



X-Tek X-ray and CT Inspection

XTV160 MK4 X-ray System

Safety Manual

XTM0634-A4

NIKON METROLOGY | VISION BEYOND PRECISION



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About this manual

This manual applies to a typical machine with the model type given on the front cover. Any non-English manual is a translation of the ORIGINAL Instructions for the safe use of this machine.

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Sources of additional information

Contact **support.xray.nm@nikon.com** to:

- Get technical support (customers and distributors)
- Request quotations and order service parts

Current application software, drivers and manuals can be downloaded by Nikon personnel from:

<https://shared.nikonmetrology.com/>

Access for customers, resellers etc should be requested via **SharePoint access**

<https://public.nikonmetrology.com/SitePages/HomeExtUsers.aspx>

Documentation feedback, suggestions for new or missing content or other comments can be sent to: **EngDoc.NM-Derby@nikon.com**

Safety symbol definition

The following symbols are used throughout this document. Please familiarise yourself with their meaning:



A red circle with a diagonal line indicates an action that is prohibited. A specific warning will be displayed inside the circle as a black symbol.



A white symbol inside a blue circle indicates a mandatory action that must be taken to avoid a hazard.



A black symbol inside a yellow triangle with a black border indicates a hazard.



A black symbol on a white background with a red diamond border indicates a harmful chemical or irritant.



A white symbol on a green background indicates a safe condition.



The note symbol is used to draw your attention to additional important information.

1 About this manual

This manual provides important health and safety information which must be read and understood before operating the system.



This manual may contain additional information about system features that are not applicable to your specific hardware configuration.



It is important to read ALL accompanying safety and installation instructions to avoid damage to the product and potential injury to yourself or others.

This manual is divided into the following sections:

- **Important health and safety information** - It is mandatory to read and understand this section before operating the X-ray system.
- **Safety systems** - Details the safety systems of the system.
- **Warnings** - It is mandatory to read and understand this section before operating the X-ray system.
- **Introduction to the X-ray system** - Provides an overview of the system and its components.
- **Maintenance** - Covers preventative maintenance which should be carried out to ensure reliable and safe operation.
- **Declaration of conformity** - Provides the declaration of conformity for the named machine.

This manual covers the following model: XT V 160.

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2 Important health and safety information

2.1 Safety notice

It is extremely important to read ALL safety information and instructions and any accompanying documentation before operating the system. The *operator safety manual* is an integral part of the product and must be kept with the X-ray system at all times.

Observe all cautions and warnings during routine use of the system. All operators must have read and understood the safety information and the X-ray system's operating instructions and have received relevant training before using the X-ray system for X-ray inspection. Any operator performing *routine maintenance tasks* as detailed in the X-ray system's operator manual must have received appropriate training in these procedures.



Before opening the operator door (or any other access panels), you must switch X-rays off from the X-ray zone of Inspect-X.



Do not attempt to unpack, install or commission the system. Unpacking and installation must only be performed by a qualified Nikon Metrology service engineer.



Do not move the system. Contact a Nikon Metrology representative if you wish to relocate the X-ray system. Moving the system will affect the system calibration and may compromise the X-ray shielding.

The X-ray system is designed to operate under strict environmental conditions, which are listed in a later section of this manual.

The system should be sited on flat, suitably rated ground, with sufficient clearance left for service access. Refer to the relevant installation drawing for your system for further details. It is necessary to leave space all around the system to allow for radiation checks and maintenance of internal components.

It is recommended that an RCD/Earth Leakage Breaker rated for 30mA is fitted to the supply.



This system is a Class A product and should not be connected to the domestic electrical supply. In a domestic environment, this product may cause harmonic interference. If the user wishes to connect to a domestic supply they may be required to take adequate measures to prevent interference.



Machines ship configured for a UK style 230 V (50/60 Hz) AC supply to a single live conductor, a neutral conductor referenced to earth, and a separate earth (TN-S). Other supply earth arrangements are not supported.



The user must not configure or modify the electrical supply in any way.



Using domestic electrical fittings or inadequate wiring may lead to fitting/wire overheating, failure, or electrical fire.



This system has high protective conductor currents
 $3.5 \text{ mA} < I_L < 10 \text{ mA}$.

It must be connected via either permanent fixed wiring or a suitable industrial plug and socket.

The installation of this machine must be carried out in accordance with the latest installation drawing and procedure, obtainable from Nikon Service Centres.

Fusing requirements

Supply voltage/tap (V)	Fuse/breaker capacity (A)
100	13
110	13
115	13
200	6
220	6
230	6
240	6

2.2 Intended use

Nikon Metrology X-ray products are intended for non-destructive inspection of industrial and electronic components using X-rays. It is prohibited to use this system to inspect any live organisms or tissue.

Do not use the system for any purpose other than its intended use.



The acquisition computer supplied with the system is not a general purpose computer and no additional software should be installed without the agreement of customer support. The Windows operating system should be configured to only install updates after confirmation from Nikon Service and NEVER to update graphics drivers, as this can adversely affect the performance of the system or result in malfunction.

2.3 In case of emergency



To make the system safe in case of emergency, push the emergency stop button and isolate the system from mains power. The emergency stop button is located on the control console.

2.4 Health and safety information

1. The relevant "Health and Safety at Work" authorities, for your country, may need to be informed that you are in possession of equipment designed for the generation of X-rays. This is a statutory requirement in many countries, including the UK.
2. You must comply with all legislation for X-ray generating equipment existing in your country. In some countries, both national and local government regulations apply. For example, in the USA the use of X-ray equipment is controlled by both Federal and State regulations. In the UK, the applicable regulations are the Ionising Radiation Regulations 2017 (IRR17).
3. It is essential that the personnel engaged in the operation and maintenance, and any repair of this equipment, be competent and experienced in this work, and that they comply with the relevant statutory requirements and regulations.

These include either the provisions of the Health and Safety at Work Act 1974 (UK Regulations), or the Occupational Safety and Health Act (OSHA) as published in the Code of Federal Regulations (USA), title 29, part 1910, and any additions or amendments that may become legal requirements.

The personnel should also comply with the equivalent statutory requirements of their own country.

4. Any operator performing routine maintenance on the X-ray system must be trained to carry out these procedures.

Refer to the *operator manual* provided either physically or electronically with the X-ray system for details of these procedures.

5. Ensure that the control console and monitor support arms are adjusted for comfortable operator use and then firmly locked in position, where applicable.
Take advice on the safe use of computer and monitor equipment as provided by local regulations.
6. Take care when loading and unloading samples from the system. Never overload the manipulator. Repeated opening of the door and sample loading may lead to discomfort. Customers should comply with Provision and Use of Work Equipment Regulations (PUWER).
7. Noise emitted by the X-ray system is minimal. The level of noise will not exceed an A-weighted pressure level of 70 dB (A).
8. The cabinet can be cleaned with a cloth dampened with water. Switch off and isolate mains power before cleaning, and allow to dry before reconnecting. Take care when cleaning as mechanical hazards are present.

2.5 Understanding the hazards

2.5.1 X-ray radiation

X-rays are ionising radiation. High doses of ionising radiation can cause lasting injuries, disfigurement and (in extreme cases) death.

The X-ray system has been designed and built to United Kingdom Ionising Radiation Regulation Standards (IRR 2017).

The system is certified by Nikon Metrology to emit less than one microsievert per hour (1 µSv/h) on all external surfaces. Certification is provided with the system. There is no significant X-ray radiation risk to users under normal operating conditions.



If the system is damaged, it must not be used and Nikon Metrology must be contacted immediately. Nikon Metrology will then arrange for an approved engineer to examine the system for radiation leakage before it can be re-commissioned.

This does not replace the need for statutory radiation safety checks to be carried out at the site in accordance with your regional or national legal requirements.

2.5.2 High voltages



The system contains high voltages. These pose no risk to users under normal operating conditions.

2.5.3 Laser radiation



The system may be fitted with a Class 2 laser product. The laser module is classified as Class 2 in accordance with IEC60825-1 2007 and complies with 21 CFR 1040.10 and 1040.11.



Do not stare into the beam. The laser is safe for accidental viewing as protection is afforded by the blink reflex (aversion response). There is no hazard to the skin.

2.6 Hazard warning labels

Hazard warning labels are fixed to the X-ray system for your information and safety.



Labels must not be removed or tampered with.



If you require replacement labels, please contact Nikon Metrology.



Labels are not shown to scale.

Caution label near the roof on the sides and / or rear of the cabinet.



DO NOT LOAD CABINET ROOF

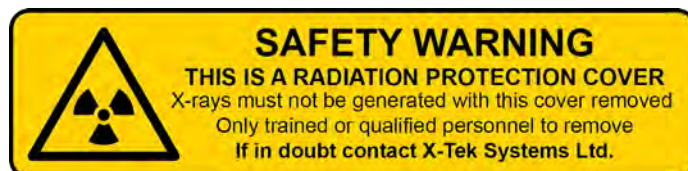
LOADS PLACED ON THE ROOF OF THIS SYSTEM MAY RESULT IN FAILURE OF THE RADIATION SHIELDING

Safety warning label fitted above the machine identification label.



WARNING: X-RAY PROTECTION
DO NOT DRILL OR SCREW INTO ANY PART OF THE CABINET
DO NOT REMOVE ANY PART OF THE CABINET
DO NOT MODIFY ANY PART OF THIS EQUIPMENT

Safety warning label fitted on removable radiation protection covers.



SAFETY WARNING - THIS IS A RADIATION PROTECTION COVER
X-rays must not be generated with this cover removed. Only trained or qualified personnel to remove. If in doubt contact X-Tek Systems Ltd.

Warning label placed on the radiation protective lead glass window in the operator door.



RADIATION PROTECTIVE GLASS
DO NOT REPLACE
CONTACT X-TEK SYSTEMS LTD.

Earth current leakage warning label located adjacent to the machine identification label.



WARNING
THIS SYSTEM HAS HIGH PROTECTIVE CONDUCTOR CURRENTS
 $3.5\text{mA} < I_L < 10\text{mA}$.
SYSTEM MUST BE CONNECTED VIA EITHER PERMANENT FIXED
WIRING OR A SUITABLE INDUSTRIAL PLUG AND SOCKET

Warning labels placed on the warning lamp tower.



PRE-WARNING



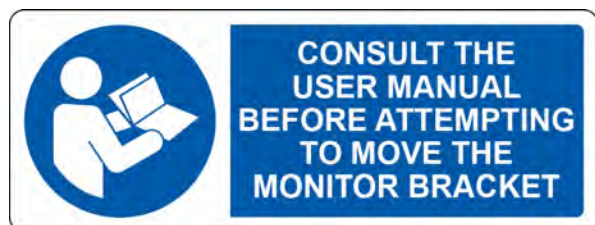
X-RAYS ON

Radiation warning label affixed to the front of the cabinet adjacent to the operator door.



CAUTION
X-RAYS PRODUCED WHEN ENERGISED

Mandatory label placed on the rear of the monitor arm.



CONSULT THE USER MANUAL BEFORE
ATTEMPTING TO MOVE THE MONITOR
BRACKET

Warning label fitted on electrical covers.



DANGER
DISCONNECT THE MAINS SUPPLY BEFORE
REMOVING THIS COVER

Warning label located near the cabinet feet.



WARNING
HAND CRUSH HAZARD
DO NOT OVER EXTEND FEET
MISALIGNMENT OR OVER EXTENSION MAY LEAD TO
SERIOUS INJURY

Laser warning label fitted to the front of the cabinet and manipulator, if a laser module is fitted to the system.



LASER RADIATION
DO NOT STARE INTO BEAM
CLASS 2 LASER PRODUCT

Laser aperture warning label. Fitted to the laser module, if a laser option is fitted to the system.



Laser Aperture
Beta CW 670 nm



Laser radiation
Do not stare into beam
Class 2 laser product
IEC 60825-1 Amendment 2/2001
Product description and name
Product code
Serial number
CE Laser aperture

Caution label placed on the manipulator platform.



DO NOT STEP, STAND OR SIT ON THIS
SURFACE
MAY CAUSE INJURY AND / OR
EQUIPMENT DAMAGE

Caution label placed on the manipulator inside the cabinet, dependent on the load rating of the manipulator platform.



MAXIMUM 500 g



MAXIMUM 5 kg

Warning label placed on the top hinge of the service door.



HEAVY
SERVICE DOOR
250 kg

Warning label placed on the operator door.



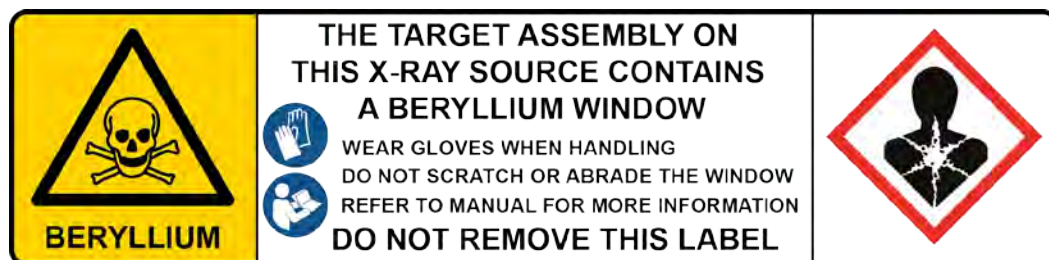
HEAVY
USER DOOR
50 kg

Warning label on the X-ray source inside the cabinet.



HEAVY
X -RAY SOURCE
2 PERSON LIFT
40 kg

Warning label fitted to the X-ray source target if a beryllium window is fitted.



BERYLLIUM

THE TARGET ASSEMBLY ON THIS X-RAY SOURCE CONTAINS A BERYLLIUM WINDOW
WEAR GLOVES WHEN HANDLING
DO NOT SCRATCH OR ABRASE THE WINDOW
REFER TO MANUAL FOR MORE INFORMATION
DO NOT REMOVE THIS LABEL

Warning label fitted on cooling system reservoir.



CAUTION
FILL WITH UNDILUTED HEXID A4
ONLY

Hexid A4 Supplied by:
Applied Thermal Control, UK.
Tel: +44 (0) 1530 839 998

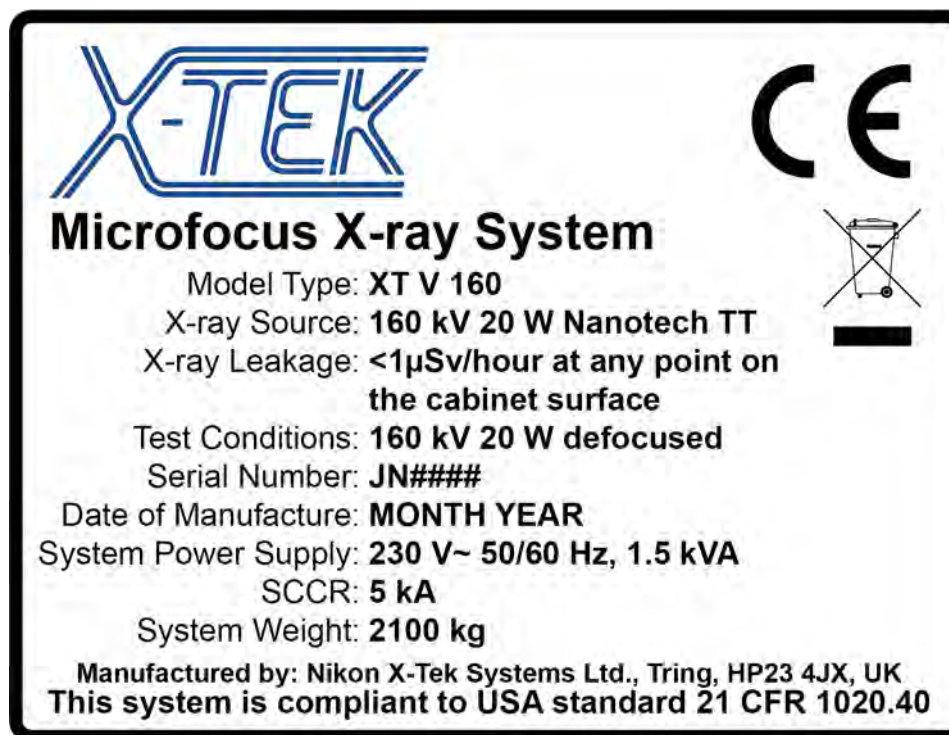
COMPOSITION:
Water, Propylene Glycol and
Fluorescein Biocide:
1-2-Benzisothiazol-3(2H)-one 0.002%

Fuse label located on the rear of cabinet

ID	TYPE	FUNCTION	ID	TYPE	FUNCTION
F2	8A gG 10x38	230 VAC T1 O/P	F15	SPARE	SPARE
F3	10A aM 10x38	75 VAC (L) T1 O/P	F16	3.15A (T) 5x20	PSU1 24V O/P
F4	10A aM 10x38	75 VAC (N) T1 O/P	F17	6.3A (T) 5x20	PSU2 24V O/P
F5	6A DC 10x38	100 VDC SUPPLY	F18	4A (T) 5x20	PSU2 48V O/P
F6	5A (T) 5x20	PSU1 SUPPLY	F19	5A (T) 5x20	INTENSIFIER (OPTION)
F7	5A (T) 5x20	PSU2 SUPPLY	F20	1A (T) 5x20	PSU5 SUPPLY (LASER POINTER)
F8	5A (T) 5x20	BACKING PUMP	F21	1A (T) 5x20	IRIS + J/S BOX SUPPLY
F9	3.15A (T) 5x20	COOLANT PUMP	F22	2A (T) 5X20	COOLING TRAY FANS
F10	3.15A (T) 5x20	MONITOR	F23	2A (T) 5X20	ELECTRICAL AREA FANS
F11	3.15A (T) 5x20	COMPUTER	F24	2A (T) 5X20	MANIPULATOR AUX. SUPPLY
F12	5A (T) 5x20	PSU3 SUPPLY	F25	2A (T) 5X20	C.T. ARM
F13	2A (T) 5X20	CABINET LIGHT	F26	500mA (T) 5X20	USB XODIAC SUPPLY
F14	2A (T) 5X20	DETECTOR PSU SUPPLY			

ID	TYPE	FUNCTION	ID	TYPE	FUNCTION
F2	8A gG 10x38	230 VAC T1 O/P	F15	SPARE	SPARE
F3	10A aM 10x38	75 VAC (L) T1 O/P	F16	3.15A (T) 5x20	PSU1 24V O/P
F4	10A aM 10x38	75 VAC (N) T1 O/P	F17	6.3A (T) 5x20	PSU2 24V O/P
F5	6A DC 10x38	100 VDC SUPPLY	F18	4A (T) 5x20	PSU2 48V O/P
F6	5A (T) 5x20	PSU1 SUPPLY	F19	5A (T) 5x20	INTENSIFIER (OPTION)
F7	5A (T) 5x20	PSU2 SUPPLY	F20	1A (T) 5x20	PSU5 SUPPLY (LASER POINTER)
F8	5A (T) 5x20	BACKING PUMP	F21	1A (T) 5x20	IRIS + J/S BOX SUPPLY
F9	3.15A (T) 5x20	COOLANT PUMP	F22	2A (T) 5x20	COOLING TRAY FANS
F10	3.15A (T) 5x20	MONITOR	F23	2A (T) 5x20	ELECTRICAL AREA FANS
F11	3.15A (T) 5x20	COMPUTER	F24	2A (T) 5x20	MANIPULATOR AUX. SUPPLY
F12	5A (T) 5x20	PSU3 SUPPLY	F25	2A (T) 5x20	C.T. ARM
F13	2A (T) 5x20	CABINET LIGHT	F26	500mA (T) 5x20	USB XODIAC SUPPLY
F14	2A (T) 5x20	DETECTOR PSU SUPPLY			

Machine identification label fitted to the side of the cabinet.



X-TEK
Microfocus X-ray System
Model Type: XT V 160
X-ray Source: 160 kV 20 W Nanotech TT
X-ray Leakage: <1µSv/hour at any point on the cabinet surface
Test Conditions: 160 kV 20 W defocused
Serial Number: JN####
Date of Manufacture: MONTH YEAR
System Power Supply: 230 V~ 50/60 Hz, 1.5 kVA
SCCR: 5 kA
System Weight: 2100 kg
Manufactured by: Nikon X-Tek Systems Ltd., Tring, HP23 4JX, UK
This system is compliant to USA standard 21 CFR 1020.40

2.7 Disposal and recycling

This product is required to comply with the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU.

It is marked with the following symbol:



This symbol indicates that this product is not to be disposed of with household waste, according to the WEEE Directive (2012/19/EU) and your national law. This product should be handed over to a designated collection point or to an authorised collection site for recycling waste Electrical and Electronic Equipment (EEE).



Danger! The beryllium target window is subject to special disposal requirements due to the toxicity of dust, fumes or chemical activity.

Improper handling of this type of waste could have a possible negative impact on the environment and human health due to potentially hazardous substance that are generally associated with EEE and products of this type. At the same time, your cooperation in the correct disposal of this product will contribute to the effective usage of natural resources.

For non-EU countries, please consult with national and local waste disposal regulations and only use government-approved recycling facilities.

For more information about recycling this product, please contact Nikon Metrology / Nikon X-Tek Systems Ltd.

3 Safety systems

The radiation enclosure is fully lined with lead to absorb stray X-rays. The door is lead lined and fitted with double safety interlocks, preventing X-rays from being generated when the door is opened. The X-ray controller has interlock control circuitry to ensure that all interlock switches are made before there can be any generation of X-rays.



Report any safety system failure to Nikon Metrology and under no circumstances override safety interlocks.

The interlocks include:

- X-ray controller key.
- Vacuum sensing circuit to ensure that the vacuum is at an acceptable level.
- Cabinet door interlock switches.
- External warning lamp system.
- Coolant flow sensing.



Interlocks should under no circumstances be modified, tampered with or bypassed.



The interlock system should only be repaired, replaced or adjusted by qualified personnel.

During manufacture, the cabinet and all associated components undergo a radiation survey to ensure they comply with the stated specification. The system is then issued with a radiation certificate.

Periodical radiation checks must be carried out either by Nikon Metrology during annual service or by your own staff provided they are competent and appropriately trained and have access to the necessary measuring instruments. In some territories persons making such measurements are required to be licensed or certified by a national body.



If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

With regards to the X-ray hazard, the performance level of the safety-related parts of the control system (SRP/CS) achieves PL E against EN 13849-1:2008.

3.1 X-ray status indication

X-ray status indicators are mounted on the front of the cabinet or on a signal tower mounted on top, in clear view of the operator and nearby personnel, to indicate the state of the X-ray system.

The warning lamps have failure detection circuitry. If the lamps are damaged, or removed from the system, X-ray generation will be prevented. Lamp failure will be indicated in the system status panel in Inspect-X.

There are two labelled indicators, or warning lamps:

- Amber indicator - PRE-WARNING

PRE-WARNING

- Red indicator - X-RAYS ON

X-RAYS ON



Amber indicator

When the operator turns X-rays on using the controls on the PC, the PRE-WARNING indicator is turned on. No X-rays are generated during this period. At any time during this period, the operator may cancel the X-rays on sequence.

Red indicator

After the 'pre-warning' period, X-ray generation will commence. The PRE-WARNING indicator will turn off and the X-RAYS ON indicator will illuminate. The X-RAYS ON indicator will remain on when X-rays are being generated.

3.2 Emergency stop



To make the system safe in case of emergency, push the emergency stop button and isolate the system from mains power.

The emergency stop system isolates all power to the system components should a hazardous situation arise.

Power isolation ensures that:

- No X-rays can be generated.
- Movement of all axes of the manipulator is stopped.

The emergency stop button is located on the control console. Operation of this button will result in immediate system power isolation, with the exception of the computer and monitor to prevent data loss.



Releasing the emergency stop button will not automatically result in restoration of power. Activation of the 'Power On' button on the control console is required to manually reset the emergency stop system and restore power.

3.3 Door interlocking

There are two access doors into the X-ray chamber: a small operator door and a larger service door. The service door covers the whole front side of the chamber and the operator door is built into the service door.

Samples are loaded into the system by the operator through the operator door. The service door is only to be used when greater access to the X-ray source or manipulator is required for servicing. Both doors are interlocked to prevent X-ray generation and movement of the manipulator when either door is not fully closed.

- X-ray generation is prevented by removing power to the high voltage supplies for the X-ray source. With no high voltage present, no X-rays can be generated.
- Manipulator movement is prevented by removing power from the motors.



The safety relay is configured for automatic reset operation. Closing the door is sufficient to reset the safety relay. X-ray generation will, however, not automatically restart when the door is closed. The operator must re-initiate X-ray generation using the computer controls.



In normal use, always switch X-ray generation off via the X-ray controls in Inspect-X, never by relying on the door interlocks, prior to opening the operator door.

3.4 Coolant sensing

The coolant flow and level are sensed by the X-ray source. Low coolant levels or a failure in flow of coolant will prevent the generation of X-rays. Coolant failure will be indicated by a status LED on the **X-ray source** (on page 40).

4 Warnings

While there are hazardous aspects associated with the operation of this equipment, under normal use, no hazard is presented to the operator. The areas where a potential hazard may occur are listed in the following sections.

4.1 General



The following warnings are identified as hazards:

- High voltages are associated with the production of X-rays. Whilst under normal operating conditions these do not pose a problem, care should always be taken to ensure that equipment is not exposed, damaged or operated in an unsuitable environment, for example, wet or very damp conditions.
- Both X-ray production and manipulator use are interlocked to the door closed switch.



The following warnings are identified as mandatory actions which must be followed to prevent a hazard:

- Always observe all current safe working practices when working on electrical systems.
- Turn off the machine and remove/isolate all mains inputs before removing any inspection covers.
- The X-ray system operates at hazardous voltages and so access to service areas is restricted to suitably skilled technicians. The machine must be isolated from the mains supply before removal of any covers.
- The Inspection computer supplied with the system is not a general purpose computer and no additional software should be installed without the agreement of Customer Support. The Windows operating system should be configured to only install updates after confirmation from Nikon Service and NEVER to update graphics drivers, as this can disable the imaging setup.



The following warnings are identified as prohibited actions that must not be performed:

- Do not remove any panels or covers from the machine whilst operating or powered up in any way.
- Do not try to produce X-rays with any safety interlock overridden or with any radiation panels removed.
- Do not apply power to the machine until all covers or panels have been fitted and secured correctly.
- Never operate the system at full X-ray power without a sample between the X-ray source and the imager.
- If the user interlock door switches become damaged, the operator must stop using the system at once and report this damage to Nikon Metrology.
- Do not interfere with or try to override the door interlock switches as this may result in exposure to mechanical or radiation hazards.
- Damage, however small, to the cabinet door glass (where fitted) must not be repaired, as the glass is a special leaded type. If damaged, the system must not be used, and the damage reported to Nikon Metrology.
- Ensure the required space set out in the installation drawing is left around the system. Do not block or restrict any exterior vents.

4.2 Electrical



The following warnings are identified as hazards:

- High voltages are necessary for the production of X-rays. Whilst under normal operating conditions these do not pose a problem, care should always be taken to ensure that equipment is not exposed, damaged or operated in an unsuitable environment, for example, wet or very damp conditions.
- Check that the electrical supply is suitable according to the equipment's rating label.



The following warnings are identified as mandatory actions which must be followed to prevent a hazard:

- The X-ray system operates at hazardous voltages and so access to service areas is restricted to suitably skilled technicians. Panels covering high voltage components are clearly labelled; the system must be isolated from the electrical supply before working on these areas.
- All electrical maintenance must be carried out by a qualified Nikon Metrology service engineer.
- When isolating power from the system, shut down the computer first to prevent data loss.



The following warnings are identified as prohibited actions that must not be performed:

- Never carry out any maintenance work on the X-ray source while X-ray power is on.
- Never disconnect any cables while the system has electrical power.
- Never disconnect any earth connections when the system has electrical power.
- Do not adjust, make or re-make any electrical power connections whilst the system is connected to a live supply.
- Do not attempt to disconnect any of the high voltage connectors. The high voltage connectors should only be worked on by trained service engineers, with system power isolated.

4.3 X-ray source assembly



The following warnings are identified as hazards:

- Take care not to trap fingers when opening and closing the X-ray source assembly to change the filament.
- When the system has been operating at high power, the components of the X-ray source, in particular the focus cup, may become hot and care must be taken when handling these parts.
- Ozone build-up in the cabinet is possible if the target window is damaged and electrons are allowed to escape through to atmosphere. Auto-defocus should prevent damage to the target. In case of target damage sufficient for generation of ozone, image brightness/quality degrades significantly.



The following warnings are identified as mandatory actions which must be followed to prevent a hazard:

- In normal use, always switch X-ray generation off via the X-ray controls in Inspect-X prior to opening the operator door, never by relying on the door interlocks.
- When the system has been operating and the source is opened for service operations, the internal source components must be grounded to the source body using an insulated-handled screwdriver prior to any physical handling.



The following warnings are identified as prohibited actions that must not be performed:

- Do not start the turbo pump with the X-ray source open, for example when changing the filament.
- Do not leave the system unattended while conditioning the source.

4.4 Vacuum system

To maintain the quality of vacuum required to ensure that the high voltage inside the tube can be maintained without flashover and the electron beam is not unduly dissipated before reaching the target, a two-stage pumping system is used. The first vacuum pump is generally known as a 'backing' pump. This pump alone is, however, not adequate to produce the vacuum required for generating X-rays. A second and finer turbomolecular (turbo) vacuum pump is necessary to bring the vacuum down to the required level.



The following warnings are identified as hazards:

- Damage will result if the vacuum pumps are operated whilst open to atmosphere.
- The backing pump will be hot to the touch during normal operation of the equipment; let the backing pump cool to a suitable temperature before handling.
- If the backing pump emits visible fumes, or smells, power off immediately. This will usually indicate a serious vacuum leak, such as incorrect sealing of the X-ray source lid, an open vent valve, or incorrectly fitted turbo pump or vacuum gauge. Fumes emitted by the pump under these conditions may be harmful, and should be avoided.



The following warnings are identified as mandatory actions which must be followed to prevent a hazard:

- Only vent the vacuum system to the atmosphere when the **X-ray Power** button (and therefore, the vacuum system) is turned off. When venting, start to do so slowly using the vent button located on the source.



The following warnings are identified as prohibited actions that must not be performed:

- Do not attempt to operate the vacuum system unless it is fully connected.
- Do not start the vacuum system whilst changing the filament.
- Never try to open the X-ray source when the system is under vacuum.
- Never cover the backing pump exhaust vent.
- Never move the system when the turbo pump is running.

4.5 Mechanical



The following warnings are identified as hazards:

- The user door is heavy (~50 kg) and care must be taken when opening and closing to prevent injury to the operator or damage to the cabinet.
- The service door is very heavy (~250 kg) and care must be taken when opening and closing to prevent injury to the operator or damage to the cabinet.
- The X-ray source is heavy (~40 kg) and requires two people to lift.



The following warnings are identified as mandatory actions which must be followed to prevent a hazard:

- The cabinet is very heavy and should only be moved or lifted using correctly-rated equipment and only by authorised Nikon Metrology personnel. Any movement of the cabinet requires it to undergo a radiation check.
- If for any reason the manipulator becomes jammed, the operator must remove power to the X-ray system before attempting to unjam the manipulator. Contact Nikon Metrology for further advice.
- The system feet must only be adjusted by authorised Nikon Metrology personnel. Incorrect adjustment may lead to the feet becoming detached from the system resulting in a serious crushing hazard.



The following warnings are identified as prohibited actions that must not be performed:

- Never modify any part of the system.
- Do not drill or screw into the cabinet.
- Never operate the system without the radiation protection covers in place.
- Do not interfere with the manipulator mechanism when the X-ray system is powered.

4.6 Chemical



The following warnings are identified as hazards:

- Consumables supplied by Nikon Metrology, either with the system or on an after-sale basis, are not dangerous when used in accordance with reasonable standards of industrial practice and in accordance with instructions provided on or with the goods.
- The backing vacuum pump in this system may use mineral oil depending on the model fitted. For a brief period following switch on, and in the event of a malfunction, oil mist may be produced. Ensure all suitable precautions are taken when handling and refer to the relevant Material Safety Data Sheet.
- The X-ray cabinet uses lead for shielding. The lead is in solid form and all exposed surfaces are covered or painted so an operator should not come into direct contact. However, ensure all suitable precautions are taken and refer to the relevant Material Safety Data Sheet (MSDS).
- Some X-ray source windows are made from beryllium. Care should be taken to avoid scratching or abrading the window when removing as this may release toxic dust.
- Coolant oil is not classified as flammable but will burn.

- Self-sealing connectors on coolant hoses may leak a small quantity of coolant when disconnected. This should be cleaned up using suitable protective equipment.



The following warnings are identified as mandatory actions which must be followed to prevent a hazard:

- Fluid products must not be allowed to get into the eyes and prolonged or repeated contact with the skin must be avoided. Splashes into the eyes or onto the skin must be washed away immediately with plenty of clean water, and medical advice should be sought immediately.
- Chemicals must be kept away from food and drink.
- Inflammable products such as isopropyl alcohol (IPA, propanol) must only be used in a well-ventilated area and away from any source of ignition.
- Cooling systems contain Hexid A4 heat transfer fluid and/or mineral oil (Shell Diala). While the coolant itself is not considered hazardous, best practice dictates the use of gloves and goggles while handling. Use only pre-mixed Hexid A4 coolant to minimise biological growth and prevent corrosion. Ensure all suitable precautions are taken when handling and refer to the relevant Material Safety Data Sheet.
- When working with coolant or mineral oil clean up any spills to prevent a slipping hazard. Fluids should only be replaced by trained personnel. Comply with local regulations when disposing of used fluids.



Danger! Beryllium is subject to specific handling controls which must be followed at all times.

- Beryllium is highly toxic in particulate form; always wear gloves when touching the target window assembly.
- Always observe local health and safety regulations relating to the handling and disposal of beryllium and refer to the relevant Material Safety Data Sheet.



The following warnings are identified as prohibited actions that must not be performed:

- Any fumes produced by the system in the event of a failure, or by items in the spares kit, must never be inhaled.
- Do not scratch the target window or try to clean it with an abrasive material since this may produce beryllium dust.
- Do not allow beryllium dust to enter the body through cuts, inhalation or ingestion.
- Never attempt to modify the beryllium window.

5 Introduction to the X-ray system

The XT V 160 has been developed utilising X-Tek's extensive experience in the application and development of microfocus X-ray technology. The system provides the highest resolution and magnification possible within a compact system and is ideally suited to production lines and failure analysis laboratories. Ideal for real-time and automated inspection of electronics (BGA, μ BGA, flip-chip and loaded PCB boards), the XT V 160 is an easy to use, versatile tool which allows an operator to generate high quality images in a short time. It provides interactive visualisation and fully automatic X-ray inspection, with optional Computed Tomography (CT) or X.Tract for in-depth 3D analysis. X.Tract provides CT-quality inspection of complex, multi-layer electronics assemblies without the need to cut or slice the assembly.

The system comprises:

- A 160 kV rated lead shielded, steel framed, interlocked safety enclosure with hinged service access door and integral sample loading door.
- A 160 kV demountable microfocus open transmission X-ray source.
 - X-ray spot size: 1 μ m
 - Defect recognition capability: 500 nm
 - Geometric magnification: 2.5x -2,400x
 - System magnification: Up to 36,000x
- A five-axis manipulator, with optional CT stage.
- An Inspect-X software controlled workstation.
- Standard imaging system of 1.45 Mpixel 12bit camera with dual field 4"/6" image intensifier, with Varian 1313 or 2520 digital flat panel imaging options.

5.1 System overview

The system comprises a single enclosure that is separated into two sections. The upper section is a lead-lined chamber that houses the X-ray source, X-ray imaging components and a motorised manipulator for moving the sample under inspection. The lower section includes the electrical controls, power supplies, manipulator drives, X-ray source cooling pump and vacuum pump. Most of the components in the lower section are located in a service area at the back of the cabinet.

The X-ray source is mounted inside the lead cabinet. Voltages up to 160 kV DC and power levels up to 20 W are used to generate the X-ray beam. The beam is directed vertically upwards, through the sample to be inspected and onto an imaging sensor. The imaging sensor transmits the image data to a PC for processing and display on a monitor.

A cooling unit mounted in the service area at the back of the cabinet provides a circulating cooled water supply to the X-ray source. This unit includes a pump, radiator with air-cooling fan, a reservoir and flow/level sensors. A vacuum 'backing' pump located in the service area is used, in conjunction with a high-speed turbo vacuum pump mounted on the source itself, to produce the high vacuum inside the X-ray source necessary to generate X-rays.

The 5-axis manipulator inside the cabinet allows the sample under inspection to be moved. The sample can be moved in the X (horizontal) and Y (vertical) directions and the Z direction (magnification). The sample can also be rotated and the imaging device can be tilted relative to the X-ray source. Maximum sample weight is 5 kg (11 lbs).

There are two access doors at the front of system.

- An operator door through which the operator loads and unloads samples.
This door has a special lead glass window so that the operator can safely view the inside of the X-ray chamber.
- A service door that covers the front of the system.
This is used when greater access is required to the interior of the chamber for servicing the X-ray source and manipulator.

A movable articulated arm is attached on the left-hand side of the cabinet. A monitor extension carries a single 32" display. A shelf is mounted on the arm with a control console mounted to the

rear of this shelf. The control console includes the controls used to operate the system and the joysticks used to move the sample manipulator. A PC keyboard and mouse are also located on the shelf. The PC is located in the service area at the back of the machine and accessible from the left side of the cabinet.

A signal tower mounted on the top of the arm extension indicates when X-ray generation is imminent (amber light) and when X-rays are being generated (red light).

The system is not portable and is designed for indoor use only in a clean environment. It requires a single electrical supply of between 100 V AC and 240 V AC. No other sources of energy are required.

Cabinet dimensions, including monitor bracket and lamp tower (W x D x H) are 1,225 x 1,810 x 2,145 mm (48 x 71 x 84"). Weight is 2,100 kg (4629 lbs).



1. **X-ray status indicators.** When the red 'X-RAYS ON' lamp is lit, X-rays are being produced. The orange 'PRE-WARNING' light warns that X-rays are about to be produced.
2. **Computer monitor.** The monitor shows the Inspect-X software controls and X-ray images.
3. **Service door.** Provides access to the manipulator and X-ray source for servicing.
4. **Operator door.** Samples are loaded through this door onto the manipulator. If the door is not closed fully no X-rays are produced. The lead glass window provides safe viewing of the inspection process.
5. **Keyboard and mouse.** To control Inspect-X.
6. **Control console.** Contains an emergency stop button, system power on/off buttons, X-ray power on/off button, interlock key switch and USB 3 ports. The console also includes joysticks to control the manipulator's X- and Y-axis, magnification, rotation and imaging tilt. Virtual controls are available in Inspect-X.
7. **Service access panels.** These are located on the left and right side of the cabinet and provide access to the service area for routine maintenance and servicing. The panel on the left

provides access to the PC; the panel on the right provides access to the backing pump and cooling system. An access panel at the back of the cabinet provides access to the electrical controls and fuses.

Access panels must not be opened unless the electrical supply is isolated. With suitable training, a supervisor can check the vacuum pump oil and coolant levels, and air filters.

5.2 Environmental Conditions

The X-ray gun set is designed to be operated under the following environmental conditions:

- External temperature range to be 10°C to 30°C.
- Relative Humidity to be 30-80%, non-condensing.
- Maximum humidity to be <17°C dew point.
- Vibration to be less than -200 µm/s RMS (ISO Residential Day).
- Air cleanliness must be ISO 8 (ISO 14644-1) and Pollution Degree 2 or better.
- The gun set components are IP20 rated and not designed to be used in a wet environment.

The gun set should be installed in a sufficiently sheltered environment. It should be sited on flat, suitably-rated ground, with sufficient clearance left for service access.



The system is configured for a UK style 230V (50/60Hz) AC supply to a single live conductor, a neutral conductor referenced to earth, and a separate earth (TN-S). Other supply earth arrangements are not supported.

5.3 Control console

The control console is a single unit that combines the controls used to operate the system and the joysticks used to move the sample manipulator.

The control console contains the following buttons and switches:

- An EMERGENCY STOP button.
- SYSTEM POWER on (green) and off (red) buttons.
- X-RAY POWER on/off button (white).
- An INTERLOCK key switch.

When the INTERLOCK key switch is in the OFF position, it is not possible to generate X-rays. Always turn this switch to the OFF position and remove the key when performing any maintenance operations, such as changing the filament in the source.



1. **EMERGENCY STOP** - activated by pushing the red knob fully inwards, when all electrical power to the machine will be immediately cut (with the exception of the computer to prevent data loss). After the emergency situation has been resolved, the knob can be twisted and lifted to restore power. The system must be powered up again before it can be used.



The emergency stop also forms part of the safety interlock system.

2. **INTERLOCK Key** – enables (ON) and disables (OFF) X-ray generation; part of the safety interlock system. The key cannot be removed in the ON position.
3. **X-RAY POWER** – illuminates white when pressed and applies electrical power to the vacuum pump circuit. X-rays can be produced as soon as the vacuum reaches a satisfactory level.

4. **SYSTEM POWER On** – illuminates green when pressed and applies electrical power to the main circuits.
5. **SYSTEM POWER Off** – cuts electrical power to the main circuits when pressed.
6. **USB 3 ports** - provide easy access for USB devices.
7. **X-Y Axis Manipulator Joystick** – moves the manipulator table in the +/- X/Y direction as indicated.
8. **Image Zoom Manipulator Joystick** – changes the geometric magnification by moving the sample towards or away from the X-ray source.
9. **Tilt/Rotate Manipulator Joystick** – tilts the imager or rotates the manipulator table around the axis indicated.
10. **ESD Earth Bonding Point** - Allows attachment of electrostatic discharge (ESD) wristbands or other equipment to earth to avoid static discharge, which may damage electronic components.

5.4 Monitor and console arm adjustment

To adjust the monitor height, firmly support the monitor with one hand and pull the locking lever down to release the monitor with the other. Raise or lower the monitor to suit and re-tighten the locking lever. If the lever is either too tight or too loose adjust with the knurled nut.



If the monitor is not supported when released, it will drop and tip forward, possibly resulting in damage to the monitor and/or cables.



The monitor can be rotated by releasing both grub screws at the top of the mount. These should be re-tightened after adjustment.



Do not use the grub screws to hold the monitor post in a raised position, adjust height using the locking lever.



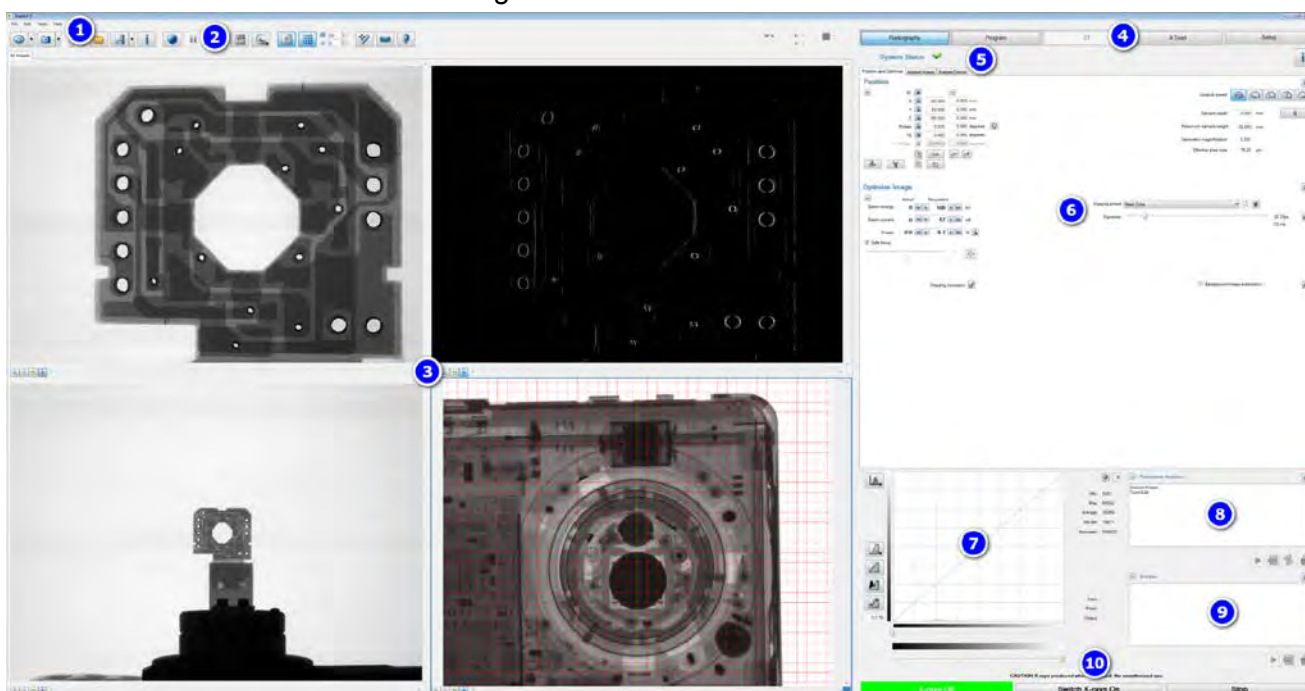
The amount of force needed to move the monitor arm and control console arm can be adjusted by tightening or loosening the resistance grub screws located at each hinge point.



5.5 Inspect-X

Screen layout

The screen is divided into the following areas:

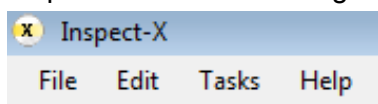


For more in-depth instructions on using Inspect-X and other software features, refer to the *Inspect-X Online Help*.

Electronic documentation is also provided in PDF format and can be found on the system's start menu in the Nikon Metrology folder.

1. Inspect-X is the software that controls Nikon Metrology X-ray inspection systems. Inspect-X is used with a single large screen (3840 x 2160 pixels), or dual Full HD screens (1920x1080). The image window displays on the left side with the toolbar above the image window. The control area is displayed on the right. **Menu bar**

The menu bar is located at the top of the window and provides access to a number of Inspect-X functions through a series of menus.



2. Imaging control toolbar

The imaging control toolbar contains controls for enabling and disabling live imaging, saving images, annotating images and controlling how the images are displayed.



3. X-ray image window

The image window can display four images at once, which can be a mix of captured or previously saved and re-loaded images plus one live image. These are displayed either as four tabs, or if supported and enabled on your system as four images in a split screen configuration.

If your inspection system is configured with either the 2D or 3D Computed Tomography (CT) options, an additional imaging tab is displayed when setting reconstruction options in the CT workflow. This allows the setting of the CT volume (3D) or area (2D) of interest for the reconstruction.

If your system is configured for device analysis (XT V systems only) then an additional device analysis tab is displayed during the set-up procedure.

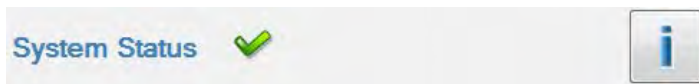
4. Workflow buttons

The workflow buttons provide access to the controls and settings for Radiography, Program, CT, X.Tract and Setup. The buttons shown depend on the capabilities of the inspection system.



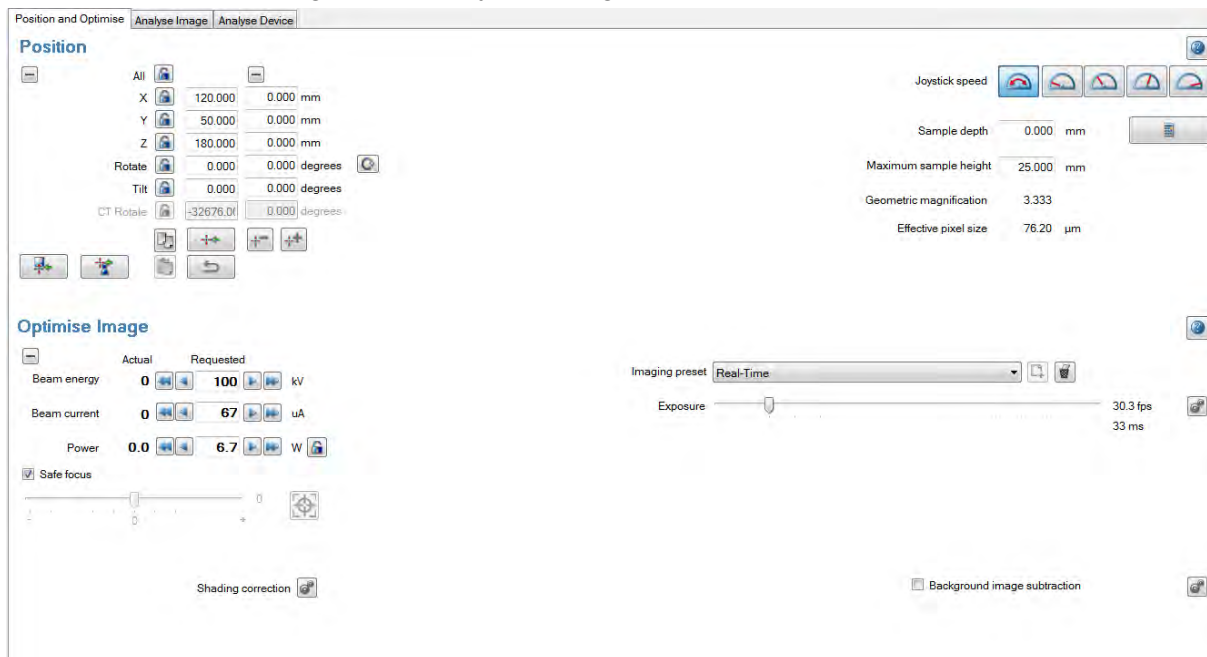
5. System messages

Error, warning and information messages appear here, alerting you to problems in a workflow or successful completion of an operation. A green tick next to System Status shows that interlocks are made and X-rays can be generated. A red cross indicates that interlocks are not made; no X-rays can be generated.



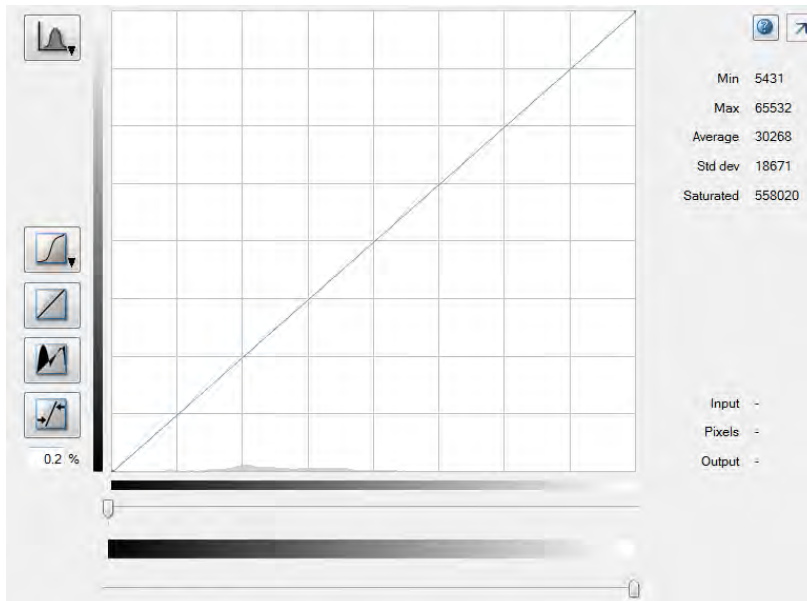
6. Control panel

Once a workflow has been selected, the control panel displays relevant controls and settings on a series of tabs designed to step you through the selected process.



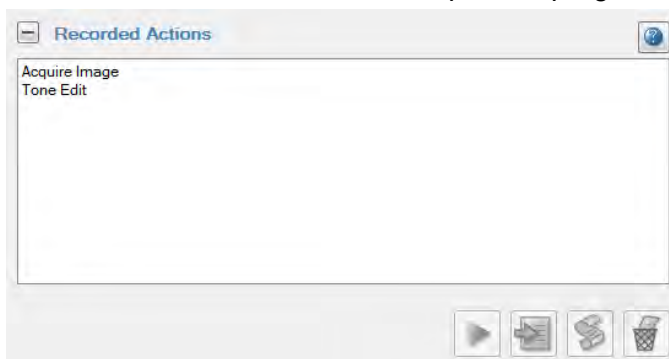
7. Histogram

Shows the grey level distribution within an image and provides access to tools to adjust the tone of an image and to display a black and white binary image or a pseudo-colour image.



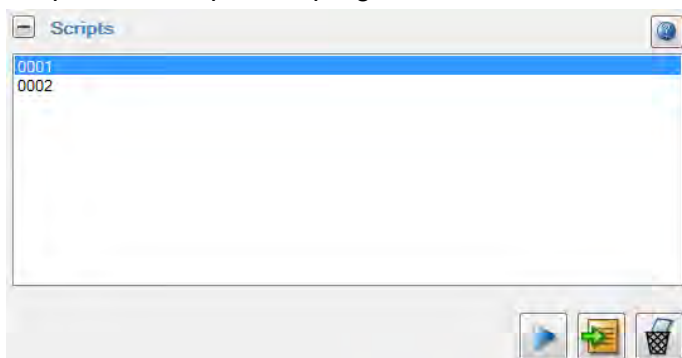
8. Recorded Actions

Shows a list of actions recorded during the acquisition, processing and analysis of an image. Use these actions to create an inspection program.



9. Scripts

Shows a list of scripts (collections of actions) based on recorded actions. You can also add scripts to an inspection program.

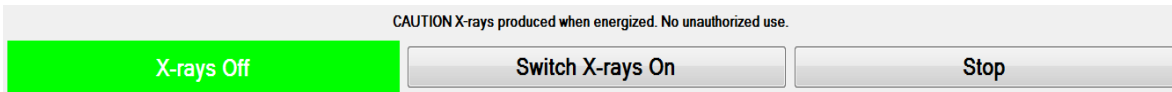


10. X-ray zone

The controls for switching X-rays on and off and stopping the manipulator in an emergency are always located in the bottom right corner of the screen.



X-rays should always be turned off before opening the operator door; do not rely on the door interlocks to switch X-rays off.



11. Manipulator Map (Not shown on overview)

The **Manipulator Map** floating window can be displayed from the **imaging control toolbar**. It shows an X-ray image-based map (on XT V systems) which can be used to position the manipulator.



The manipulator map may appear next to the image window, depending on the system settings.

5.5.1 The Inspect-X manipulator and imaging controls

The controls that you need to position your sample and adjust the image so that you can see appropriate detail are presented on Inspect-X's **Position and Optimise** tab. This tab is available to you in the **Radiography**, **CT** and **X.Tract** workflows. The following section describes how to:

- **Position the sample** (on page 34)
- **Optimise the image** (on page 35)
- **Switch X-rays on and off** (on page 37)

Position the sample

To inspect a sample, move it into the path of the X-ray beam using the manipulator. Control the manipulator axes using:

- The joysticks on the operator console.
- The **Axes** controls and readouts in the **Position** panel on the **Position and Optimise** tab.
- Saved manipulator position sets.
- The manipulator map (on XT V systems).
- Interactions with the live image window.

When using the joystick controls, the movement speed can be set with the **Joystick speed** controls. The automatic setting scales the movement speed with the movement of the joystick, that is, the movement speed is proportional to the amount a joystick is moved.






There are some small differences to the **Axes** controls in Inspect-X dependent on the type of manipulator within the X-ray system. In particular, there are different numbers of axes that may be controlled. Additional controls are displayed if you are using CT or X.Tract workflows, which allow you to centre, rotate or tilt a sample.



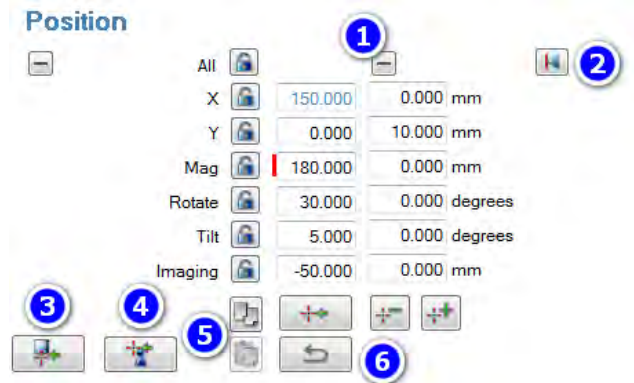
Before using the manipulator to position the sample, ensure that the manipulator has been homed. This needs to be performed each time Inspect-X or the computer is re-started. Home the manipulator from the **Setup** workflow.


Position panel

1. Shows requested and current positions for each axis in the left column and increment value in the right column.

Requested positions are shown in blue. In the example shown (Position panel), the X-axis position will change to the requested position (150.00) when you click , and the Y-axis will increment or decrement by 10 mm when you click  or .

2. Allows you to define limits of travel of axes on horizontal systems. The Mag-axis in the image above has a travel limit applied, shown by a red bar. This is especially useful in preventing collisions. It is recommended to set limits when loading new samples. XT V systems have an anti-collision system built in so the limit controls are not needed.



3. Opens the **Saved Positions** window, which allows specific manipulator positions to be saved and recalled.
4. Moves the manipulator to the **Load** position. You can then open the operator door and load the sample onto the manipulator.
5. If you want to move the manipulator to a position and then move back to the previous position, you can copy the original positions and then paste back these values.
6. The  button resets the requested values back to the actual positions.

Optimise the image

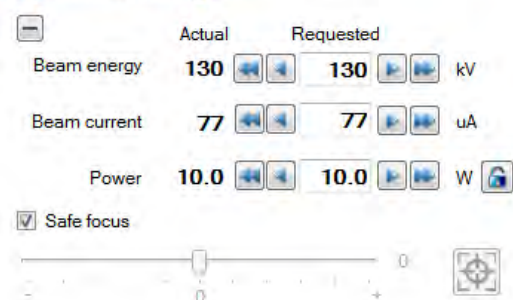
The X-ray parameters that need to be set to perform an X-ray inspection of a sample are:

- **Beam energy (kV)**, which controls the energy of the X-rays and hence the penetration of the sample.
- **Beam current (µA)**, which controls the brightness of the image by controlling the amount of X-rays generated.
- **Power (W)**, which is the product of the beam energy and current.

The X-ray target can only dissipate a certain amount of power before damage occurs. The X-rays are automatically defocused whilst **Safe focus** is selected to prevent damage. The power can be locked to optimise the X-ray spot size. Safe focus should **not** be disabled under normal operating conditions.

To adjust the X-ray conditions, use the controls in the **Optimise Image** panel on the **Position and Optimise** tab. You can adjust the conditions with X-rays switched on or off.

Optimise Image



Generally, the highest contrast in an image is obtained by the lowest X-ray energy (lowest kV) that produces the desired sample penetration:

- If you are unable to see detail in your sample, increase the X-ray energy (kV).
- If the contrast is poor because the sample is being over-penetrated, decrease the X-ray energy (kV).
- If the image is too dark, increase the flux (μA).
- If the image is saturated, and you cannot see detail, decrease the flux (μA).
- Ensure that the image is sharp with the fine focus control.



Fine focus controls are by default only enabled below the defocusing threshold of the fitted target. For example, <7 W for the 225 kV reflection target and 3 W for the 180 kV transmission target.



Adjusting the X-ray conditions and image settings is an iterative process and requires some knowledge of what to alter. In particular, knowledge of how to reduce the noise in the image is important. There are two major sources of noise: X-ray photon noise and electronic noise within the imaging detector.

The effective resolution of the X-ray image is a function of the X-ray spot size and the effective pixel size of the imaging panel, which depends on the sample geometric magnification.

X-ray spot size

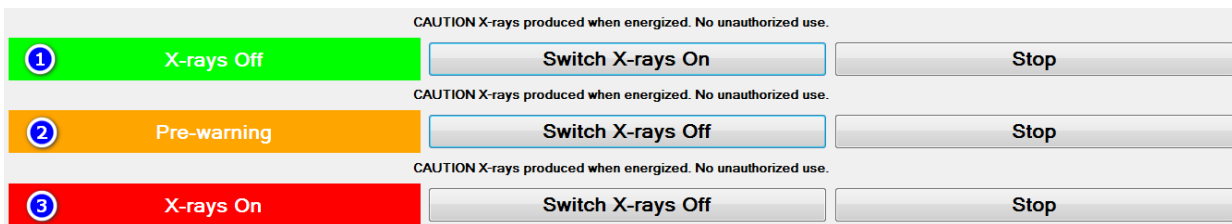
The X-ray spot size is dependent upon the X-ray power, which is the product of the beam energy and beam current. Increasing either the kV or the μA increases the power and once the defocus limit of the target is reached, the X-ray spot is automatically defocused to prevent damage to the target material, making the spot size larger. The larger the X-ray spot size, the lower the defining resolution. However, if the X-ray spot size is smaller than the effective pixel size (displayed in Inspect-X) of the imaging panel, then the dominant factor in the defining resolution is the effective pixel size. The total power value can be locked to keep the spot size at a given value by clicking the padlock icon.

Effective pixel size

The effective pixel size is dependent upon the geometric magnification of the sample, and thus dependent on the Z-axis position and imaging panel pixel size.

Switch X-rays on and off

The X-ray zone always displays in the bottom-right corner of the Inspect-X window.



It clearly shows the status of the system and whether X-rays are switched on (3) or off (1). When you click **Switch X-rays On**, a pre-warning is displayed (2), corresponding to the physical warning light. After a short delay, the X-rays are switched on (3). There are two buttons in the X-ray zone, which are used to:

- Switch X-rays on or off.
- Stop all movement of the manipulator in an emergency (**Stop**).



X-rays should be switched off using these controls prior to opening the system door.



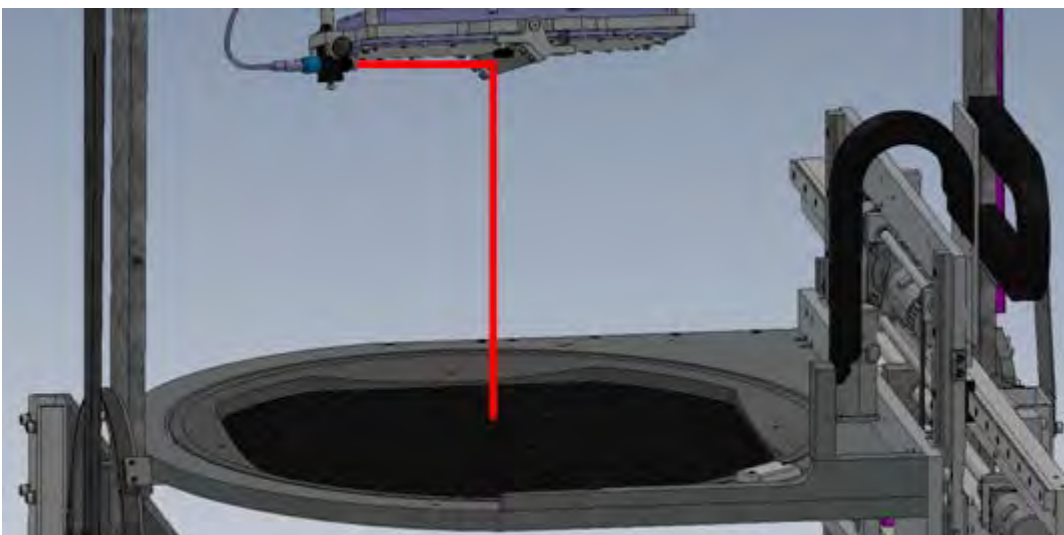
Do not use the interlocks to switch the X-rays off during normal use. Doing so shortens the life of the filament.



By default the pre-warning delay only occurs if the system door has been opened since the last X-ray On.

5.6 Laser pointer

A laser pointer is an optional item, which may be fitted to the X-ray system. The laser pointer system consists of a diode laser module mounted underneath the X-ray system imaging system aimed at a Mylar foil mirror. This mirror directs the laser beam downwards onto the upper side of the sample tray whilst being invisible in the X-ray image. The path of the laser beam is aligned to coincide with the centre of the X-ray image as shown below:



5.6.1 Use the laser pointer

The laser pointer is aligned with the centre of the X-ray image to allow you to easily position your sample for inspection. The part of the sample illuminated by the laser beam will appear near the centre of the X-ray image.

5.6.2 Clean the laser optics

If the laser pattern becomes fuzzy or unclear you should check that the laser lens and Mylar foil mirror are clean. Remove any contamination, as necessary.



Switch off power to the X-ray system before checking the laser optics.
Do not stare into the laser beam.

6 Maintenance

6.1 Preventive maintenance

Checks should be carried out at frequent intervals, dependent on the duty cycle of the system and the type of environment. Please consult with your company health and safety officer, or local authority to establish a suitable routine inspection procedure. The following should be regarded as a guide to a minimum standard.

A full inspection and service should be carried out annually, or twice a year if the environmental conditions are harsh or the usage cycle is above average.

If you have any queries about maintenance procedures, please contact Nikon Metrology.



Routine maintenance is only to be carried out by trained personnel.
Servicing is only to be performed by trained service engineers.

6.1.1 Interlock testing

The preventive maintenance schedule should include this interlock testing procedure:

Equipment Interlock testing						
Name	Location	Activation method	Verification method	Test frequency	Comment	Pass/Fail
Operator Door	Upper and lower door corner	Open the door	Try to move the manipulator. Should not respond to commands.	Weekly		
Operator Door	Upper and lower door corner	Open the door	Ensure the interlock status is reported in Inspect-X properly for the X-ray source interlocks as well as the manipulator	Weekly		
Emergency Switch OFF (EMO)	On the operator table, near joysticks	Push the button down until it locks	All systems apart from computer are powered down - pumps are stopped, manipulator cannot be moved with controls.	Monthly		

6.1.2 External connections

Check the routing of all external cables to avoid any physical stress:

- Install the electrical supply cable outside of usual walkways, to minimise the hazard for pedestrians.
- Protect the electrical supply cable from being mechanically stressed (squeezed, pinched, pulled).
- Keep the electrical supply cable easily accessible for an emergency disconnection.
- Protect the electrical supply cable and its terminals from being splashed or immersed in water.



Do not apply power to the system before having checked that all cables and pipes are properly connected.

6.1.3 Status indicator LED

There is a coloured indicator LED located on the X-ray source.



Status indicator LED (circled)

The possible colours and their meaning are:

Bright Green	Normal operation
Red (upper position)	“X-ray on” lamp failure
Red (lower position)	“Pre-warning” lamp failure
Orange	Electronics over temperature
Yellow	Oil over pressure
Blue	Coolant flow failure

6.1.4 Maintenance checks



If a warning buzzer sounds, or warning messages appear on the monitor(s), there is a fault with the system.



If the coolant flow/level warning lamp is illuminated, do not use the system. Report any problems to a trained service engineer.



If in doubt about any faults, do not use the system.

The X-ray source filament has a lifetime of approximately 200 hours. Only trained personnel should perform filament changes, as correct filament setup is very important in achieving good system performance.

Daily

An operator should perform the following checks on a daily basis:

1. Before switching the system on, a visual check should be made for signs of any leakage of fluids. The system uses coolant and mineral oil, either of which could leak under extreme circumstances.
If there is any evidence of leakage from under the system, DO NOT switch the machine on and request a Nikon Metrology-trained engineer to inspect the system.
Deal with any spillage using absorbent granules and alert other users by placing signs in the area to indicate a slipping hazard.
2. Check that the operator door operates smoothly and closes correctly with firm pressure.
3. Check all indicator lamps for correct functionality.
4. Check inside the cabinet for any foreign objects. Nothing should be left anywhere inside the cabinet.
5. Run through the power-up sequence and note anything unusual.

Weekly

An operator should perform the following checks on a weekly basis:

1. Operate the manipulator through the whole of its range to check for unusual noises, which might indicate a loose drive chain or any jamming of the mechanism. Also, check that the end of travel limits operate correctly by moving each axis to both limits of travel. Any problems will require the attention of a trained engineer.
2. Check that all switches and warning lamps operate correctly.
3. Check that the external cooling fans are producing a reasonable flow of air and are not producing any unusual noises.

Monthly

Access to the service area of the system is required to perform monthly maintenance tasks. A Nikon Metrology-trained supervisor should perform the following tasks on a monthly basis:

1. Check all electrical connections for physical security.
2. Check cables for signs of deterioration or damage.
3. Check all connections to accessories fitted to the system and computer.
4. Check all cooling and filter vents on the back of the cabinet and top and bottom of the X-ray source for obstructions, and clean as necessary.
5. Check all vacuum system connections for security.
6. Check the cooling system and coolant level.
7. Check the oil level in the backing pump.
8. Check the emergency stop button(s) function correctly.
9. Unplug one of the coolant hoses from the target and check the coolant flow interlock functions. Have absorbent material available to clean up any leakage.

7 Declaration of conformity

This section contains pictures of typical declaration documents with a text version to provide a translation of the contents. They are not intended to be the actual certificates, which will be issued and supplied specifically for each machine.

DECLARATION OF CONFORMITY							
Name of manufacturer: Nikon X-Tek Systems Ltd.							
Address of Manufacturer: Unit 5E, Tring Business Centre Icknield Way, TRING HP23 4JX UK							
Declare under our sole responsibility that the following product:							
Industrial X-Ray Inspection Machine							
Model: XT V 130C / 160 (Mk 4) JN####							
Conforms with the relevant Essential Health and Safety Requirements (EHSRs) of the Machinery Directive 2006/42/EC , with the relevant requirements of the Low Voltage Directive 2014/35/EU and with the essential protection requirements of the EMC Directive 2014/30/EU and EU Council Directive 2013/59/EURATOM ,							
and that, where applicable, the following standards and normative documents have been applied:							
<table border="1"><tr><td>BS EN 60204-1:2006+A1:2009</td></tr><tr><td>Ionising Radiations Regulations 2017</td></tr><tr><td>Title 21 CFR 1020.40</td></tr><tr><td>BS EN ISO 12100:2010</td></tr><tr><td>BS EN ISO 13849-1:2015</td></tr><tr><td>BS EN 61326-1:2013</td></tr></table>		BS EN 60204-1:2006+A1:2009	Ionising Radiations Regulations 2017	Title 21 CFR 1020.40	BS EN ISO 12100:2010	BS EN ISO 13849-1:2015	BS EN 61326-1:2013
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BS EN ISO 12100:2010							
BS EN ISO 13849-1:2015							
BS EN 61326-1:2013							
Date: 5th March 2019							
Name: David John Bate							
Function: Vice President of Engineering (Research)							
Signature: 							
<div>Doc Ref. XTF029 V7</div>							
The technical documentation for the machinery is available from the above address.							

DECLARATION OF CONFORMITY

Name of manufacturer: Nikon X-Tek Systems Ltd.

Address of Manufacturer: Unit 5E, Tring Business Centre,
Icknield Way,
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Declare under our sole responsibility that the following product:

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Title 21 CFR 1020.40
BS EN ISO 12100:2010
BS EN ISO 13849-1:2015
BS EN 61326-1:2013

Date: 05th March 2019

Name: David John Bate

Function: Vice President of Engineering (X-ray)

Signature:

A handwritten signature in black ink, appearing to read 'D J Bate', is written over a light blue horizontal line.

Doc Ref.

XTF029 V7

The technical documentation for the machinery is available from the above address.



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