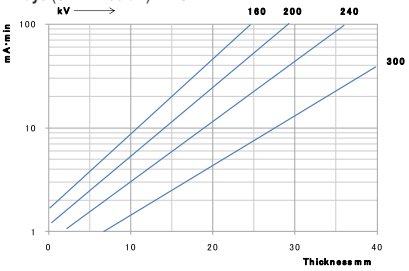
Darkroom illumination

The film is processed at yellow-orange safety illumination with wavelength of 590 nm. Length of exposure and a distance of the processed material from the illumination source should be tested.

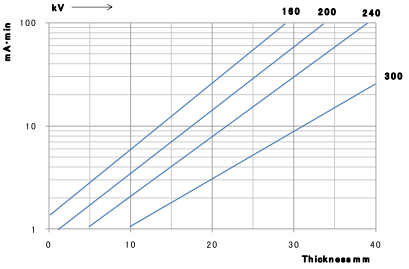
Exposure charts for steel

For optical density D=2, front and back lead screens 0,025 mm thick, automatic processing, FOMADUX LP-D Developer, 8 minute processing cycle at 28 °C (corresponds with 2 minutes of developing time).

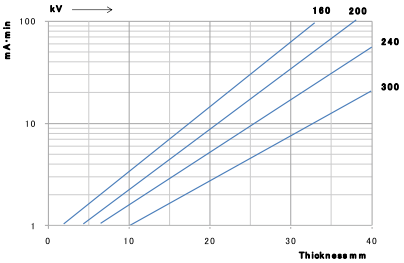
X-rays (SFD = 100 cm) **INDUX R4**



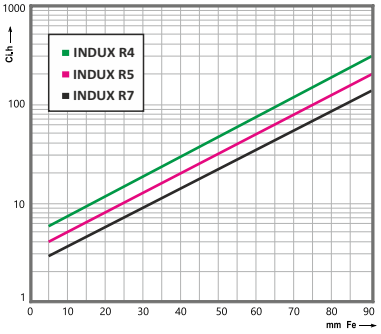
X-rays (SFD = 100 cm) **INDUX R5**



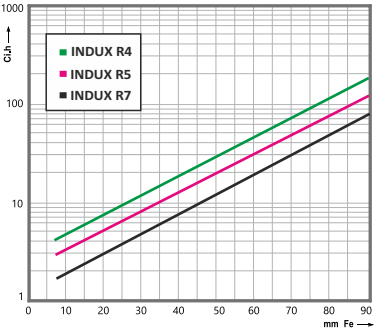
X-rays (SFD = 100 cm) **INDUX R7**



Gamma rays (Iridium 192)



Gamma rays (Cobalt 60)



Processing

INDUX R4, R5 and R7 are intended both for the manual and automatic processing.

Recommended chemicals for the manual processing:

FOMADUX LP-T Developer
(5 minutes of developing time at 20 °C, dilution 1 + 3)
FOMADUX FIX Rapid Fixer
FOTONAL Wetting Agent

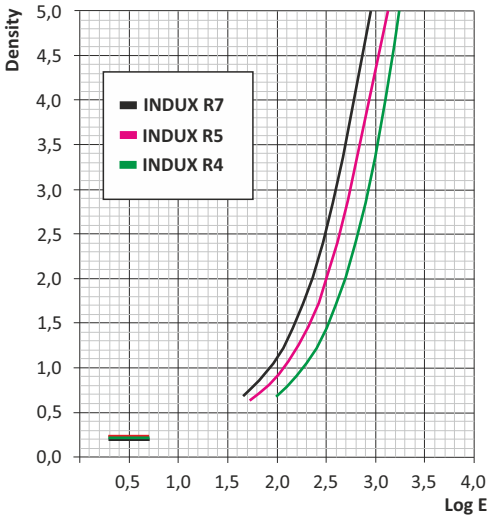
Recommended chemicals for the automatic processing:

FOMADUX LP-D Developer-Replenisher
(2 minutes of developing time at 28 °C)
FOMA LP-DS Developer Starter
FOMADUX FIX-Set Hardening Fixer – part A (fixer) + part B (hardener)

FOMA industrial X-ray films INDUX R4, R5 and R7 can also be processed in FOMA ECO chemie (FOMADUX LP-ECO, FOMADUX FIX – ECO) intended for both automatic and manual processing or in corresponding processing chemicals of other manufacturers.

Sensitometric characterist

220 kV/10 mA/8 mm Cu, automatic processing, FOMADUX LP-D Developer, 8 minutes of processing time at 28 °C (corresponds with 120 seconds developer immersion time)



Archiving of processed films

The manufacturer guarantees the archival permanence of minimum 50 years when complying with conditions following:
– films must be perfectly fixed and washed
– films must be stored at a relative humidity of 30 to 60% out of reach of harmful gases.

Storage of unexposed films

Unexposed films should be stored in the vertical position in the original packaging in a dry and cool place at a temperature of 10 to 25 °C and at a relative humidity of 40 to 60 %, out of reach of harmful gases and any ionizing radiation.

After opening the film bag, you must re-close it with two folds to secure it against opening. This prevents air moisture from entering the film bag.
Exposed films should be processed as soon as possible.

Information according to Article 33 of REACH: The product INDUX contains lead. This substance is included in the list of substances (for possible inclusion in Annex XIV). After handling, hygiene rules must be followed. More information at www.foma.cz

FOMADUX NDT ROLLFILM

TECHNICAL RADIOGRAPHIC FILMS

Characteristics of the produkt

FOMADUX NDT ROLLFILM is a special confectioning form of technical radiographic film with designed for non-destructive material testing with use of X- or gamma radiation. The special form of the packaging ensures the film´s resistance to light, humidity and greasy impurities.

The film is placed between two lead screens (thickness 0,025 mm) of the same dimensions; the screens are in perfect contact with the film; the film is packed in a light- and moisture-proof package – using the "edge to edge" system.

Usage

This kind of film is ideal solution for testing of long welds, e.g. welds of pipelines, pressure vessels or large parts in the aerospace industry, as the length can be chosen so that all the radiogram can be exposed to a single piece of film.

Packed film is wound onto a cardboard core and inserted in a transport box from which required length can be simply wound out. There is a print in the package axis on the side with folded edges; the print helps determine the film center and the film length. Contact of the film with a wet or impure object has no effect on the quality of the final radiograph.

How to remove the film from the package before processing: In a dark room hold the non-printed part of the package together with lead screen and the film with one hand and strip off the printed part of the package and the second lead screen with the other hand. Thus the film will be easily and quickly removed from the package.

Advantages of the rollfilm

The full length of the weld can be radiographed onto a single piece of film, i.e. we avoid using several film sheets for one weld. Required film length is determined according to the weld length. Further advantages:

- Using without cassettes
- Lightproof package is resistant to humidity and greasy impurities
- By single – usage films we avoid faults caused by their repeated usage
- Perfect contact between the film, lead screens and checked object ensures optimal quality of the image
- The "edge to edge" packing system allows optimal use of the film surface where there is not sufficient space for placing the film

Processing

FOMADUX is intended both for the manual and automatic processing.

Processing technology

Long films must be processed carefully. Generally it is possible to split the film after marking it and then to process it in the ordinary way or to fully exploit the advantages of the ROLLFILM package and to process it in full length.

a) When machine processing it is necessary to ensure precise leading (by a suitable jig) of the film into the axis of the developing machine.

b) In manual processing of ROLLFILM, prior to processing it is necessary to wind the film into a special wire coil that facilitates contact of the film with baths. It is also possible to split the film and to process it in parts in ordinary frames used for processing in a darkroom.

Recommended chemicals for the manual processing:

FOMADUX LP-T Developer
(5 minutes of developing time at 20 °C, 1 + 3)
FOMADUX FIX Rapid Fixer.
FOTONAL Wetting Agent

Recommended chemicals for the automatic processing:

FOMADUX LP-D Developer-Replenisher
(2 minutes of developing time at 28 °C)
FOMA LP-DS Developer Starter
FOMADUX FIX-Set Hardening Fixer – part A (fixer) + part B (hardener)

FOMADUX NDT ROLLFILM can also be processed in FOMA ECO chemie (FOMADUX LP-ECO, FOMADUX FIX-ECO) intended for both automatic and manual processing or in corresponding processing chemicals of other manufacturers.

Darkroom illumination

The film is processed at yellow-orange safety illumination with wavelength of 590 nm. Length of exposure and a distance of the processed material from the illumination source should be tested.

Archiving of processed films

The manufacturer guarantees the archival permanence of minimum 50 years when complying with conditions following:

– films must be perfectly fixed and washed
– films must be stored at a relative humidity of 30 to 60% out of reach of harmful gases.

Storage of unexposed films

Unexposed films should be stored in the original packaging in a cool, dry place (temperature ranging from 10 to 25 °C, relative humidity from 40 to 60 %), out of reach of harmful vapours, gases and ionizing radiations.

Exposed films should be processed as soon as possible.

Packaging

Rollfilm with Pb

– lightproof, humidity and greasy resistant
– sandwiched between two lead screens(thickness 0,025 mm)
– ·width 60, 70 or 100 mm in length up to 90 m

Rollfilm BLR

– bare rollfilm
– intended for using in cassettes
– width 60, 70 mm or 100 mm in length up to 150 m

By using and processing of the product Fomadux arise wastes, which is necessary to environmentally liquidate according to valid legislation.

Wastes:

– packaging foil : PET / AL / PE or PAPER / PE / PAPER
– Pb foil
– waste developers
– waste fixers

Information according to Article 33 of REACH: The product FOMADUX contains lead. This substance is included in the list of substances (for possible inclusion in Annex XIV). After handling, hygiene rules must be followed. More information at www.foma.cz

FOMATEST SC 981

Test strip for process monitoring intended for a complete range of speeds FOMA industrial X-ray films.

General information

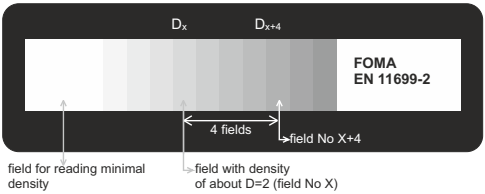
FOMATEST SC 981 is a pre-exposed test film strip designed for monitoring the quality of processing of INDUX radiogra-phic films, in accordance with the requirements for classified film systems to EN 11699-2 standard. It helps to monitor and optimize the processing system, to indicate the proper time for baths exchange or processor adjustment.

Packaging

Boxes of 25 sheets of daylight packaging: test strips are exposed on INDUX film, size 6 x 24cm, and supplied as one-sheet, vacuum – sealed, lead screen containing FOMAPAK packages.

Test film exposure

To make a FOMATEST SC 981 test strips, a control pattern is X-ray exposed at INDUX film. The test pattern consists of 10 fields with stepwise increasing exposure, completed by an area for minimum density reading and a space for sample identification data.



Application

1. Proof of standard processing according to EN 11699-2

   Classification of a film system into C1–C6 classes according to EN 11699-1 anticipates a standard processing quality. If a proof should be presented to a customer that a given film series has been classified correctly according to EN 11699-1 by an NDT workstation, it is necessary to check the processing quality by Fomatest SC 981 before and after the series. This test allows for measuring and evaluation of minimum density D_{min}, speed index S_X and contrast index C_X. If these sensitometric characteristics before and after processing of the series keep within the tolerated limits, the whole series is considered as satisfactory.

2. Control and diagnostics of processing .

FOMATEST SC 981 test strips are processed in regular intervals in a given processing system. Values of minimum density, speed index and gradient index are evaluated from the test strip by means of a densitometer. As reference data, the test results are used that were measured and recorded at the beginning of the whole series, usually in fresh processing solutions. During regular monitoring of the process, the measured test strip speed and contrast index should not exceed the tolerable deviations from the reference data. In a chart, monitored values are plotted against time. If all parameters are within the tolerated limits, the process is considered satisfactory. More detailed instructions for use are attached.

Darkroom illumination

S.C. 981 test strips are handled and processed in the same way as other films of INDUX series, i.e. at yellow safety illumination with wavelength of 590 nm. The distance of the processed material from the illumination source should be tested.

Processing

Test strips are designed for monitoring and control of any process used by a customer. Processing parameters are those commonly used by a customer, usually as recommended by the processing baths manufacturer. Processing based on other than FOMADUX baths may be also monitored by SC 981 test strips.

Storage

Unprocessed tests should be stored in the original packaging at the temperature not exceeding 25 °C, out of reach of harmful fumes and ionizing radiation.

Life time of unprocessed tests is 6 months.

Information according to Article 33 of REACH: The product INDUX contains lead. This substance is included in the list of substances (for possible inclusion in Annex XIV). After handling, hygiene rules must be followed. More information at www.foma.cz

FOMATEST THIO

THE KIT FOR CHECKING STABILITY OF PROCESSED INDUSTRIAL X-RAY FILMS

General information

FOMATEST THIO is a kit for a simple check of stability of processed X-ray films INDUX in terms of their ability to be archived. By means of the test kit inadequate fixing and washing processing of the film, whick makes the stability of the exposed image and the service life of the film shorter may be determined immediately.

The FOMATEST THIO kit is supplied in a box containing a small bottle with 30 ml of FOMATEST THIO, a dropper, an etalon strip, application instructions, and a package of paper filters.

Testing

Selection of the test area

The test is done on a completely processed and dry radiogram, where an absolutely clear and unexposed spot of about 1 square cm is selected (which is not part of the image, because the chemicals leave yellowish coloration). If there is no such spot on the film, the test may be performed on an unexposed film that was processed under identical conditions as the tested radiogram.

The basic test

The dropper is held about 1 to 2 cm above the tested zone of the film and one drop of FOMATEST THIO is released without the dropper touching the surface. The chemical reacts within 2 minutes plus minus 15 sec. Using a small piece of the filter paper the drop is absorbed carefully, again without touching the tested area of the film at all. The remaining fluid is removed by pressing finger lightly on the filter paper. The emulsion must not be damaged by the filter paper. The tested zone is dried by airflow. The described procedure is repeated on the reverse side of the film on the same place.

Test evaluation

The film must be protected against the effects of direct sunlight or other intense light sources. The film must be evaluated as soon as possible, not later than 30 minutes after the test. Delay in evaluation may result in incorrect evaluation, because the yellow spot on the tested area darkens gradually. The tested area is placed over a standard white background and compared visually with the enclosed etalon strip positioned next to the test spot. The etalon colour that is closest to the colour of the spot identifies the expected life of the radiograph.

Colour grades of the etalon correspond to values in the following table:

Color grade	Content of thio-sulphate (S_2O_3)^{2}total – on both sides of the film (g/m^2)	Archivability in years Life expectancy (LE)[1/]
1. darkest	more than 0.35	not capable of being archived, find and correct error,requires additional processing[2/]
2. dark	max. 0.20	up to 10 years, average archivability LE = 10
3. light	max. 0.10	up to 100 years, long-term archivability, LE = 100
4. lightest	max. 0.04	permanent, archivability film, LE = 500

1/ LE according to ISO 18901:2010, for permanent archives LE is 500 years

2/ If the color of the test spot is more saturated than the darkest grade of the etalon, the quality of the fixer (pH and silver content) and the rinse water (amount of through-flow) must be checked and corrected for the application. Thereafter, the film must be fixed again in the fresh solution and rinsed again in running water. Older processed films may be fixed and rinsed again. For automatic processing the films may be placed in the fixing cell and drawn through the fixer and rinse, and dried. In manual processing the films are fixed for 2 minutes in a fresh fixer and rinsed for 10 to 15 minutes in running water. Finally, the FOMATEST THIO test is repeated.

Storage

The solution must be stored in a dry and cool, preferably dark place. The bottle must be closed tight after use. The color chips should be protected against contact with chemical solutions (alcohol, acetone, ethers, etc.).

Safety precautions

Avoid contact of FOMATEST THIO solution with the skin, clothing, and photographic materials. Should the skin or eyes come into contact with FOMATEST THIO, the affected spot should be rinsed with clear water immediately. The solution stains and the spots are difficult to remove.

FOMASTEP E-09

ETALON OF OPTICAL DENSITIES WITH THE PROTOCOL OF CALIBRATION

General information

FOMASTEP E-09 is etalon of optical densities for calibration of densitometers, intended for evaluating of processed NDT x-ray films. There are 9 fields of 10x15mm size with graduated optical densities on the etalon, which fully cover the range of optical densities D = 0 ~ 4,0.

Calibration and protocol of calibration

The parts of the etalon are practically measured data of optical density, which have been measured with the calibrated densitometer of proved connection to state etalon ČMI. These data are mentioned in the attached protocol of calibration, which confirms the connection of calibrating measuring instrument, the practically measured data and measurement uncertainty.

Application

FOMASTEP E-09 is being used for checking and calibration of working measuring instruments operating densitometers.

Packaging form

FOMASTEP E-09 is made out from polyester base and exposed using the light method. Etalon is in covering envelope from polyester and together with relevant protocol of calibration is inserted in labelled envelope (name of the producer, product name, and date of production).

Storage

Both opened and unopened product must be stored in a dry and air place at the temperature of 5 to 20°C and at a relative humidity of 30 to 50 %.

Warranty

Recommended usable life of etalon is 12 month from the date of measurement.

PERSONAL MONITORING FILM

FILMS FOR PERSONAL DOSIMETRY

General information

Foma PMF is a set of two films intended for personal dosimetry of gamma radiation, x-radiation and electrons:

Foma DF10 is a high speed film double coated on a blue coloured polyethylene terephthalate base.

Foma DF2 is a low speed (emergency) film.

The films are supplied in the 3 x 4 cm size (according to ISO 3665). One package contains 150 pieces of DF10+DF2 film sets packed in light-proof and moisture-proof packing.

The films are intended for use with dosimetric film holders. Depending on the processing method they can be used for measu-rement of personal dose equivalents of photon radiation in the energy span from 15 keV to 6 MeV in the range from 0.1 mSv to 2 Sv.

Darkroom light

Due to their high speed, the films should be processed under indirect red safelight (recommended filters Agfa R1 or R4) using a 25 watt bulb placed at a distance of at minimum 75 cm from the film.

Processing

Dosimetric Foma films can be processed using the powder x-ray developer Foma DP with Foma DP-R replenisher and rapid fixer Fomafix P with replenisher. Application of a mildly acidic stop bath is recommended between developing and fixing.

Film processing is performed at temperatures from 19 to 21 °C. Development time depends on developer concentration, temperature and on the intensity of solution exchange in the film vicinity. It must be determined experimentally. Typical values are between 5 and 7 minutes.

Packing

The film is supplied in the 3 x 4 cm size (according to ISO 3665). One package contains 150 pieces of two sheet moisture-proof packets from plasticized PVC.

Storage

The films should be stored at temperature up to 25°C and relative humidity not exceeding 60% outside the reach of the effects of ionising radiation and aggressive vapours. If the difference between temperature of storage and temperature of use is more than 15°C then films must be acclimated for min. 3 hours.

Dosimetric characteristics of the films and their optimisation

The basic dosimetric characteristic is the optical density versus ionising radiation dose curve of the film. As opposed to the visible radiation, this curve is linear with a dose from the lowest doses. If the films are to be used for personal dosimetry purposes, the lowest measurable dose should be approximately 0.1 mSv according to international recommendations ICRP 60 and ICRP 75. This can be achieved with the films Foma DF10 experimentally by an appropriate selection of developing conditions. The procedure is as follows. The set of personal monitoring films is exposed to gamma radiation (emitter Cs-137 or Co-60) with kerma in the air in the range from 0.1 mGy to ca. 40 mGy. These films are then developed together with films that were not exposed to the radiation (fog or background) in given equipment for a variety of time periods (approx. from 5 to 7 minutes).

The determination of the optimum development time is then based on the condition that for the high speed film DF10 the optical density of background (fog) increased by 4 σ of the background must correspond with kerma in the air lower than 0.1 mGy (read from the gamma radiation calibration curve).

Fig. 1 displays the calibration curve i.e. dependence of optical density on the ionising radiation dose for DF10 films and gamma radiation Cs-137 obtained under optimum processing performed in the National Personal Dosimetry Service (CSOD, s.r.o., Czech Republic).

The lowest measurable dose is 0.08 mSy (± 30 %) and the measurement uncertainty is better than ± 15 % for values higher than approx. 0.2 mSv. The requirements of the recommendations ICRP 60 and ICRP 75 are thus met by a considerable margin (uncertainty from -33 % to +50 % in annual dose limit). The corresponding curve for x-radiation with energy 49keV (approx. 70 kV + 0.5 mm Cu) is shown in fig. 2.

Calibration curves for emergency films Foma DF2 are shown in fig. 3 and 4 for gamma radiation and x-radiation with maximum efficiency (49 keV) respectively. These curves were obtained under developing conditions determined for high speed films Foma DF10 as optimum. It is evident from figs. 1 and 3 that the ranges of gamma radiation doses overlap with a considerable margin and the upper limit of the measuring range is above 1 Gy. If the developing time is reduced by 50%, it will be possible to use Foma DF2 films for measuring the doses up to at least 2 Gy. However, the lower limit of the measuring range will also be increased.

Energy dependence of Foma films is shown in fig. 5. As a result of this dependence the speed of DF10 is approximately 17x higher for x-radiation with energy 49 keV (ca 70 kV + 0.5 mm Cu). This fact is apparent from the comparison of fig. 1 and fig. 2 (or fig. 3 and fig. 4). For these reasons, in film dosimetry this energy dependence must be compensated for using some of the published methods. Filtration analysis method yields very good results in the whole energy span 15 keV 6MeV as it is also shown in fig. 5.

Fading, i.e. decrease in optical density with time after exposure to radiation, does not exceed 10% during 3 months in the case of films Foma DF10 provided that the ambient temperature is not higher than 30 °C and relative humidity does not exceed 60%. Fading can be compensated for by an appropriate selection of

All calibration curves and the progress of energy dependence (Fig. 1 to 5) were measured in the Czech National Personal Dosimetry Service (Celostátní služba osobní dozimetrie, CSOD s.r.o., Czech Republic) under the optimum processing conditions.

The stated calibration curves serve for the basic orientation as for the progress of the dependence of optical density on the radiation dose and as for the scope of the practical applicability of the films. As the resulting values may be influenced by the way of processing of the films and the technology of measuring of optical densities, we recommend verifying the calibration under the conditions corresponding to the practical application of the films.

*Note: The classification according to the older ISO 1757:1996 standard is "**ISO 1757-3-W-2**" (the standard was cancelled on 10 May 2011).*

Fig. 1 Dependence of the optical density on gamma radiation dose for the film FOMA DF10

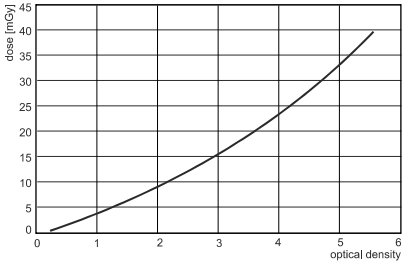


Fig. 2 Dependence of the optical density on x- radiation dose (49 keV) for the film FOMA DF10

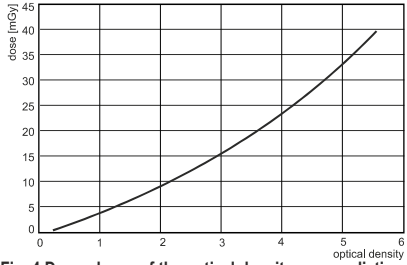


Fig. 3 Dependence of the optical density on gamma radiation dose for the film FOMA DF2

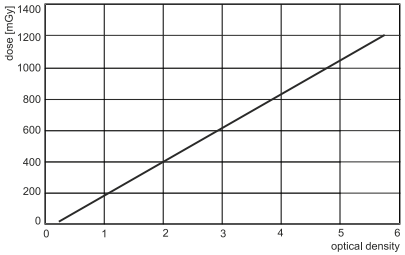


Fig. 4 Dependence of the optical density on x- radiation dose (49 keV) for the film FOMA DF2

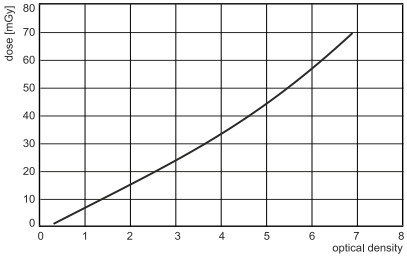
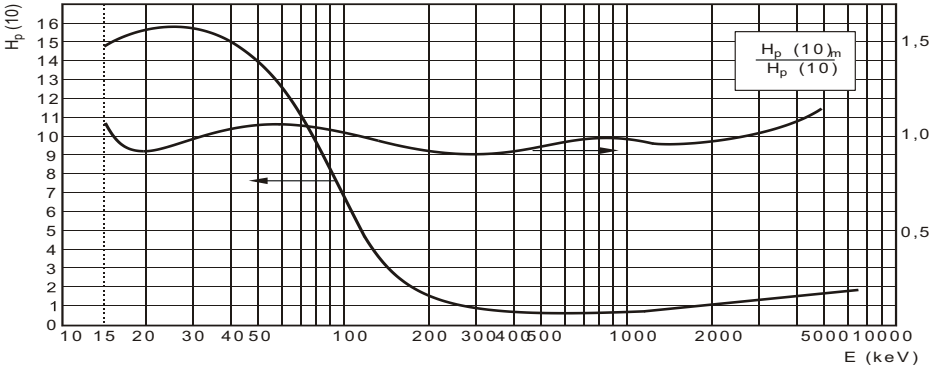


Fig. 5 Energy dependence of the film FOMA Df10 and results of this compensation by the filtration analysis method (measured by NationalPersonal Dosimetry Service).



FOMADUX LP - ECO, FOMADUX FIX-ECO

PROCESSING SOLUTIONS FOR RADIOGRAPHIC FILM PROCESSING

General information

The liquid concentrates of chemicals are intended for both automatic and manual processing of industrial X-ray films in processing machines using 8 – 12 minutes cycle. The processing solutions are prepared by diluting concentrated chemicals with water. They do not contain chemicals with adverse impacts on the environment or human health. The baths are primarily intended for the processing of FOMA industrial X-ray films, however, they may also be used to process comparable products of other manufacturers.

The processing baths are labelled as follows:
Developer / Replenisher FOMADUX LP-ECO
Hardening fixer FOMADUX FIX-ECO

Characteristics

Developer / Replenisher FOMADUX LP-ECO is a single-component concentrate for preparing a developer for manual and automatic processing of industrial x-ray films. The developer provides high image quality and is typical with particularly fine grain and well-balanced contrast, making full use of the film speed. The composition of the developer makes the maintenance of the developing tanks and devices easier and prevents sediment formation even when hard water is used. The processing developer solution is classified as safe and health- and environment-friendly.

Hardening fixer FOMADUX FIX-ECO is a single-component fixer concentrate based on ammonium thiosulphate which provides high fixing speed and efficiency. It is typical with its increased hardening capacity, high buffering power, and long-term stability. The processing fixer solution is classified as safe and health- and environment-friendly.

Packing

Developer / Replenisher FOMADUX LP-ECO
1 container of 5 litres of concentrate
Hardening fixer FOMADUX FIX-ECO
1 container of 5 litres of concentrate

Preparation of working solutions

The developer solution is prepared by adding 12 litres of water to 5 litres of FOMADUX LP-ECO Developer / Replenisher, which forms 17 litres of solution. This amount of solution allows developing approximately 20 m^2 of material. The recommended replenishment of developer by freshly prepared solution during automatic processing is 600 to 800 ml per 1 m^2 of material.

The fixer solution is prepared by adding 12 litres of water to 5 litres of FOMADUX FIX-ECO Fixer, which forms 17 litres of solution. This amount of solution allows fixing approximately 15 m^2 of material. The recommended replenishment of developer by freshly prepared solution during automatic processing is 1000 to 1200 ml per 1 m^2 of material.

Recommended conditions for automatic processing:

temperature	developing time	fixing time
28°C	2 min.	2 min.

Recommended conditions for manual processing:

temperature	developing time	fixing time
26°C	2,5 min.	2 min.
24°C	3 min.	2 min.
22 °C	4 min.	2 min.
20 °C	5 min.	2 min.

The minimum fixing time for both processes is 100 sec.

We recommend determining the values for each specific film and machine by trial processing.

If necessary, feel free to consult FOMA employees.

Storage

The chemicals should be stored in the original packing in a dry place at temperatures +5 to +25 °C and relative humidity 40 to 60%, for a period not exceeding 12 months.

Information on the environmental ways of disposal, principles of safe handling during transport, storage and use are stated in the safety data sheet of the product.

FOMADUX LP-D, FOMADUX MIX

LIQUID CHEMICALS FOR AUTOMATIC PROCESSING OF INDUSTRIAL X-RAY FILMS

General

The liquid concentrate of chemicals are intended for automatic processing of industrial X-ray films in processing machines using 8 – 12 minutes cycle. The processing solutions are prepared by diluting concentrated chemicals with water. The liquid chemistry is especially suitable for processing of FOMA X-ray INDUX films as well as for comparable materials of other producers.

The chemicals are labeled as follows:

FOMADUX LP-D Developer-Replenisher

FOMADUX MIX

Features

FOMADUX LP-D Developer-Replenisher provides high image quality with particularly fine grain and well balanced contrast, making full use of the film speed.

Its formula quarantees the product long-lasting stability, prevents deposits formation even with hard water.

FOMADUX MIX

Part A – Rapid Fixer provides high fixing and buffering action, strong hardening power and long-term stability.

Part B – Hardener increases hardening power of the fixer, resulting in high mechanical resistance of the film and short processing time.

Packing

FOMADUX LP-D

liquid concentrate for the final volume of 20 litres:

Part A – 1 container of 5 litres

Part B – 1 bottle of 0.25 litre

Part C – 1 bottle of 0.5 litre

FOMADUX MIX

set for 21 l of solution:

Part A – FOMAFIX - 1 container of 5 litres (fixer)

Part B - 1 bottle of 1 liter (hardener)

Preparation of working solutions

The developer solution is prepared from developer concentrate FOMADUX LP-D according to instructions. Basic and regeneration bath is the same.

For preparation of working solution of replenisher 5 litres of liquid concentrate FOMADUX LP-D part A is mixed with 10 litres of water. Continuosly mixing this solution the FOMADUX LP-D part B and FOMADUX LP-D part C is successively added. After that water is filled up to the final volume of 20 litres. The reservoir with the working solution of replenisher must be safely closed by a cover.

For preparation of 21 liters working solution of FOMADUX MIX is part A (5 liters of fixer) diluted with 15 liters of water and afterwards is added successively part B (1 liter of hardener) to the solution under continuously mixing. Basic and regeneration bath is the same.

Processing

Recommended development conditions:

temperature	developing time	processing time
28°C	2 min.	8 min.

Recommended replenishment doses are 600 to 800 ml/m^2.

Recommended standard fixing conditions:

temperature	time
28°C	2 min.

Minimum fixing time = 100 sec.

Recommended replenishment doses of ready-made fixing bath (i.e. with hardener) are 1000 to 1200 ml/m^2.

Replenishment values being for reference, the exact values are to be determined by trial processing involving the processing machine and film used, the daily processing capacity and processing time.

In case of any need do not hesitate to ask special technical help of FOMA service.

Storage

The chemicals should be stored in the original packing in a dry place at temperatures +5 to +25 °C and relative humidity 40 to 50% for a period not exceeding 24 months.

A possible crystalline fraction in parts A and C is not a defect, it will dissolve again after heating to 40 °C and agitation the solution.

Information of the ecological disposal, principles of safe use at transport, storage and handling are stated in the safety data sheet of the product.

FOMADUX LP-T, FOMAFIX, FOTONAL

LIQUID CHEMICALS FOR MANUAL PROCESSING OF INDUSTRIAL X-RAY FILMS

General

The liquid concentrate of chemicals intended for manual processing of industrial X-ray films. The liquid chemicals are especially suitable for processing of FOMA industrial X-ray films INDUX as well as for equivalent materials of other producers.

The chemicals are labeled as follows:

FOMADUX LP-T Developer

FOMAFIX Rapid Fixer

Features

FOMADUX LP-T Developer is a one-compound concentrate for manual processing of industrial X-ray films. The developer provides high image quality with particularly fine grain and well balanced contrast, making full use of the film speed. Its formula quarantees the product long-lasting stability, prevents deposits formation even with hard water.

FOMAFIX Rapid fixer

Is a concentrate of fixing bath on basis of ammonia thiosulphate providing high fixing and buffering action, strong hardening power and long-term stability.

Wetting agent FOTONAL

Is a liquid concentrate containing surface active substances and additives which ensure uniform dewatering of the film surface, acceleration of drying and elimination of spot occurrence.

Packing

FOMADUX LP-T Developer concetrate

1 container of 5 litres

FOMAFIX Rapid Fixer

1 container of 5 litres

FOTONAL Wetting agent

1 bottle of 250 ml

Preparation of processing baths

FOMADUX LP-T Developer is diluted with water at 1 + 3 (to 1+ 4), from one 5 litre packing 20 to 25 litres of processing solution can be made. The processing tank should be closed with cover.

Recommended standard developing conditions:

temperature	processing cycle
20°C	5 min.

As replenisher the concentrate FOMADUX LP-T diluted with water at 1+2 (3) is used.

Recommended replenisment for industrial X-ray films is 800 ml/m^2. Optimum replenisment conditions are dependent on the way of processing, size of processing tank, the daily processing capacity etc.

FOMAFIX concentrate is intended for preparation of 20 to 25 litres of fixing bath.

Recommended standard fixing conditions:

temperature	time
20°C	3 min.

Minimum fixing time = 2 min.

For replenishment the same basic bath is used.

Recommended replenishment is 1000–1200 ml/m2, necessary to set with more precision by trial processing.

Apply Fotonal wetting agent into the last water scouring bath before drying.

Solution is prepared by adding 10–40 ml of the concentrate into 1 litre of water.

In case of any need do not hesitate to ask special technical help of FOMA service.

Storage

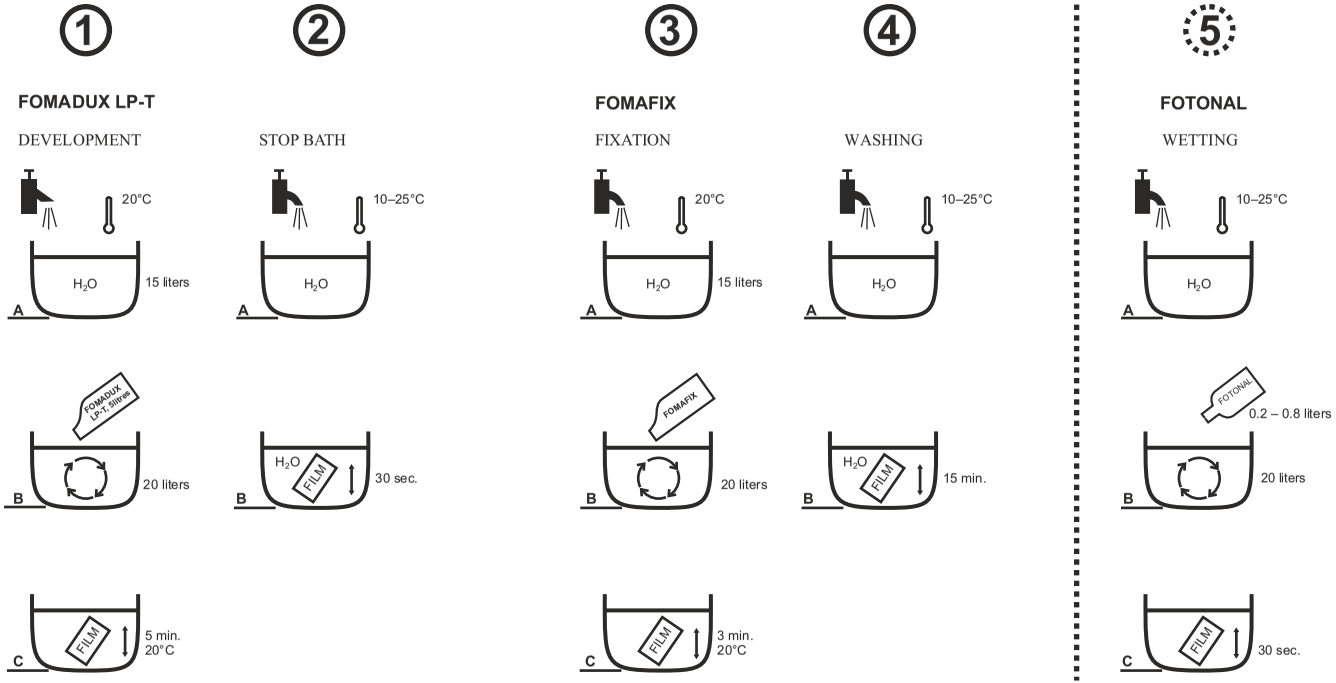
The chemicals should be stored in the original packing in a dry place at temperatures 5 to 25 °C and relative humidity 40 to 50 %.

A possible crystalline fraction is not a defect, it will dissolve again after heating to 40 °C and agitation the solution.

Expiration time is 24 months from the date of production. Applicability time for one processing solution setting when regularly replenished is 4–8 weeks.

Information of the ecological disposal, principles of safe use at transport, storage and handling are stated in the safety data sheet of the product.

MANUAL PROCESSING INSTRUCTIONS



In case of dried water drops use.

DIGITAL DENSITOMETER FMD-12

Characteristics

Digital densitometer FMD-12 is a portable battery-powered densitometer designed for measuring radiograph blackening using an external light source. It has been developed for bulb negatoscopes (it can alco be used on negatoscopes with fluorescent and LED light, we recommend recalibration of the instrument using a densitometric etalon, e.g. FOMASTEP E-09).

Technical Description

Densitometer FMD-12 consists of the actual measuring instrument, the measuring probe, and the connecting shielded cable. The connector for connecting the probe using the shielded cable is located on the face of the instrument under the display and protected against spontaneous disconnecting. The measuring probe is of a pencil design with a plastic black case and it is connected to the instrument using a short cable and it is removable. Densitometer FMD-12 is equipped with semi-automatic zero setting and automatic turning off, when the instrument is not used.

Instrument Recalibration

Densitometer FMD-12 allows for recalibration according to ASTM E1079 or ASTM E1079-85 ("Standard practice for calibration of Transmission densitometers") using the setting element located on the upper right side of the instrument. The recommended interval for repeated linearity checking or instrument recalibration is 90 days. For instrument recalibration, we recommend using FOMASTEP E-09 densitometric etalons.

Supply Subject

- Densitometer FMD-12
- Measuring probe
- Connecting cable with a USB connector
- Battery 9V (type 6F22)
- Calibration sheet
- Operating manual
- Suitcase

Instrument Advantages

- Very high accuracy thanks to the use of an integrated circuit with a capability to logarithm in 5 decades with an error of 0.2%
- Zeroing with any lihgt
- One of the smallest densitometers in the market

Technical Parameters

Measuring range	0 – 4,0 D
Resolution	0,01 D
Precision	±0,05 D (within 0–4.0 D)
Display	Blackening, +/-, LOBAT
Zero setting range	In any light
Zero holding time	About 5 min (±0,01D)
Zero stabilisation time	Max. 1 sec
Data stabilisation time	Max. 2 sec
Probe opening diam.	2 mm
Power – battery	9 V type IEC 6F22 or 6LR61
Consumption on/off	4,0 mA / 0,009 A
Operating time (meas.)	About 50 hrs (norm. battery)
Control	2 buttons
⏻ – on/off	– [0] – zero setting
Automatic turning off	About 5 min after turning on
Ambient temperature	5 – 35 °C
Dimensions	79 x 118 x 25 mm
Cable length	70 cm
Weight	155 g

FV-2008 PLUS

INDUSTRIAL TECHNICAL X-RAY FILM LED VIEWER

Characteristics

Industrial LED viewer of technical X-ray films FV-2008 PLUS is designed for visual examination of radiograms with high intensity of darkening. The film viewer meets the requirements of ISO 5580.

Thanks to super luminous LED chips it provides better performance than standard negatoscopes. It is designed for viewing of radiograms with an intensity of blackening up to D = 4.5. Compared to halogen film viewers it has very low electricity consumption at the maximum load and therefore the heat stress on the equipment and films is minimal.

The viewer can be controlled manually using the dimmer or the foot pedal. The operation of the viewer is very quiet.

Both warranty and after-warranty service is provided by FOMA.

Standard Accessories

- Foot pedal
- Light mask 200x50 mm
- User´s manual
- Product certificate

Technical Parameters

Screen nominal size	220x80 mm
Supply voltage	240 V / 50 Hz
Input	150 W
Light source	Highly luminous LED chips
Control range	5-100%
Max. brightness	≥ 300,000 Cd/m^2
Designed for optical density	max. 4.5 D
Surface temperature rise	< 18 °C (at 12 hours of cont. max. operation)
Dimensions (l x w x h)	400 x 150 x 140 mm
Weight	2.9 kg

FV-2010 PLUS

INDUSTRIAL TECHNICAL X-RAY FILMS LED VIEWER

Characteristics

Industrial LED viewer of technical X-ray films FV-2010 is designed for visual examination of radiograms with high intensity of darkening. The film viewer meets the requirements of ISO 5580.

Thanks to super luminous LED chips it provides better performance than standard negatoscopes. It is designed for optical viewing of radiograms with an intensity of blackening up to D = 4.2. Compared to halogen film viewers it has very low electricity consumption at the maximum load and therefore the heat stress on the equipment and films is minimal.

The viewer can be controlled manually using the dimmer or the foot pedal. The operation of the viewer is very quiet.

Both warranty and after-warranty service is provided by FOMA.

Standard Accessories

- Foot pedal
- Light mask 400x70 mm
- User´s manual
- Product certificate

Technical Parameters

Screen nominal size	400x100 mm
Supply voltage	240 V / 50 Hz
Input	150 W
Light source	Highly luminous LED chips
Control range	5-100%
Max. brightness	≥ 130,000 Cd/m^2
Designed for optical density	max. 4.2 D
Surface temperature rise	< 18 °C (at 12 hours of cont. max. operation)
Dimensions (l x w x h)	600 x 80 x 160 mm
Weight	4.0 kg

since 1921

EXPORT FOMA

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