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OPERATING MANUAL. MAN-059, REVISION B

OPENVISION™ DX.

OVDX-NDT-70 HARDWARE MANUAL

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TABLE OF CONTENTS.

INTRODUCTION.

OpenVision™ DX is an easy to use, digital X-ray system with live video output for real-time radiographic inspection and reporting. A patent-pending combination of a c-arm mounted 70 kV X-ray source and a digital imager allows you to observe external defects as small as 0.010-inch (250 µm) on insulated piping.

OpenVision DX can be used on various insulation and cladding combinations, including mineral wool and calcium silicate with galvanized steel, stainless steel, and aluminum cladding up to 36 inches (91 cm) in total diameter.

OpenVision DX enables the inspection of hundreds of feet (many tens of meters) of insulated piping to quickly identify indications of corrosion or corrosion precursors such as scaling, external wall loss, and wet insulation. Pictures and real-time videos are recorded and downloaded with the touch of a button for rapid review and reporting.

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EQUIPMENT SPECIFICATIONS.

Table 1 OpenVision™ DX Specifications			
Imaging Area (Field of View)	4 in. x 6 in. (10 cm x 15 cm)		
Dimensions **X-Ray Tube to Imager** **Throat Depth** **Imager Thickness** **X-Ray Tube Thickness**	 9.5 in. (24 cm) to 20.9 in. (53 cm) 21 in. (58 cm) 2.5 in. (6.4 cm) 3.4 in. (8.7 cm)		
Startup Time (est.)	30 seconds		
Shutdown Time (est.)	5 seconds		
X-Ray Energies **Low** **Medium** **High**	Voltage (kV) 40 55 70	Current (mA) 0.300 0.218 0.171	Dose @ 12 in (30.5 cm) from beam port 50 R/hr (0.5 Sv/hr) 80 R/hr (0.8 Sv/hr) 95 R/hr (0.95 Sv/hr)
Beam Collimation (Approximate)	18° Horizontal 10° Vertical		
Image Resolution	250 microns (0.01in)		
Battery Life **Continuous duty with 5 Ah battery** **Standby**	 3 hours 8 hours		
System Weight **C-arm** **Monitor w/ handle (optional)** **Packaged system (shipping weight)**	 15 lbs. (6.8 kg) 2 lbs. (.9 kg) 50 lbs. (23 kg)		
Operating Temperature	-20° F to 120° F (-29° C to 49° C)		
Storage Temperature	-20° F to 140° F (-29° C to 60° C)		
Display Options	HDMI Monitor: 7 in. LCD, 1920 x 1200 pixels WiFi Tablet: 10 in Touchscreen, 1400 x 900 PirateEye: 854 x 480 pixels Also compatible with any device that accepts an HDMI signals		
Recording (OpenVision DX) **Internal storage** **Resolution** **Image / video transfer**	 128 GB 1280 X 720 USB		
Recording (WiFi Tablet) **Internal storage** **Resolution** **Image / video transfer**	 4 GB with expandable 128 GB memory 1280 X 720 USB		
Shipping Dimensions	32 in. x 20.5 in. x 12.5 in (82 cm x 52 cm x 32 cm)		
FDA Accession #	1680071-000		

The OVDX-NDT-70 is built in compliance with ISO 9001:2015 and meets the following standards when used as directed:

- ANSI/HPS N43.5 (2005)
- Ionizing Radiation Regulations (2017)
- ISTA 3A Over the Road vibration standard
- MIL-STD-810, Method 514, Annex C, Cat 4
- REACH/ROHS
- CE

Heads Up Display (HUD)

- ANSI Z87.1+, US Federal OSHA
- US Mil Spec MIL-PRF-31013
- CE END 166 FTKN

Battery/Charger

California Energy Commission

Underwriters Laboratory for Canada and U.S.

Revision Record

Revision	Date	Description
A	06/2019	Production Release
B	03/2020	r3.0.0 Software updates, Tablet operation, Remote trigger configuration, Remote software update instructions

SAFETY PRECAUTIONS.

WARNING

Do not perform any unauthorized modifications to the OpenVision™ DX system or components of the system.

It is important that trained and qualified personnel perform or supervise a daily safety inspection of the OpenVision DX system for obvious defects before using the system. Do not compromise on safety. Always perform the daily inspection of the system prior to use.

Any foreign material (dirt, mud, ice, etc.) must be removed before using the system. Inspect, clean, and test the equipment as described in this manual to ensure long-term safety and reliability.

Do not use any component that is not approved for use with the OpenVision DX system or any after-market component as they may compromise the safety features designed into the system.

Defective equipment that is discovered during the daily inspection must be removed from service until repaired or replaced.

The user of this equipment must follow the operating instructions, in the order shown, to ensure safe operations and compliance with government regulations.

Personnel operating this equipment must be completely familiar with this manual and they must read and understand these important safety alerts before proceeding.

IMPORTANT SAFETY ALERTS

NOTICE: Can cause minor problems and reminders.

CAUTION: Can cause equipment damage or potential problems.

WARNING: Can cause serious or fatal injury.

WARNING: JOB SITE SAFETY PRECAUTIONS

Surveillance
Only trained and qualified individuals, or assistants working under their direct supervision, may operate the OpenVision DX system. The qualified individuals must be physically present at the site and able to control and limit access to the vicinity of the work.

Locking
Keep the OpenVision DX controller locked while assembling the system and when not being used to perform scanning. Locked is defined as the controller key switch in the Off position with the key removed. Store the key in a secure location.

Operating Conditions

OpenVision™ DX is designed for applications where the equipment will not be exposed to harsh handling or environmental extremes. See Equipment Specifications for more information

X-Ray Training

It is required that OpenVision DX operators are properly trained and qualified to perform radiographic inspections. This manual does not address radiographic inspection techniques or procedures.

Precautions

The OpenVision DX system is designed for portability and is ruggedized for industrial environments. However, it does contain fragile components. Use care to avoid strong vibrations and shock conditions (e.g. equipment drops or transportation outside the approved case) to the main housing, imager housing, and display(s).

CAUTION

Do not attempt to open or modify the imager housing, main housing, or X-ray tube. Opening any of these components will void the system warranty and may expose the operator to a high voltage shock hazard.

CAUTION

Do not allow liquids to come into contact with any part of the OpenVision™ DX system. The main and imager housings have been made water resistant, but they are not “Waterproof”. Appropriate care should be taken to protect all cabling and connectors to ensure reliable and safe operation of the OpenVision DX system.

WARNING: Class 2 Target Laser

Because the blink reflex (glare aversion response to bright lights) will limit the exposure to no more than 0.25 seconds, Class 2 laser pointers are considered to be safe. Furthermore, Class 2 lasers do not harm eyes unless a person deliberately stares into the beam, making laser protective eyewear not necessary. A Class 2 laser is not a skin or materials burn hazard. NEVER aim any laser towards an aircraft or vehicle in motion.

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GETTING TO KNOW YOUR OPENVISION™ DX SYSTEM.

What's Included

The OVDX-NDT-70 is shipped complete in a Pelican case.

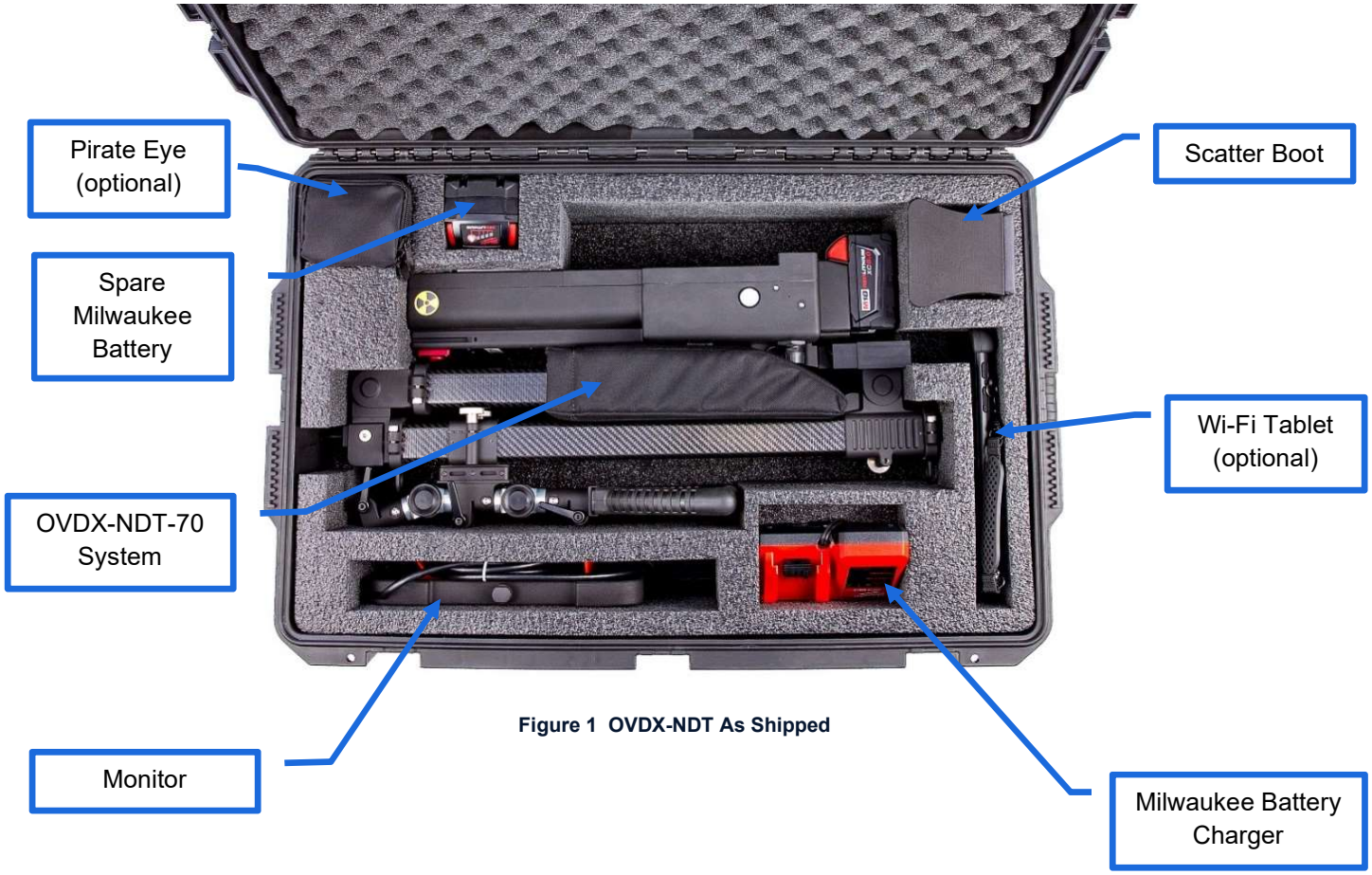
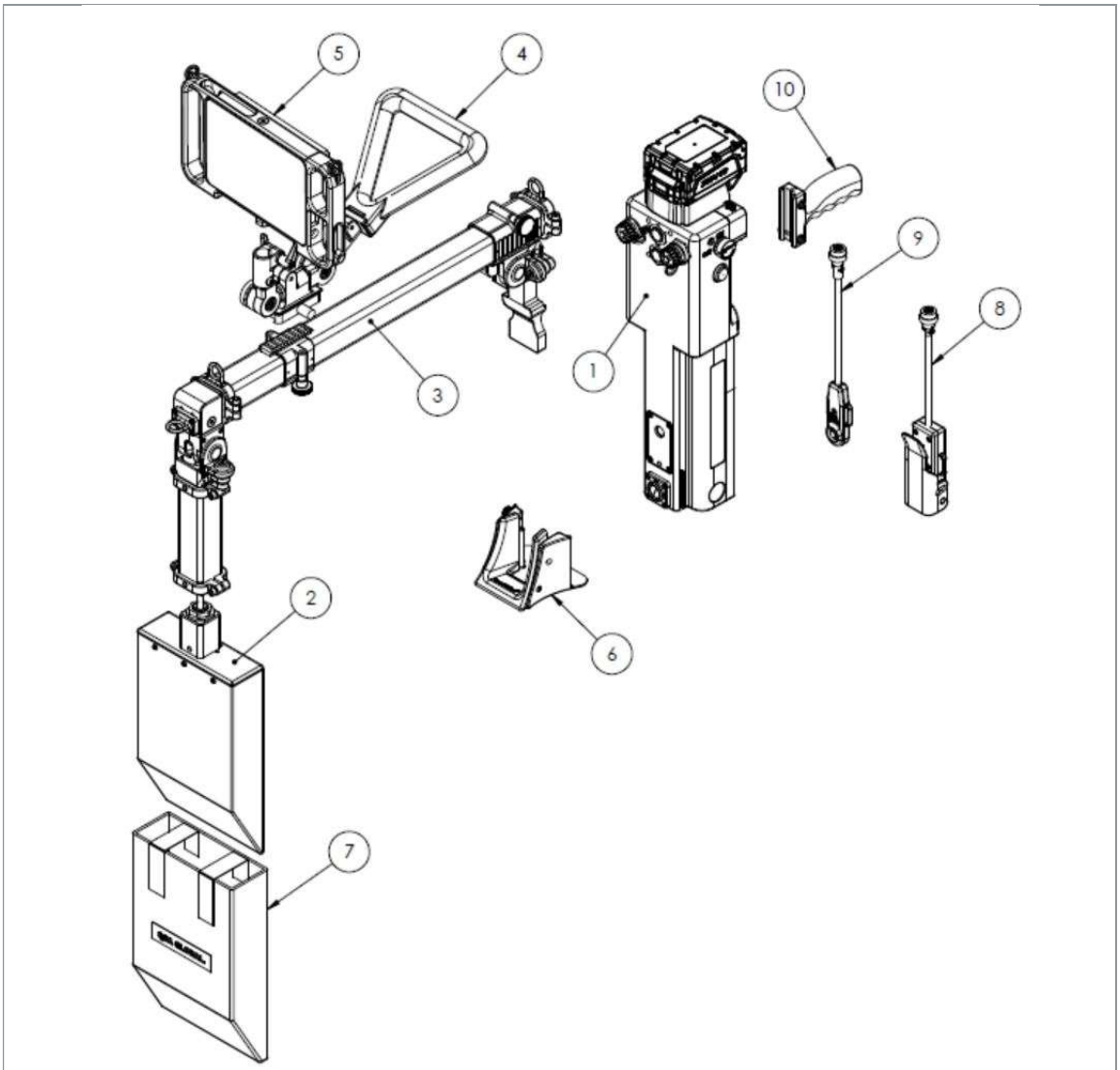


Figure 1 OVDX-NDT As Shipped

Some components are packaged and placed in bags or located loose in the Pelican case.

Figure 2 - OVDX AS SHIPPED MISC. COMPONENTS

ITEM	PART #	DESCRIPTION
1	-	Tablet Mounting Bracket (with optional tablet only)
2	-	Monitor Sunscreen
3	-	Tablet Charger (with optional tablet only)
4	ELE114	USB-A to USB-C Adapter – Allows connection USB-A flash drive (with optional tablet only)
5	ELE115	Ethernet Adapter – Allows connection from Ethernet to OVDX or Tablet
6	ELE116	USB 3.0 Adapter – Allows connection from OVDX USB-A to Ethernet Adapter
7	-	Monitor batteries and charger
8	-	USB charger cable – Allows for changing monitor batteries via USB outlet
9	ELE111	USB Wall Charger – Allows charging of monitor batteries via standard 120 outlet
10	-	Monitor power supply – Allows direct power to monitor via 120 outlet
11	TOL028	7 Piece Allen wrench set
12	313425	Bungee Sling
13	-	Monitor Mount – Allows mounting of monitor directly onto OVDX
14	313056	Controller Key – Used to turn on / power up OVDX – Removed for shipment
15	HDL010	Pistol Grip – Mounts to picatinny – Removed for shipment
16	415540-A	Trigger Button Harness (3 ft)
17	415530-B	Remote Trigger Harness (6 ft)



Item	Part No.	Description
1	415100-NDT	OVDX Main Housing Assembly
2	415200-NDT	OVDX Imager Assembly
3	415300	OVDX C-Arm Assembly
4	415400	OVDX Handle Assembly
5	415440	OVDX Lightweight Monitor Assembly
6	415600	Backscatter Shield Assembly (Scatter Boot)
7	415200-11	Imager Cover
8	415530-B	Remote Trigger Assembly (6ft)
9	415540-A	Trigger Button Assembly (3 ft)
10	HDL010	Tactical Foregrip

Figure 3 OpenVision DX Assembly Description

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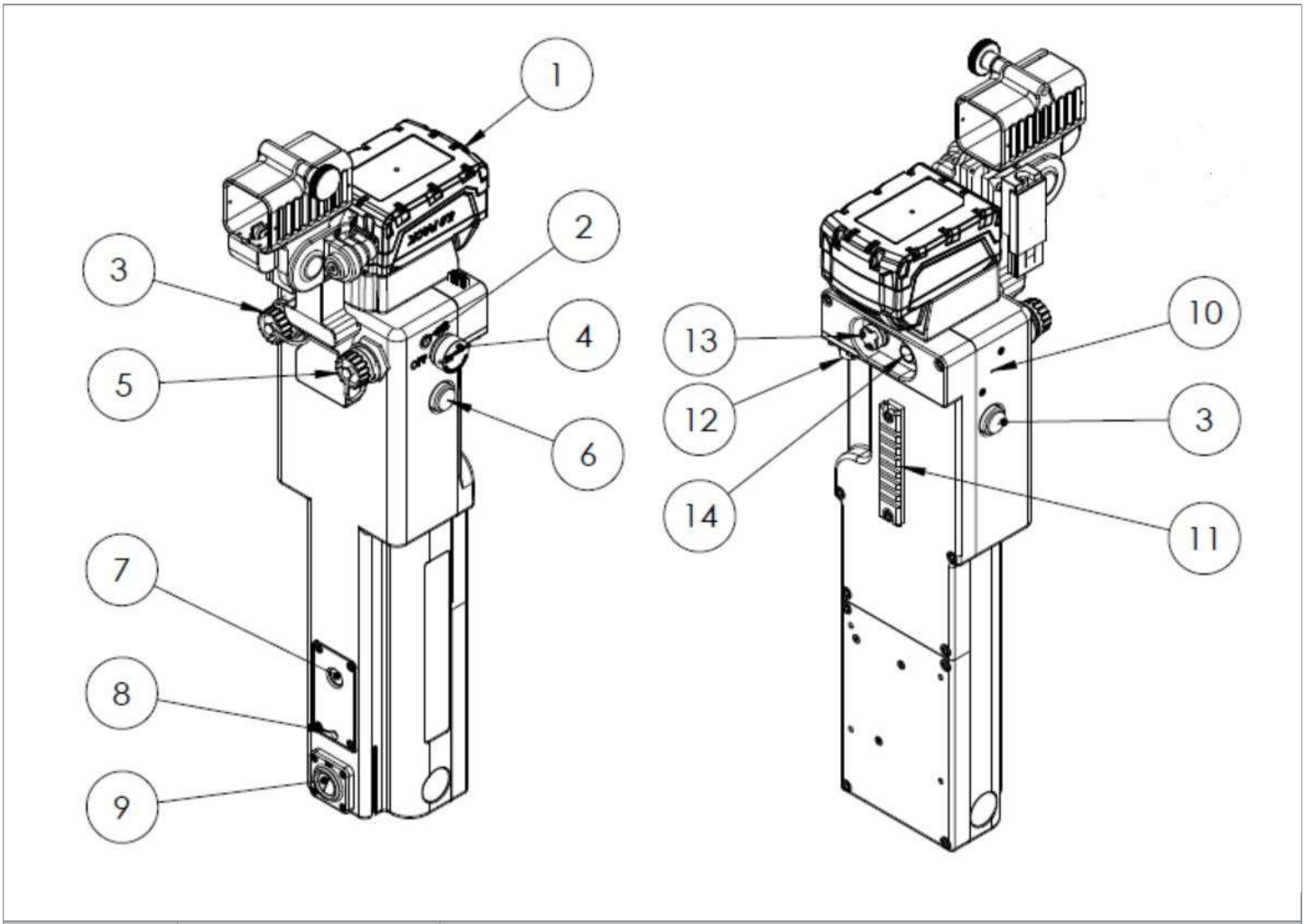
OpenVision™ DX Main Housing Details



Item	Part No.	Description
1	ELE054	Milwaukee® M18™ Battery
2	---	CPU Power Indicator
3	---	USB Connection
4	313056	Controller Key
5	---	HDMI Connection 1
6	---	System Status Indicator
7	---	Targeting Camera
8	---	Targeting Laser
9	---	X-Ray Port
10	---	Audio Speaker
11	RAI002	Picatinny Rail
12	---	Trigger Connection
13	---	Hat Switch
14	---	Image Capture / Input Button

Figure 4 OpenVision DX Main Housing Assembly (Item # 415100-NDT)

Monitor

The OpenVision™ DX monitor (Figure 5 and Figure 6) is a lightweight 7-inch HDMI display. It can be connected to either of the two HDMI ports provided on the OpenVision DX via the HDMI cable provided. The monitor comes configured to work with your OpenVision DX system. Spare Batteries and a battery charger (Figure 7) are included.

Figure 5 Monitor Assembly

Figure 6 Back of Monitor

Figure 7 Battery Charger

Trigger Assemblies

The OVDX-NDT-70 comes standard with two trigger assembles:

- 415540-A (Figure 8) can be used for X-ray firing only.
- 415530-B (Figure 9) can be used for X-ray firing and Image / Video capture. Refer to Figure 10 for the connection location. Refer to software user manual (MAN-063) for operation.

Figure 8 415540-A Trigger Button Harness

Figure 9 415530-B Remote Trigger Harness

Figure 10 Trigger Assembly Connection

PRINCIPLES OF OPERATION.

Radiography uses X-rays or gamma rays passing through a specimen onto an imaging medium (film, digital imager, imaging plate, etc.) on the opposite side. The quality and quantity of radiation reaching the imaging medium is largely determined by the object's thickness and density. Radiation *energy* (X-ray = kV; Gamma Ray = isotope) governs its penetrating power. Radiation *intensity* is governed by current (milliampere or mA) for X-rays, and by content activity (Curie/Becquerel) for radioisotopes.

Radiographic Quality

Radiographic quality depends on an image's photographic (density, contrast) and geometric (definition, distortion) properties. Proper *energy* and *intensity* selection are both essential for producing high-quality radiographs.

Sources (X-Ray & Gamma Ray)

Table 2 Radiation Comparisons

Radiation Source	Energy (Quality)	Intensity (Quantity)
X-Ray	Determined by voltage (kV) Higher kV = shorter wavelength = higher penetration	Determined by tube current (mA) Higher mA = more electrons = more X-rays
Gamma Ray	Determined by type of radioisotope (keV or MeV) Higher isotope energy = increasing penetrating capability: Co-60 > Cs-137 > Ir-192 > Se-75	Determined by radioactivity (Ci/Bq): Gamma Rays produced by unstable nuclei disintegrations Higher Ci = more disintegrations of nuclei = more gamma rays

Simplified Exposure Determination with X-Rays

By using X-rays, the OpenVision™ DX system has the advantage of real-time radiography (immediate availability of images). Time calculations (as used in gamma-ray radiography exposure) are not needed for X-ray radiography.

To determine exposure requirements, start on the lowest kV and mA settings and adjust to achieve the desired image quality.

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RADIATION ZONES.

Output Radiation Levels

OpenVision™ DX radiation levels vary depending on kV/mA settings. QSA Global, Inc performs testing at maximum power at the highest kV setting (70 kV, 0.17 mA) to verify collimation and image quality. Operators must be aware of safe boundary distances while using the OpenVision DX. When the main housing is fully expanded ("D" = 53 cm [20.8 in]), the most susceptible area of high dose rate (when specimens do not block entire X-ray output beam) is immediately adjacent to imager housing. The "C" callout in Figure 11 is positioned in this approximate area.

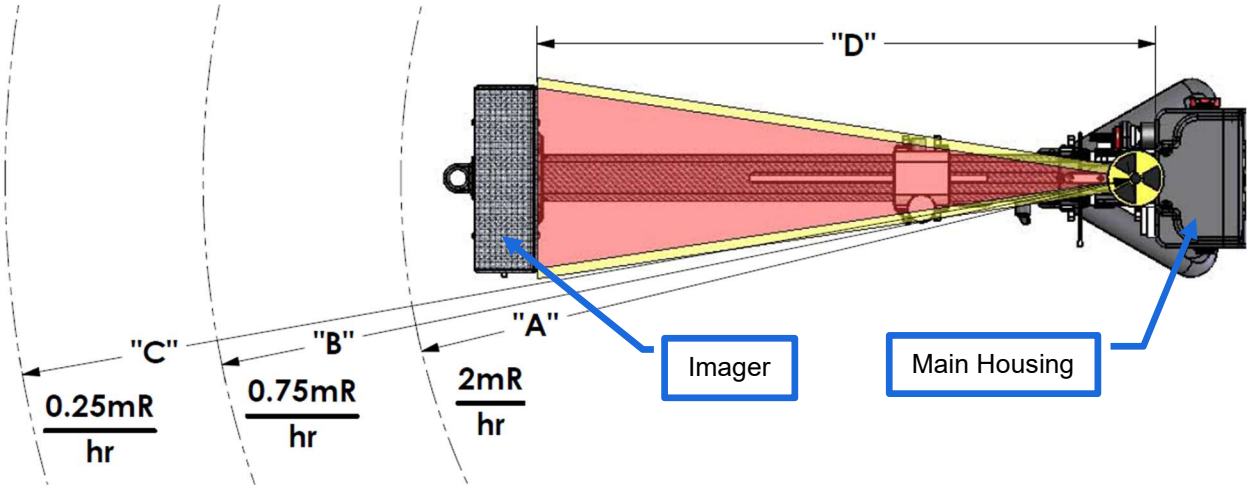


Figure 11 OpenVision DX Output Boundary Distances

Figure 11 shows boundary distances for 2, 0.75 and 0.25 mR/hr. Table 3 below details typical distances for these boundary levels with different operating conditions.

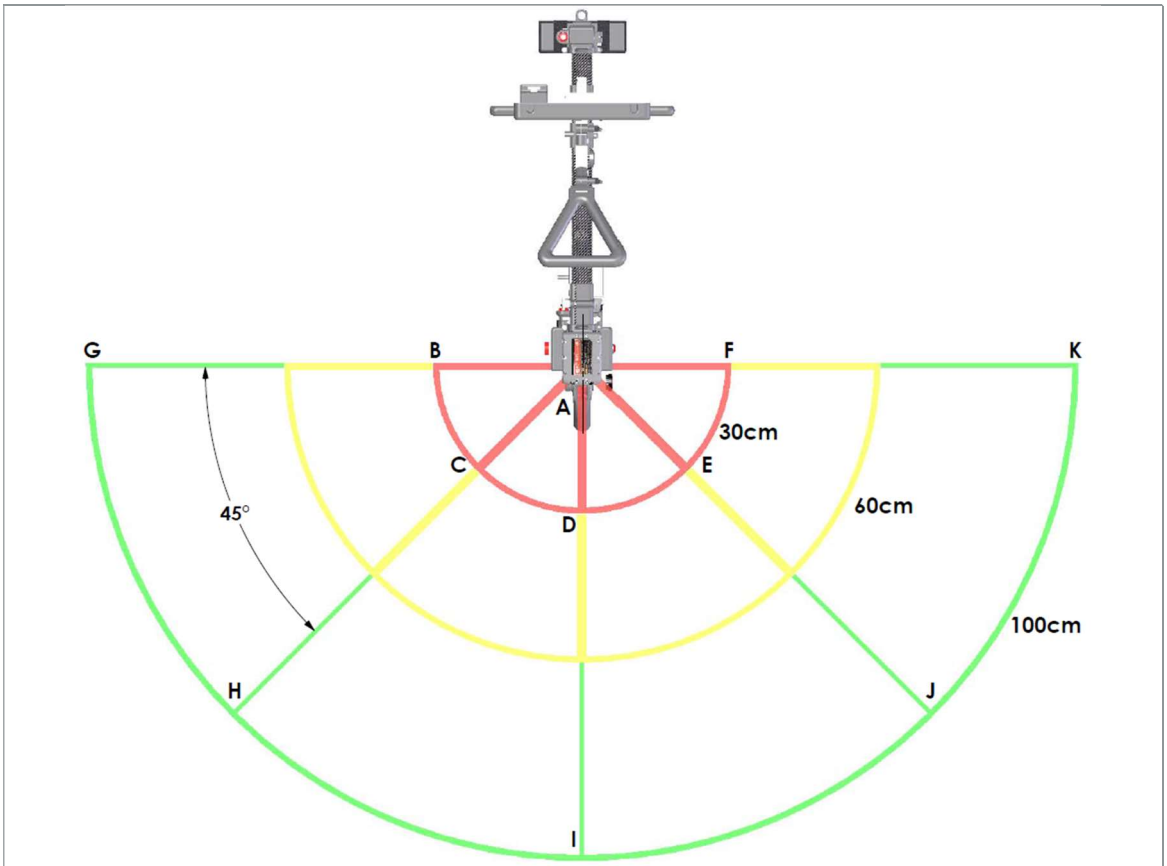
NOTICE: The imager shield (see Figure 31 on page 28, item #415230, not shown in Figure 11) provides shielding to either side of the imager when the specimen being imaged (e.g., small piping) does not completely attenuate the X-ray output.

Table 3 Boundary Distance Comparison

Main Housing Distance to Imager (in [cm]) "D"	kV / mA	Imager Shield?	Boundary Distance (ft [m])		
			2 mR/hr (20 µSv/hr) "A"	0.75 mR/hr (7.5 µSv/hr) "B"	0.25 mR/hr (2.5 µSv/hr) "C"
20.8 [53] (Fully Expanded)	70 / .17	No	82 [24.9]	134 [40.7]	231 [70.5]
20.8 [53] (Fully Expanded)	70 / .17	Yes	10.4 [3.2]	17.4 [5.3]	30 [9.2]
13.8 [35]	70 / .17	No	17.4 [5.3]	28.2 [8.6]	49 [15]
13.8 [35]	70 / .17	Yes	9.8 [3.0]	16.1 [4.9]	27 [8.5]

Actual measurements can vary based on the material being scanned and its geometry. To minimize operator exposure, QSA Global, Inc. recommends using a backscatter shield assembly (Item # 415600) with your OpenVision DX.

Backscatter Radiation Levels



Survey Point	Without Backscatter Shield mR/Hr (µSv/hr)	With Backscatter Shield in mR/Hr (µSv/hr)
A	2.5 (25)	1(10)
B	7(70)	5(50)
C	5.5 (55)	1.5 (15)
D	1 (10)	0 (0)
E	6 (60)	1.5 (15)
F	6.5 (65)	5 (50)
G	≤Background (BKGD)	≤BKGD
H	≤BKGD	≤BKGD
I	≤BKGD	≤BKGD
J	≤BKGD	≤BKGD
K	≤BKGD	≤BKGD

Figure 12 Example Scatter Radiation Survey

Figure 12 shows an example survey of backscatter radiation (user exposure) for a typical sample (**NOTICE:** for reference only; actual readings may vary). The example survey shown in Figure 12 was created with the following conditions:

- 8 in steel pipe
- 2 in calcium silicate insulation
- .040 in [1 mm] thick aluminum cladding
- 70 kV @ 0.17 mA (maximum power at the highest kV level)

See the following section for additional information on backscatter.

Backscatter

Backscatter occurs when X-rays interact with material (piping, insulation, etc.), potentially travelling in undesirable directions (e.g. towards the operator). Backscatter is dependent on many variables including geometry, material, and energy level. It can potentially increase the dose to the operator's extremities.

The best way to minimize backscatter is to use the lowest kV / mA combination to achieve acceptable images. Use of the optional backscatter shield (Figure 13) will help reduce the amount of backscatter when firmly applied to the scanning surface as shown in Figure 15.

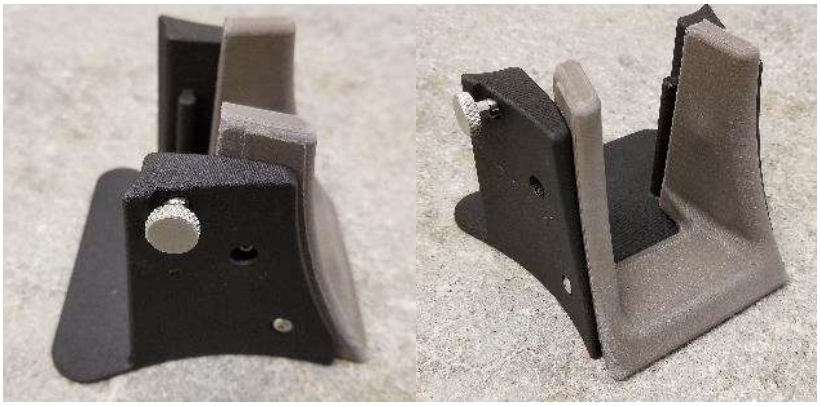


Figure 13 Optional Backscatter Shield (Item # 415600)

CAUTION

Whenever scanning an unknown material and/or geometry, it is recommended that operators monitor for backscatter levels to minimize operator dose.

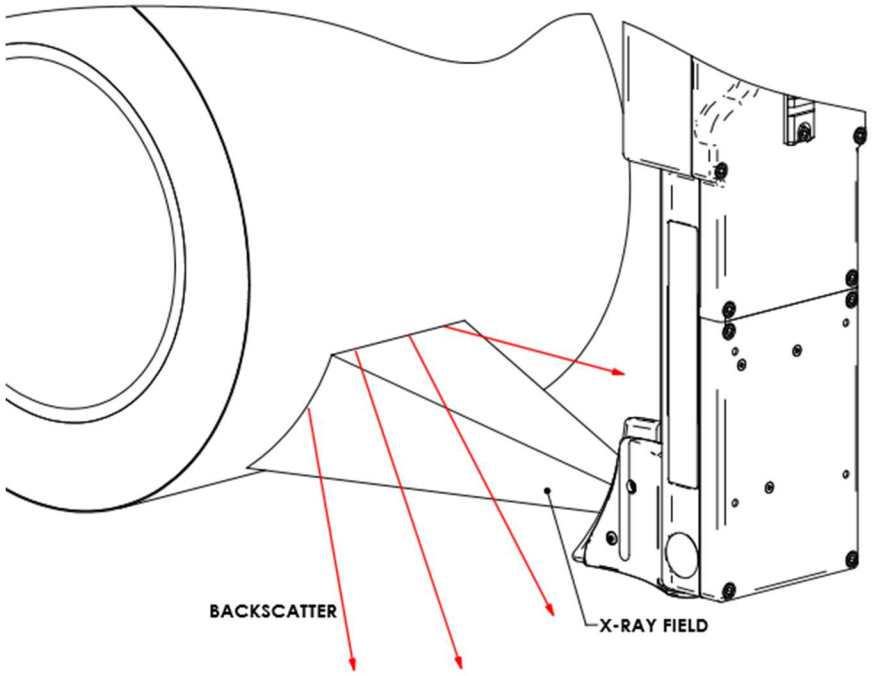


Figure 14 Example of Backscatter

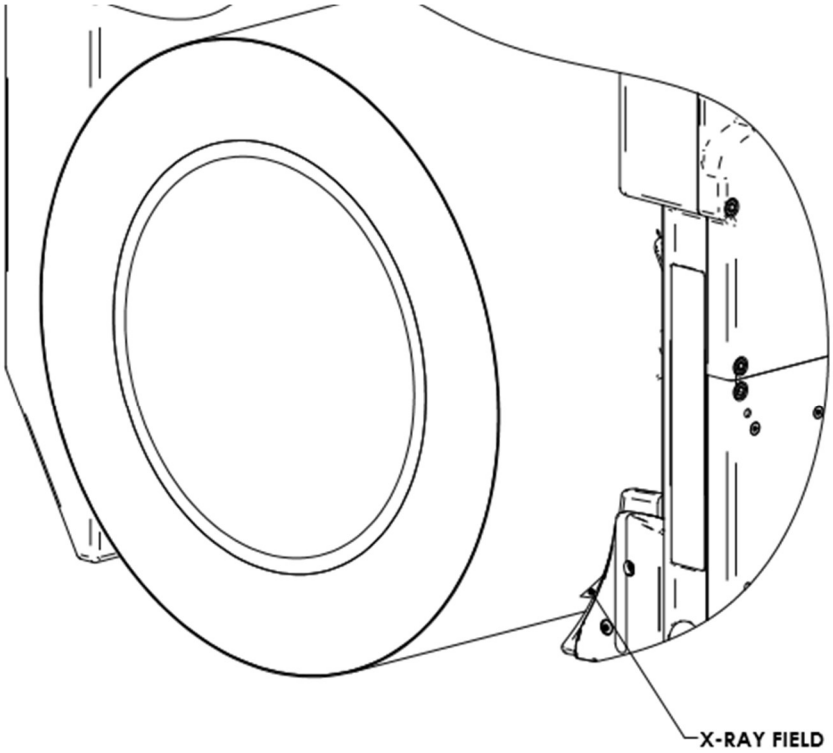


Figure 15 OpenVision DX with backscatter shield properly positioned against insulation sheathing.

WARNING

When the System Status Indicators turn AMBER (see Figure 4), ionizing radiation is being produced.

If you wish to perform extended operations with the OpenVision DX system, ensure that ambient temperatures are below 120 °F (49 °C) and above -20 °F (-29 °C).

Quick Setup / Scanning

Your OpenVision™ DX system can be setup and ready for scanning in a matter of seconds by following these steps:

- Unlock main housing by pressing red circular release button and unfold to operating position:

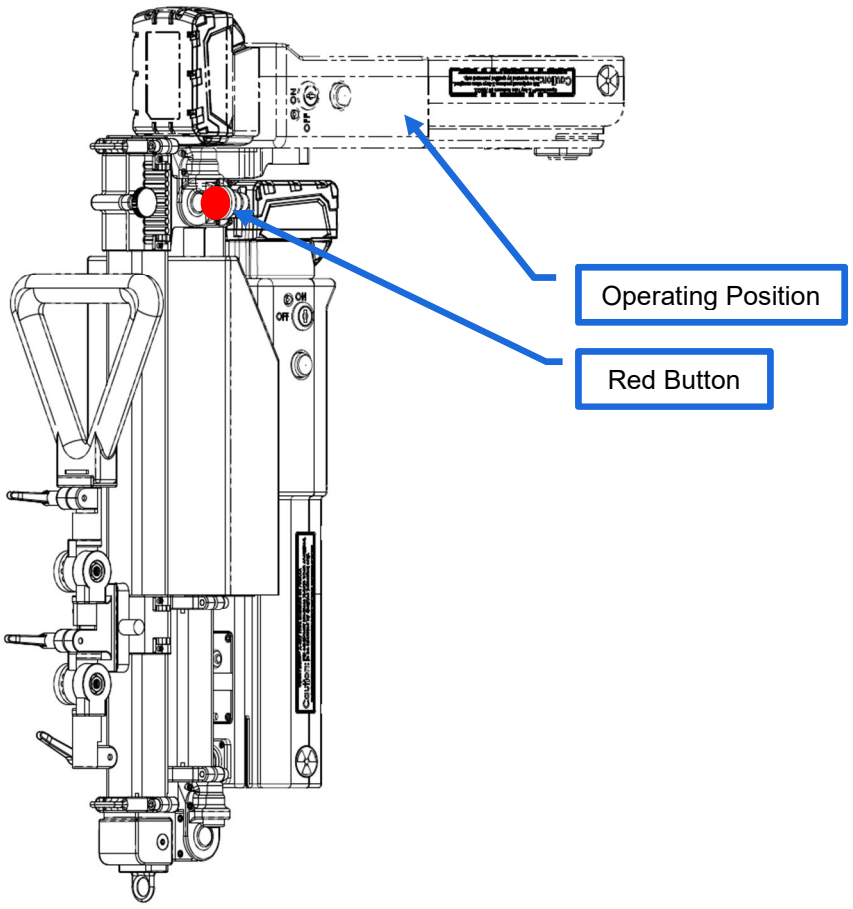


Figure 16 Unlock Main Housing

- Repeat action for imager housing:

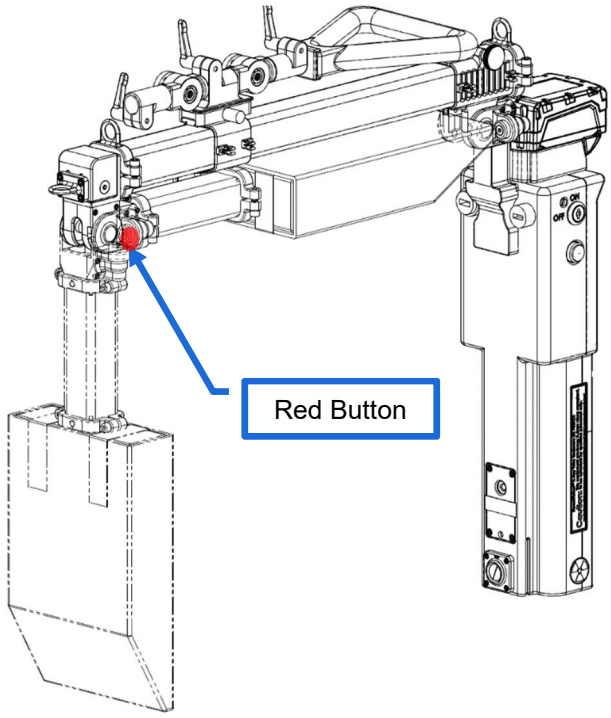


Figure 17 Unlock Imager Housing

- Position handles, attach and position pistol Grip and monitor mount as desired:

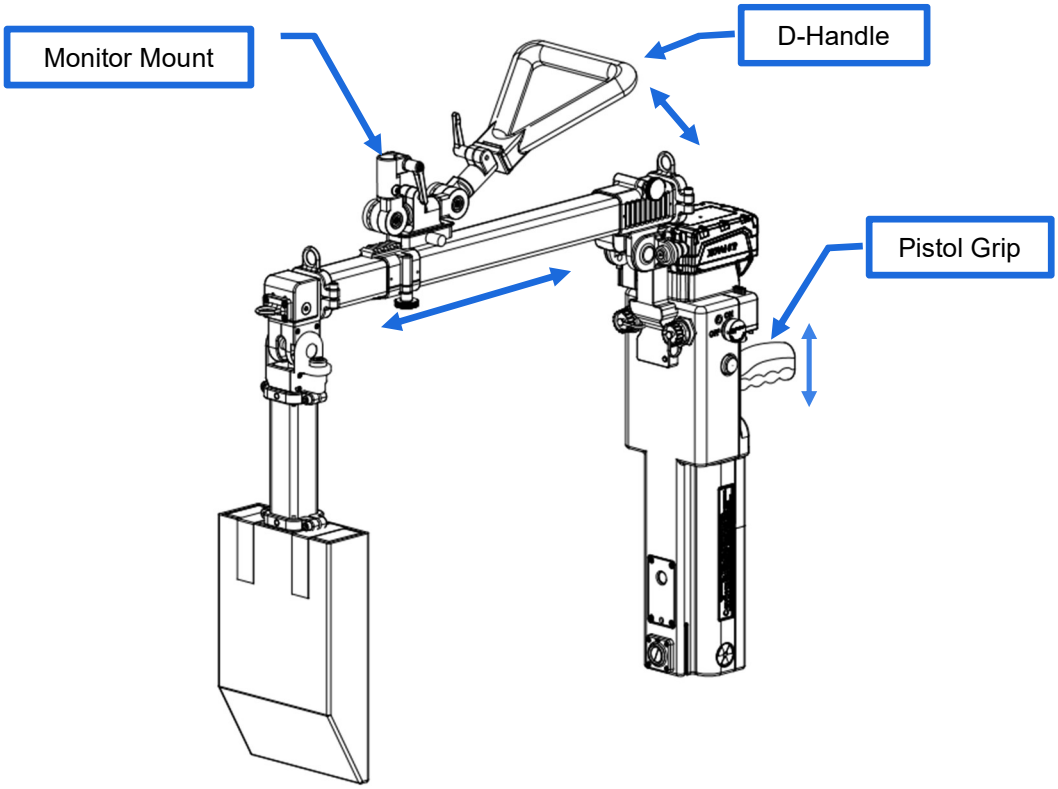


Figure 18 - Handle Adjustments

- The OpenVision DX utilizes standard picatinny rails and allows the handles and grips to be configured in multiple ways to suit different applications (Figure 19) shows one such configuration. The grip is moved to the top tube and the D-handle is moved to the main housing.

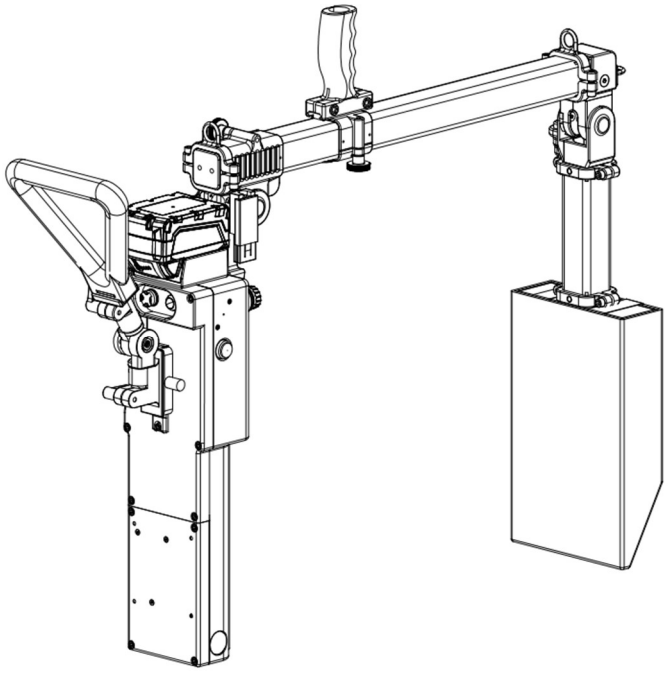


Figure 19 - Optional Handle Configuration Example

- Install the HDMI cable from monitor. Remove cover, install cable into mating connector replace cover.

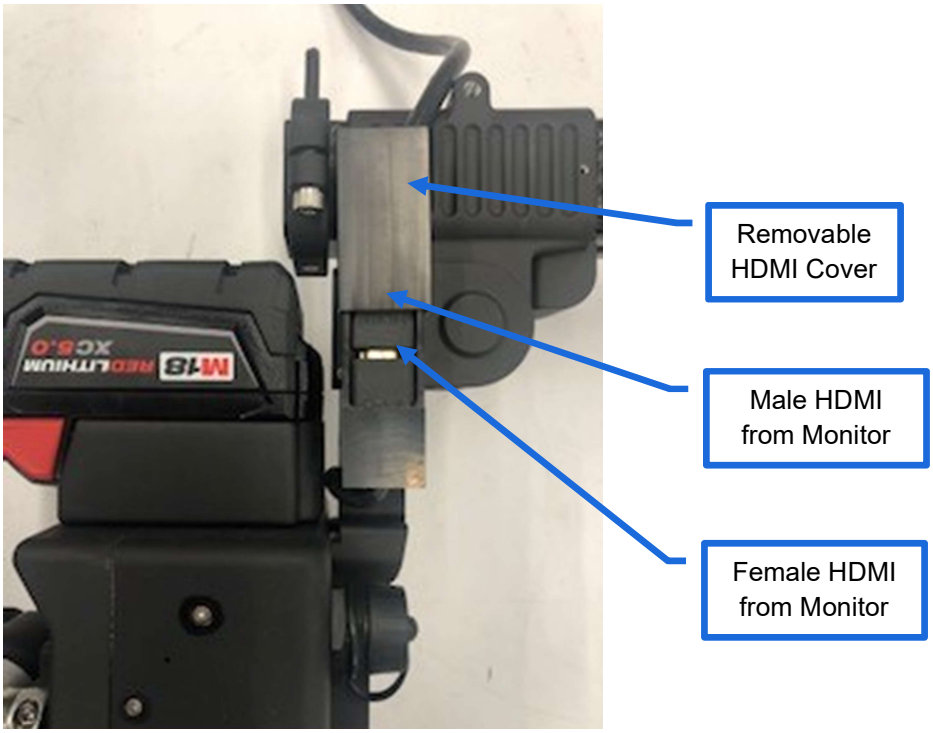


Figure 20 HDMI Cable Installation

- Turn monitor ON (located on upper-right corner of monitor).

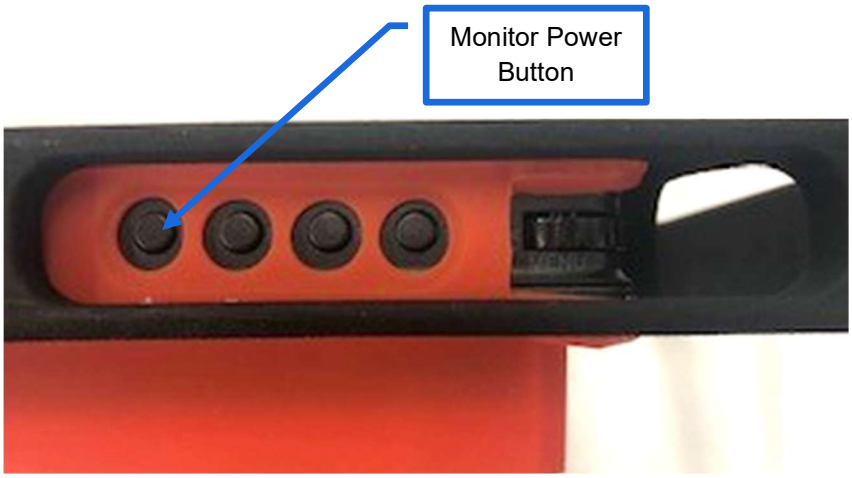


Figure 21 Monitor Power Button

- Install Trigger Switch by pushing up and twisting until it locks into place.

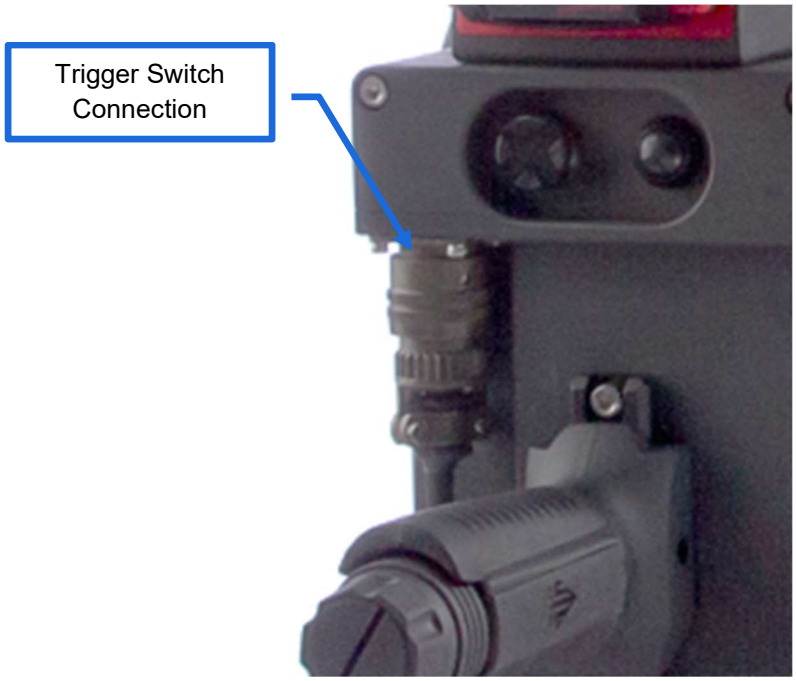


Figure 22 Trigger Switch Connection

- Install controller key and turn to ON and allow time for system to initialize. System status indicators (located on either side of main housing) will turn GREEN when system is ready.

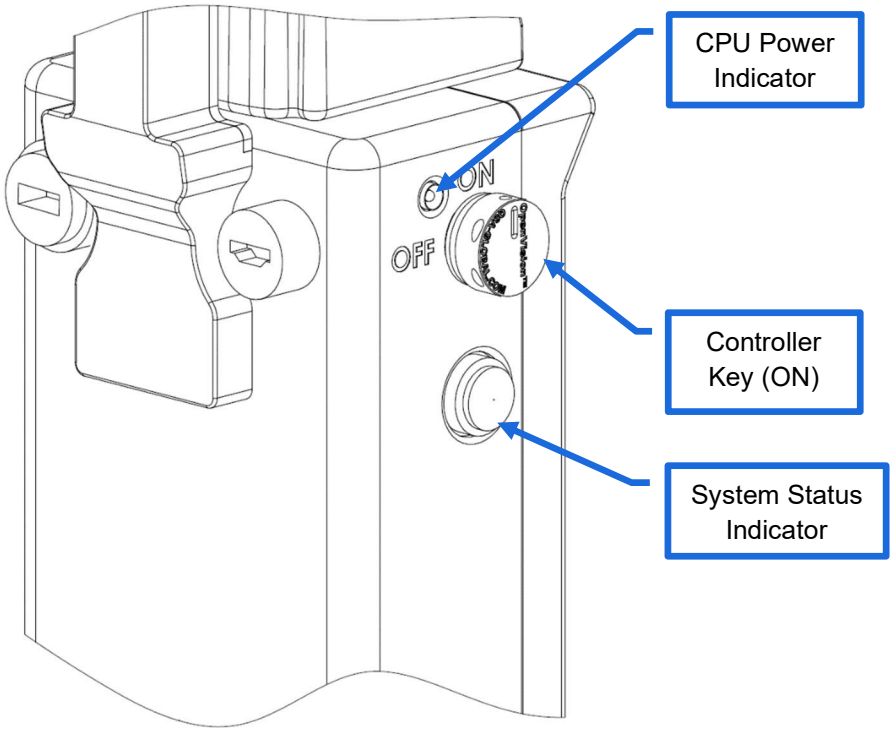


Figure 23 Indicators and Power Switch Details

- Verify kV and mA settings on main status screen.
- Safely perform test shot to verify X-ray functionality.

Heads Up Display (HUD)

This accessory (Item #415140) allows for an alternative to a display mounted directly to the OpenVision DX system. HUD specifications:

Ballistic Protection Standards:

- U.S. MIL SPEC MIL-PRF-31013
- ANSI Z87.1+
- U.S. Federal OSHA
- CE EN 166 FTKN

Temperature:

- Storage: -4 °F to 140 °F (-20 C – 60 C)
- Operating: 32 °F to 122 °F (0 C – 50 C)

Weight

- 114 g

The display position can be moved in multiple directions based on user preferences:

Figure 24 Available directional adjustments to display

To make slight adjustments to the focus, adjust the diopter to the left or right using your index finger.

Figure 25 Diopter adjustment

The standard configuration provides the image to your right eye. Clear or tinted lenses can be used based on external lighting conditions:

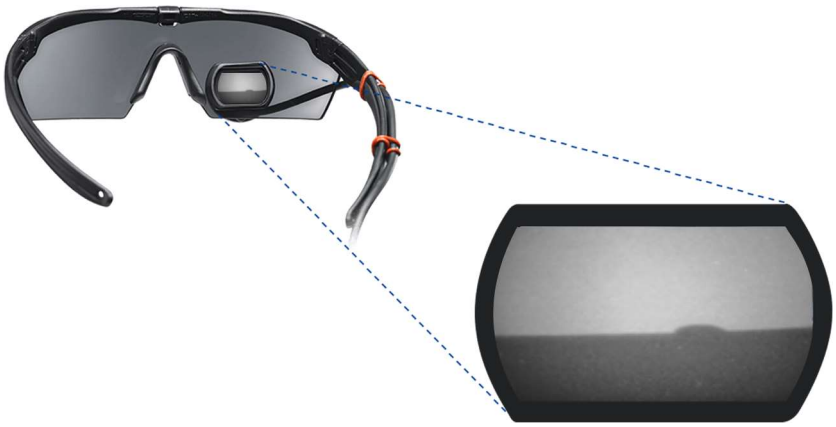
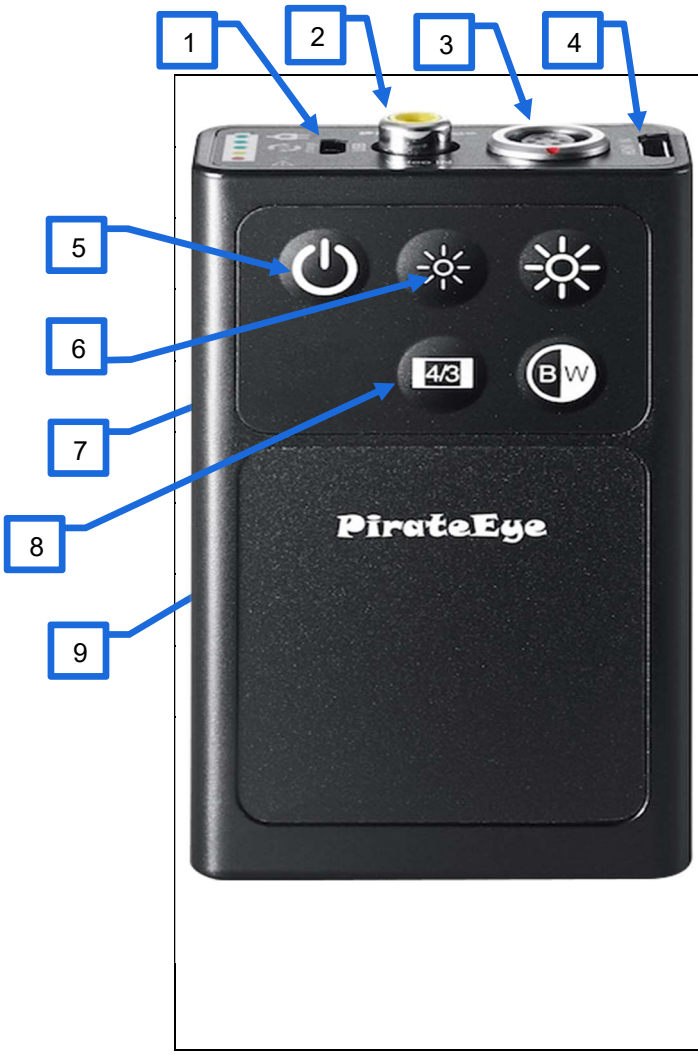


Figure 26 Example image output for HUD



1	Micro-USB charging port *
2	Video input
3	Output to heads-up-display
4	HDMI input
5	Power
6	Reduce brightness
7	Increase brightness
8	Toggle aspect ratio (4:3 / 16:9) **
9	Toggle color / black and white
*	The HUD controller must be charged separately with a USB charger. It is not powered by the OpenVision DX system. Expected battery life is 10 hours.
**	4:3 aspect ratio is recommended

Figure 27 HUD controller and power supply

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Remote Trigger and Trigger Button Options

The OVDX-NDT-70 comes standard with 415530-B Remote Trigger Harness (6 ft length) and 415540-A Trigger Button Harness (3 ft length). Optional lengths of each can be ordered.

Remote Trigger Harness 3 ft length - 415530-A (Figure 28)

Figure 28 - 415530-A

Remote Button Harness 6 ft length - 415540-B (Figure 29)

Figure 29 - 415540-B

Wi-Fi Tablet

The Wi-Fi Tablet assembly (Figure 30, Item # 415430) is an optional accessory which allows for wireless transmission. It can be mounted to the OpenVision™ DX handle assembly or be used as a hand-held tablet. See the software user manual (MAN-063) for operation instructions.

Figure 30 Wi-Fi Tablet

Imager Shield

The imager shield (Figure 31, Item # 415230) is an optional accessory which mounts to the OpenVision DX imager assembly in place of the standard imager cover (Item #415200-11).

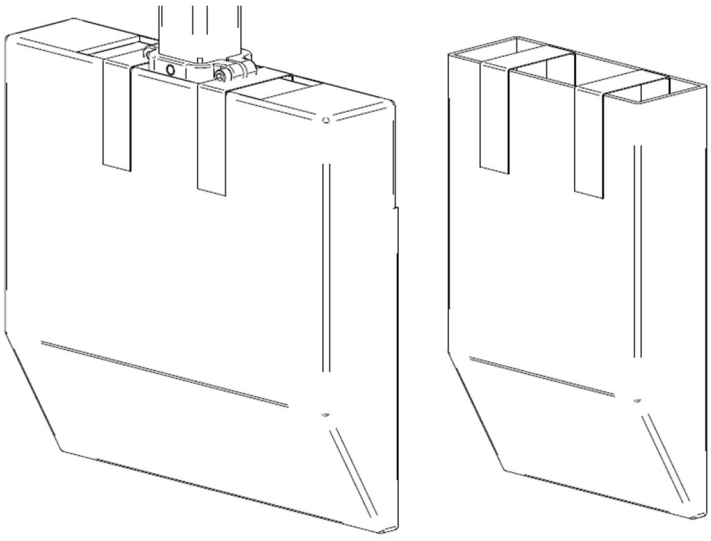

Figure 31 Imager shield installed (left), and imager cover (right, for reference)

The imager shield is most useful when imaging small pipe or other specimens that do not cover the excess beam on either side of the imager assembly and when the OpenVision DX system is fully extended. Figure 11 shows the worst-case effect of output radiation levels with and without the imager shield.

MAINTENANCE.

The OpenVision™ DX has been designed to require minimal maintenance by the operator. QSA Global, Inc. recommends daily visual inspection of the system. Specific attention should be paid to the following:

- M18™ battery and its mount (on top of Main Housing) – Ensure both are clean, and in sound shape.
- HDMI cable – Inspect for any cracks or wear.
- Allen/thumb screws – Check for tightness.
- Imager bag – Check for excessive wear.

Use a soft, damp cloth to clean to remove dirt and grime from the OpenVision DX.

CAUTION

Do not use solvents or apply cleaning agents directly on the OpenVision DX as this can damage the components and/or corrode the electronics.

TROUBLESHOOTING.

CAUTION

Opening the OpenVision DX potentially will damage the system and will void any warranty. If faced with any issues with the OpenVision DX, contact your QSA Global, Inc. representative immediately for guidance.

The OpenVision™ DX has been designed as a rugged, safe, reliable system. A series of interlocks and self-checks are built into the system to ensure safe operation. These checks may trigger an error code which will prevent normal operation of the OpenVision DX. Use Table 4 as a reference guide for system error codes.

NOTICE: Prior to any troubleshooting, please ensure that a fully-charged M18™ battery is installed. A low battery may cause system to report false error codes.

Table 4 Error Code Guide.

Error Code	Description	Corrective Action
001	Memory Failure	Hard drive and/or system memory error or failure. If restart does not clear error, contact your QSA Global, Inc. representative for repair options.
002	LED Failure	Status Indicator LED(s) are not functioning properly. If restart does not clear error, contact your QSA Global, Inc. representative for repair options.
003	X-ray Tube Failure	X-ray tube is not communicating or has malfunctioned. If restart does not clear error, contact your QSA Global, Inc. representative for repair options.
004	X-Ray Over Temperature	X-ray tube has exceeded its operating temperature, forcing system to stop emitting X-rays. Perform following actions to recover from this error: • Turn off unit • Place in cooler environment for 30 minutes • Turn unit on
005	Board Over Temperature	Main control board has overheated. Perform following actions to recover from this error: • Turn Off unit • Place in cooler environment for 30 minutes • Turn unit on
006	Imaging Camera Failure	Communication error and/or failure with targeting camera. Perform a system restart, if a restart does not clear the error, contact your QSA Global, Inc. representative for repair options.
007	Targeting Camera Failure	Communication error and/or failure with targeting camera. Contact your QSA Global, Inc. representative for repair options.
008	Low Voltage	M18™ battery has insufficient charge; change battery.

Error Code	Cause	Description
009	Camera Communication Error	Communication error with internal camera. Cycle system power to clear error.
010	Camera Communication Error	Communication error with internal camera. Cycle system power to clear error.

APPENDIX 1: PARTS LIST.

Part #	Description
OVDX-NDT-70	OpenVision™ DX System, Complete
415400	OVDX Handle Assembly
415440	OVDX Lightweight Monitor Assembly
415600	OVDX Backscatter Shield Assembly
ELE088	HDMI Cable
ELE054	Milwaukee® M18™ Battery
313056	Controller Key
415140	Pirate Eye Head Mount Display
415230	Imager Shield Assembly
415430	Tablet Assembly
415530-A	Remote Trigger Assembly (3 ft)
415530-B	Remote Trigger Assembly (6 ft)
415540-A	Trigger Button Assembly (3 ft)
415540-B	Trigger Button Assembly (6 ft)