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OPERATING MANUAL. MAN-059, REVISION A

OPENVISION™ DX.

OVDX-NDT-70 HARDWARE MANUAL

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INTRODUCTION

The OVDX-70-NDT is the world's only hand-held live video X-Ray system specifically designed for corrosion under insulation inspection. With patent pending ergonomic features and improved weight distribution, crews can quickly set up and begin scanning. Transfer files simply from OVDX via USB memory stick for review and inclusion in inspection reports.

SYSTEM SPECIFICATIONS

Table 1 OVDX Specifications			
Imaging Area (Field of View)	4 in. x 6 in. (10 cm x 15 cm)		
Dimensions			
X-Ray Tube to Imager Clearance	9.5 in. (24 cm) to 20.9 in. (53 cm)		
Throat depth	21 in. (58 cm)		
Imager Thickness	2.5 in. (6.4 cm)		
X-Ray Tube Thickness	3.4 in. (8.7 cm)		
Startup Time (est.)	30 seconds		
Shutdown Time (est.)	5 seconds		
X-Ray Energies	Voltage (kV)	Current (mA)	Dose @ 12 in (30.5 cm) from X-Ray Tube
Low	40	0.300	50 R/hr (0.5 Sv/hr)
Medium	55	0.218	80 R/hr (0.8 Sv/hr)
High	70	0.171	95 R/hr (0.95 Sv/hr)
Beam Collimation (Approximate)	25° Horizontal 17° Vertical		
Image Resolution	0.004 in. (0.1 mm)		
Battery Life			
Continuous duty with 5 AH battery	3 hours		
Standby	8 hours		
System Weight			
C-Arm	11 lbs. (5 kg)		
Monitor w/ Handle (optional)	6.4 lbs. (2.9 kg)		
Packaged System (shipping weight)	53 lbs. (24 kg)		
Operating Temperature	-20° F to 120° F (-29° C to 49° C)		
Storage Temperature	-30° F to 140° F (-34.5° C to 60° C)		
Display Options	10 in. LED Monitor: 1024 x 600 pixels PirateEye: 854 x 480 pixels Any device that accepts HDMI signals		
Recording			
Internal Storage Capacity	128 GB		
Resolution (Image and Video)	1280 X 720		
Image / Video Transfer Method	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		

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The OVDX-70-NDT 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

HMD

- 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.

SAFETY PRECAUTIONS.



WARNING

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

It is important that trained and qualified personnel perform or supervise a daily safety inspection of the OpenVision™ system for any defects. Do not compromise on safety. Always perform daily system inspections 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™ system or any after-market component. Doing so may compromise the safety features designed into the system.

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

Equipment operators must follow all 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™ 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.

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Operating Conditions

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

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 "Water Proof". 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

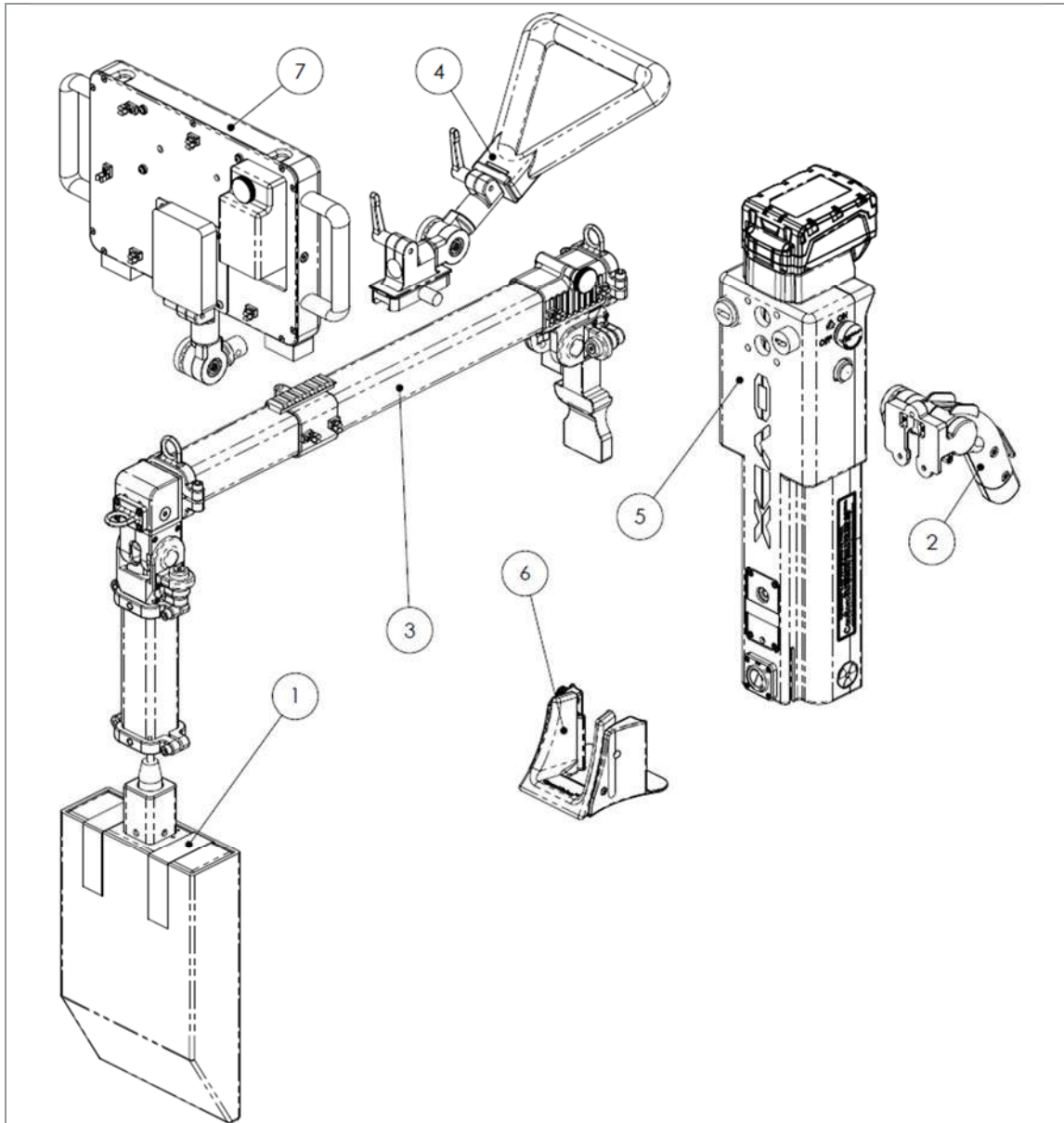
Because the blink reflex (glare aversion response to bright lights) will limit the exposure to no more than 0.25 seconds, Class 2 laser pointers are considered to be safe. Furthermore, Class 2 lasers do not harm eyes unless a person deliberately stares into the beam, making laser protective eyewear not 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™ DIGITAL X-RAY (OVDX) SYSTEM.

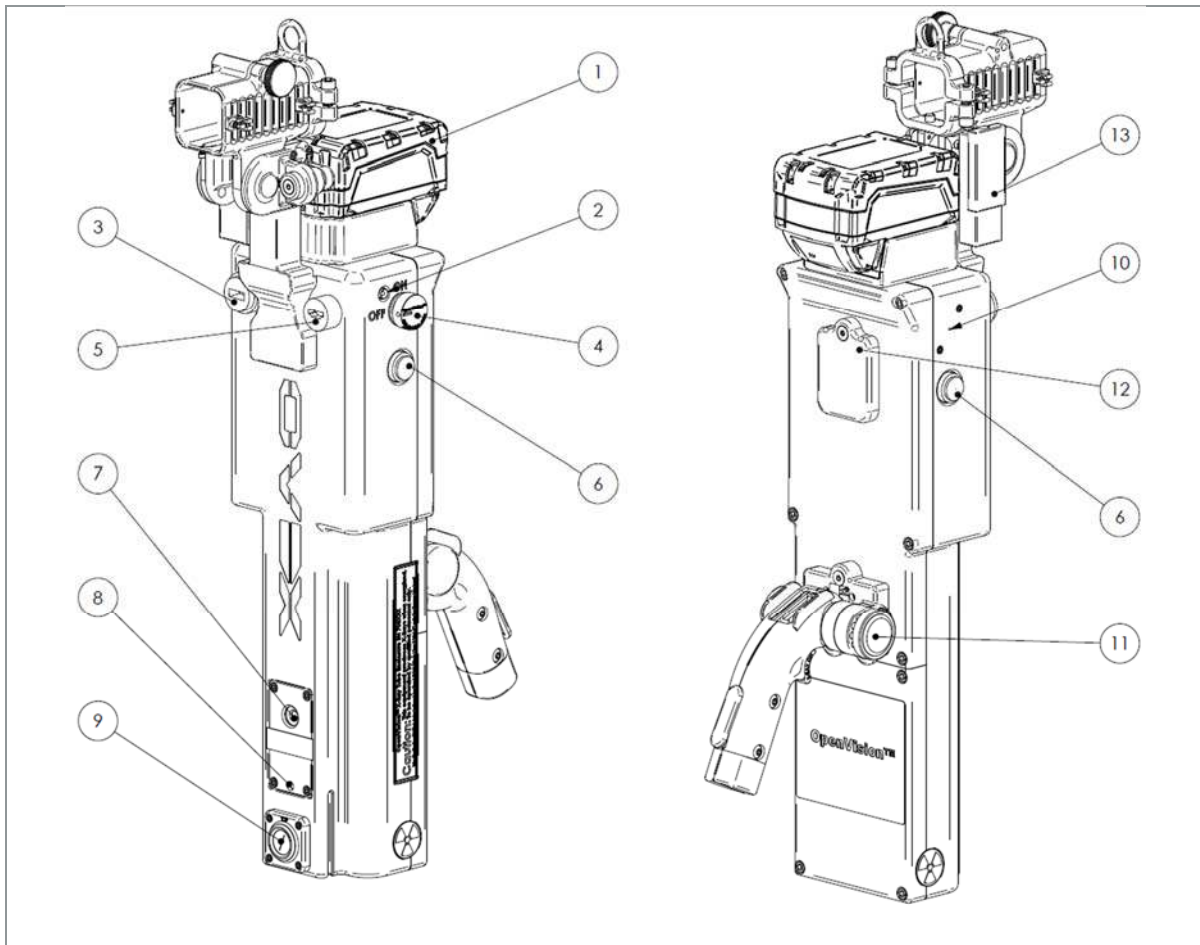
System Overview



Item	Part No.	Description
1	415200	OVDX Imager Assembly
2	415500	OVDX Trigger Handle Assembly
3	415300	OVDX C-Arm Assembly
4	415400	OVDX Handle Assembly
5	415100	OVDX Main Housing Assembly
6	415600	Backscatter Shield Assembly
7	415410	OVDX Monitor Assembly (optional)

Figure 1 OVDX Assembly Description

OVDX 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	415500	Trigger Handle Assembly
12	415130	Trigger Adapter Port Cover
13	---	Strain Relief for HDMI Connection 2

Figure 2 OVDX Main Housing Assembly (Item # 415100)

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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)

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

Table 2 Radiation Comparisons

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/mA settings and adjust to achieve the desired image quality.

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RADIATION ZONES.

Output Radiation Levels

OVDX radiation levels vary depending on kV/mA settings. QSA performs testing at maximum power (70 kV, 0.17 mA) to verify collimation and image quality. Operators must be aware of safe boundary distances while using the OVDX. When the main housing is fully expanded (“D” = 53cm [20.8in]), 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 3 is positioned in this approximate area.

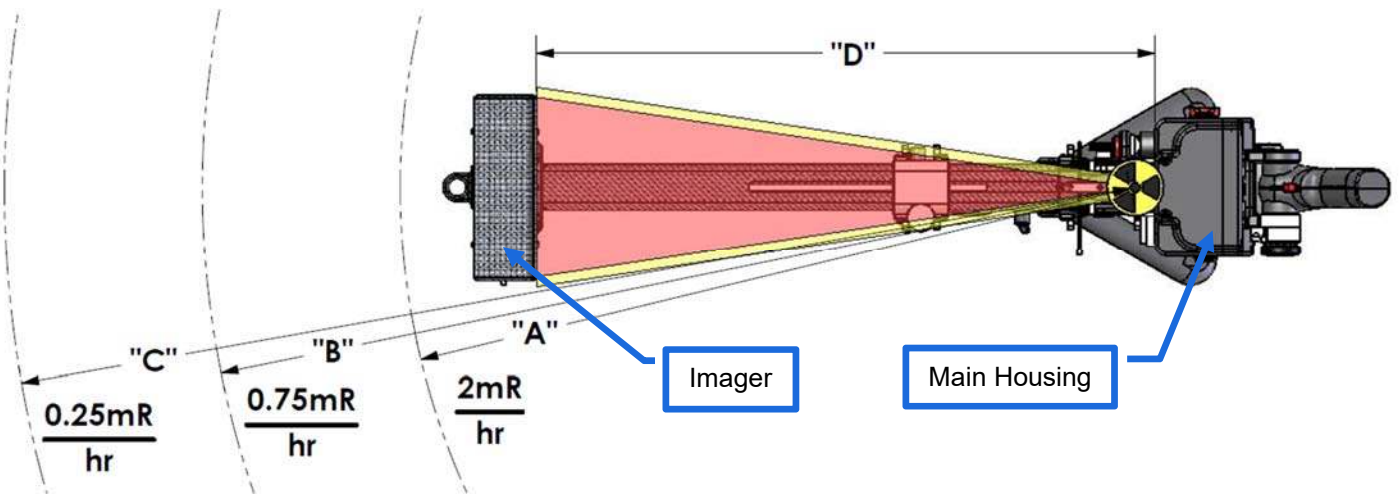


Figure 3 OVDX Output Boundary Distances

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

NOTICE: The imager shield (see Figure 25 on page 25, item #415230, not shown in Figure 3) 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.

Main Housing Distance to Imager (in [cm]) "D"	kV / mA	Imager Shield?	Boundary Distance (ft [m])		
			2mR/hr (20µSv/hr) "A"	0.75mR/hr (7.5µSv/hr) "B"	0.25mR/hr (2.5µSv/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 [35cm]	70 / .17	No	17.4 [5.3]	28.2 [8.6]	49 [15]
13.8 [35cm]	70 / .17	Yes	9.8 [3.0]	16.1 [4.9]	27 [8.5]

Table 3 Boundary Distance Comparison

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

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Backscatter Radiation Levels

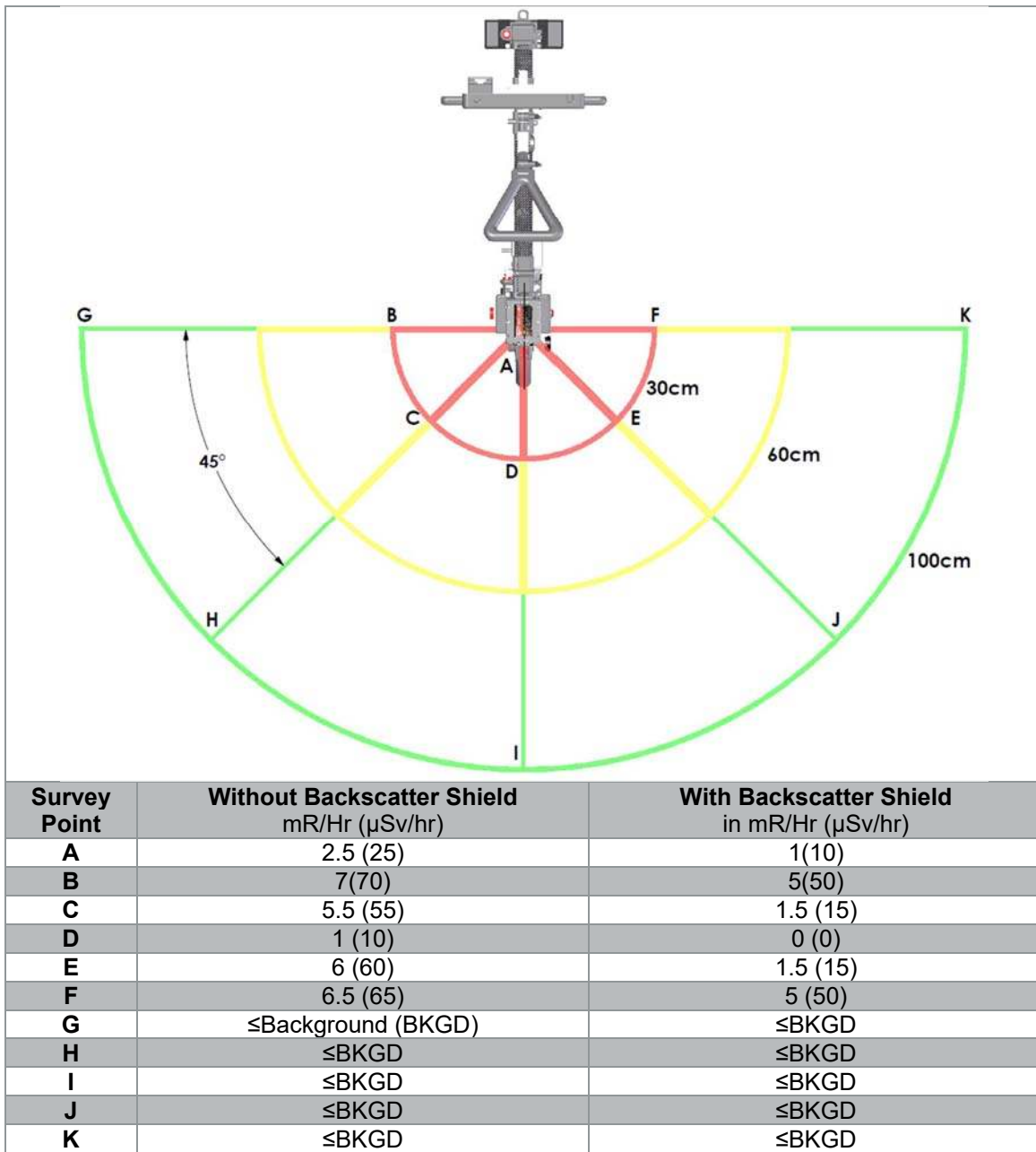


Figure 4 Example Scatter Radiation Survey

Figure 4 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 4 was created with the following conditions:

- 8" Steel Pipe
- 2" Calcium Silicate Insulation
- .040" [1 mm] thick Aluminum Cladding
- 70 kV @ 0.17 mA (maximum power)

See the following section for additional information on backscatter.

CAUTION

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

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 backscatter shield (Figure 5) will help reduce the amount of backscatter when firmly applied to the scanning surface as shown in Figure 7.

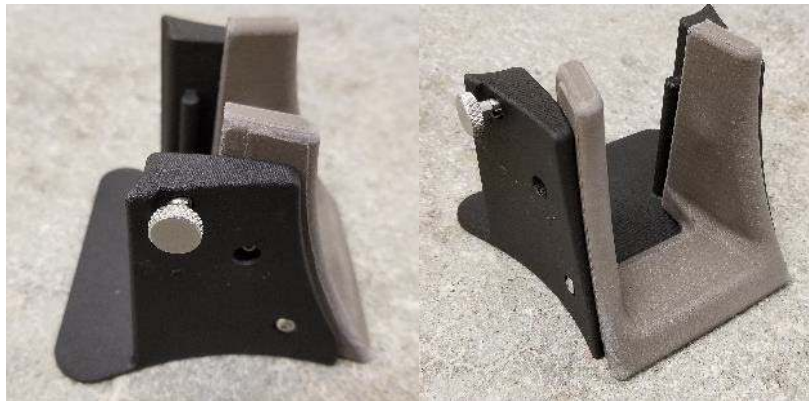


Figure 5 Backscatter Shield (Item # 415600)

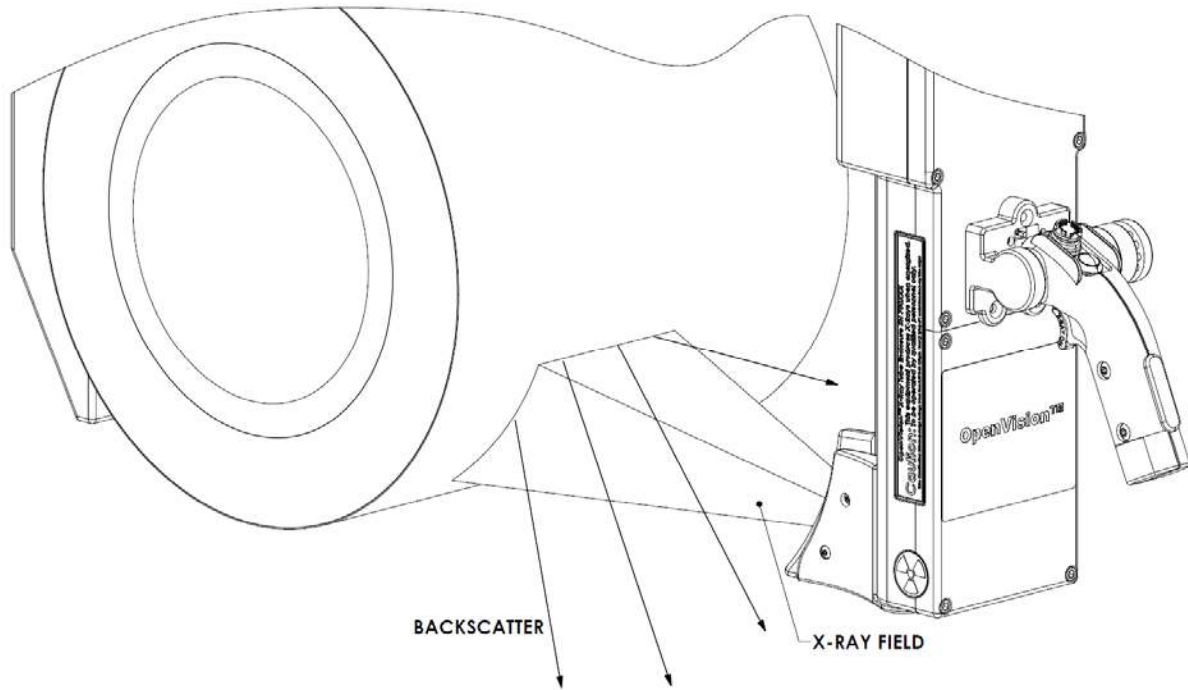


Figure 6 Example of Backscatter

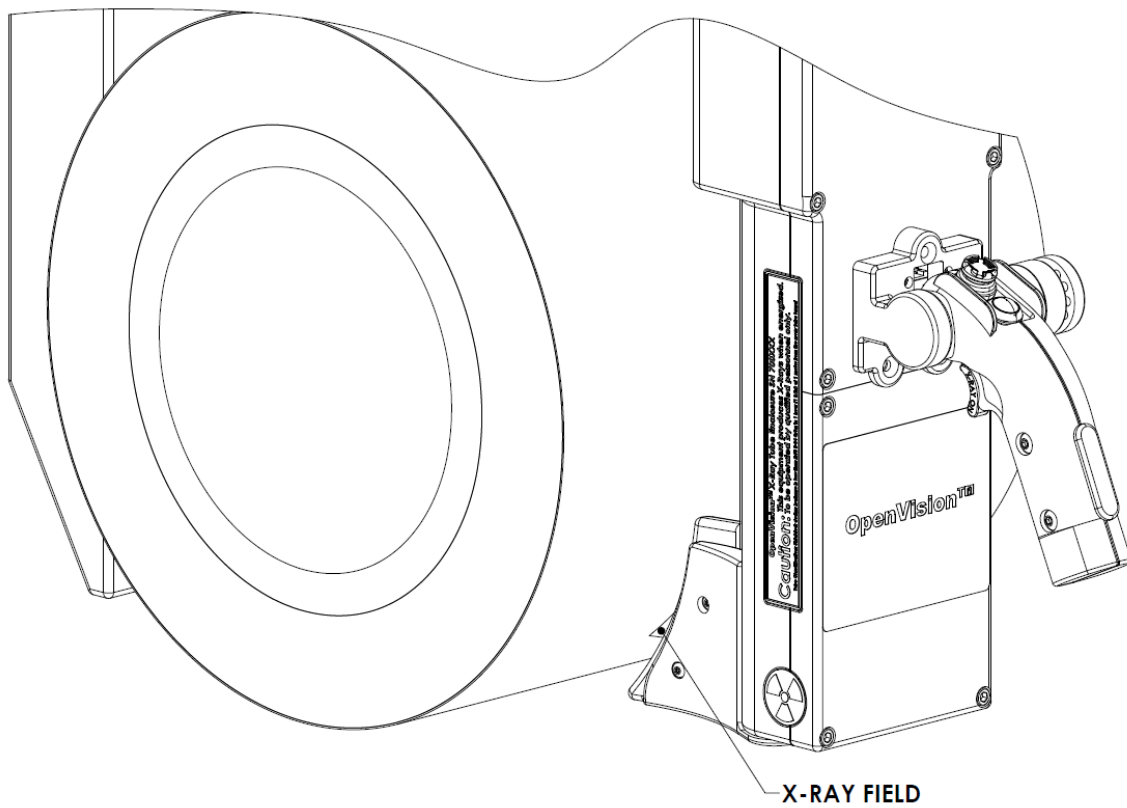


Figure 7 OVDX with backscatter shield properly positioned against insulation sheathing.



WARNING

When the System Status Indicators turn AMBER (see Figure 2), ionizing radiation is being produced.

If you wish to perform extended operations with the DX system, ensure that ambient temperatures are below 125 °F (52 °C).

Quick Setup / Scanning

Your OVDX 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:

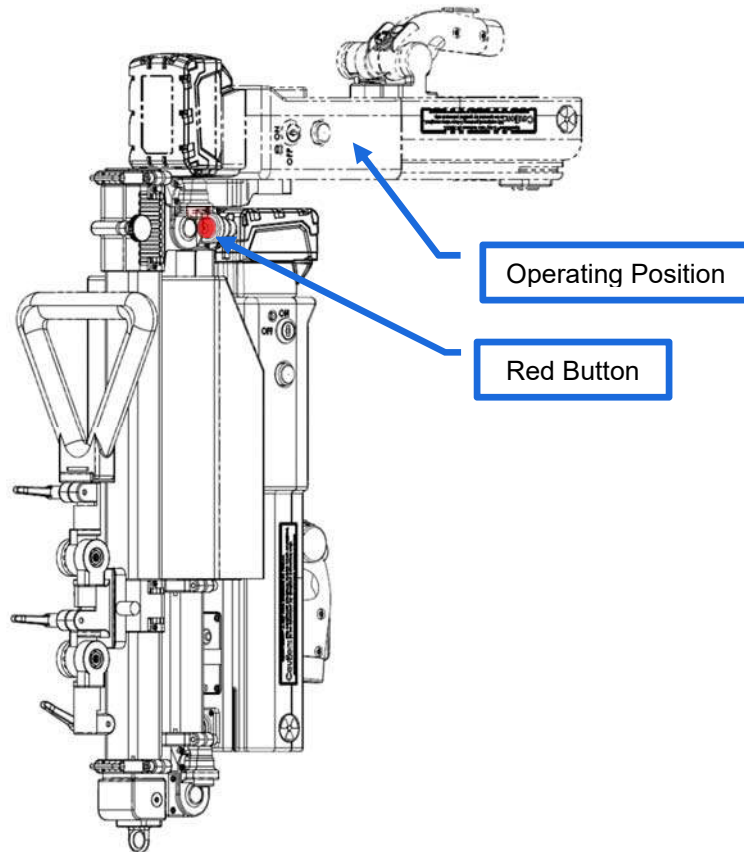


Figure 8 Unlock Main Housing

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- Repeat action for imager housing:

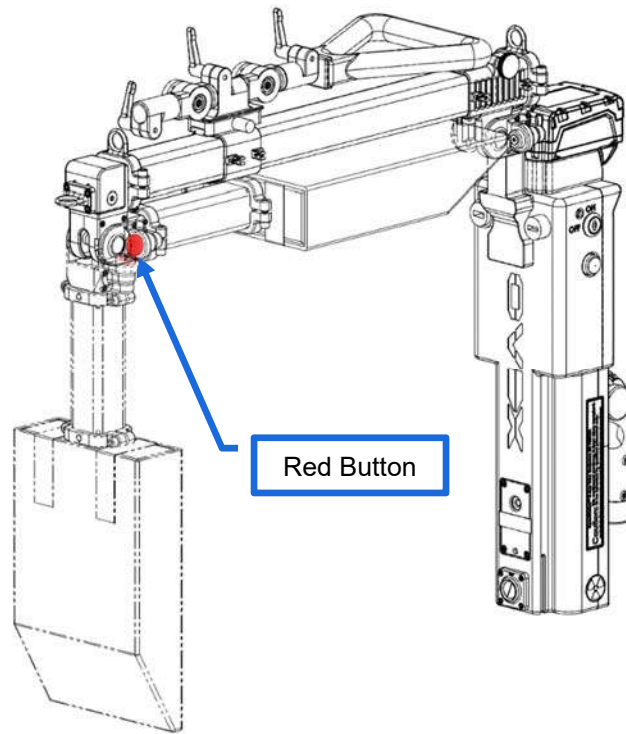


Figure 9 Unlock Imager Housing

- Install Backscatter shield by lining up grooves and slide/lock into position shown, and position handles as desired:

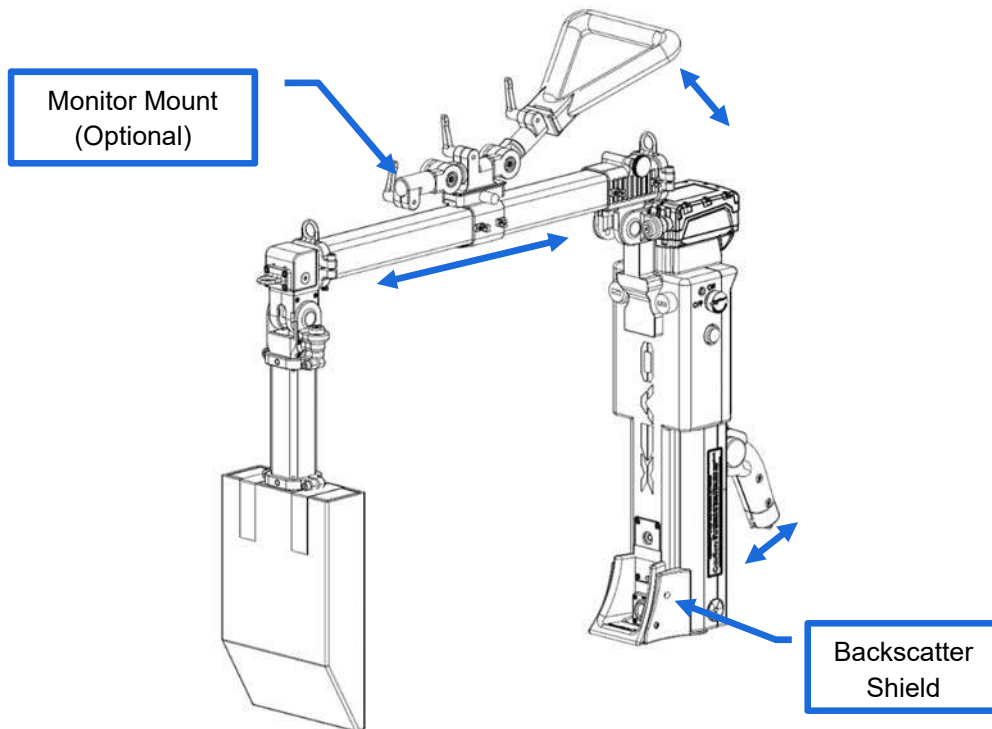


Figure 10 Backscatter shield installed, available handle adjustments

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- 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.

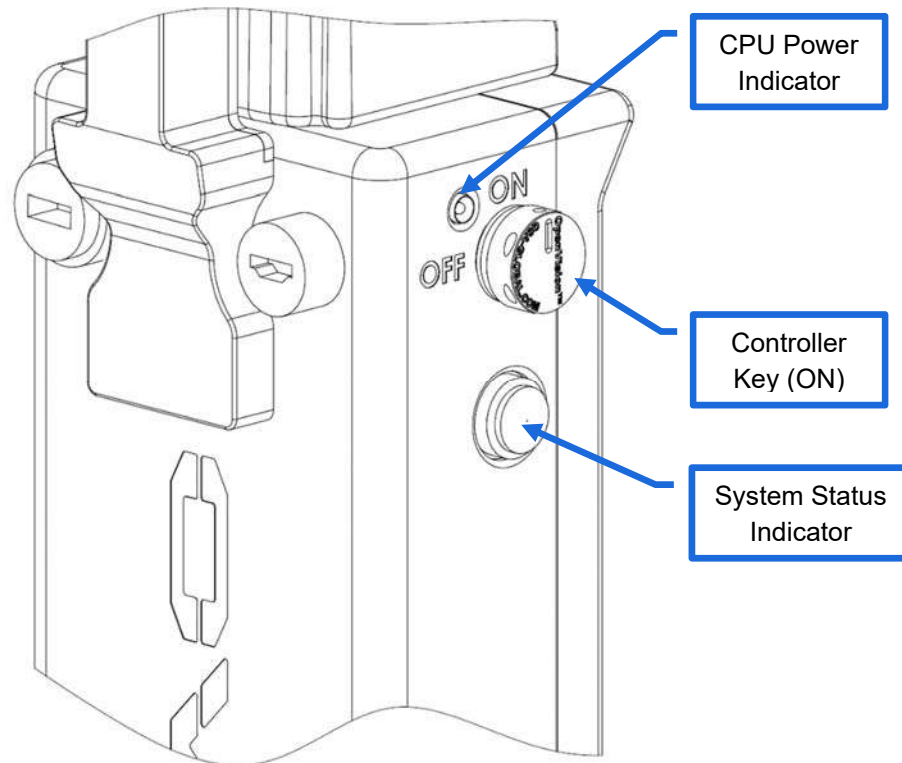


Figure 11 Indicators and Power Switch Details

- Verify kV/mA settings on main status screen.
- Perform test shot to verify X-ray functionality.

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ACCESSORIES.

Heads Up Display (HUD)

This accessory (Item #415140) allows for an alternative to a display mounted directly to the 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 (-20C – 60C)
- Operating: 32°F to 122°F (0C-50C)

Weight

- 114g

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



Figure 12 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 13 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 14 Example image output for HUD

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Figure 15 HUD controller and power supply

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Handle Extension Assembly

The trigger assembly (Item # 415500) can be relocated to the top of the C-Arm by using the handle extension assembly (Item # 415510). Installation aids in inspection where the OVDX is utilized in unusual orientations or tight locations.



Figure 16 Handle extension assembly (Item # 415510, split rail slider not shown)

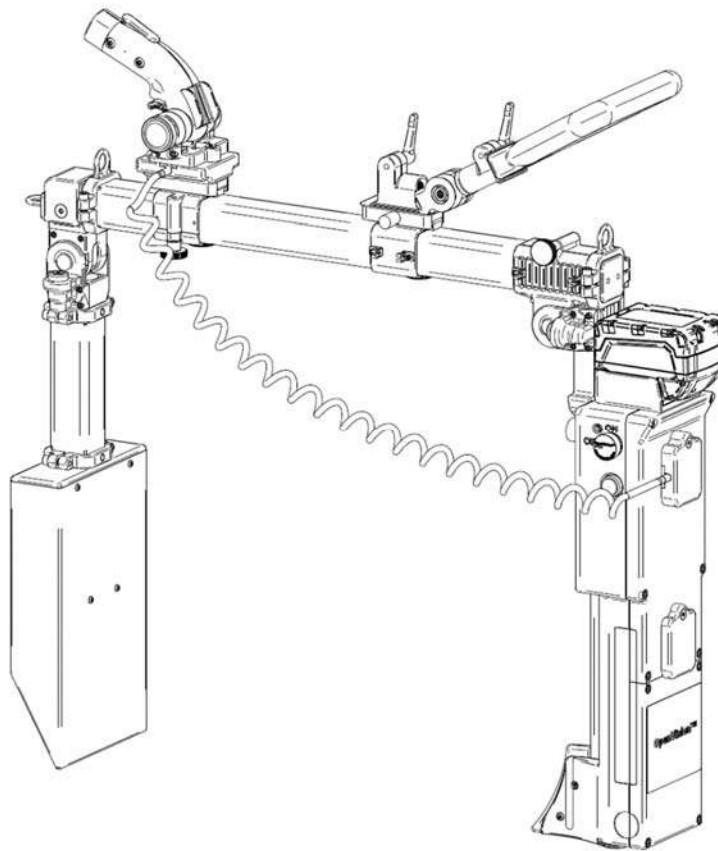


Figure 17 OVDX with handle extension assembly installed on top of C-Arm.

Installation of Handle Extension Assembly

- Remove the trigger assembly from the main housing by removing the three allen head screws at the base of the trigger assembly (hold onto screws).

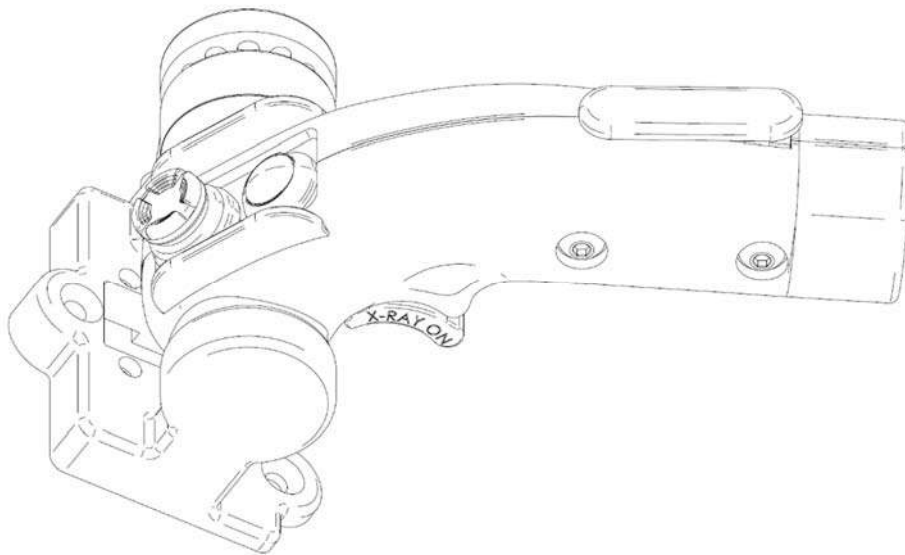


Figure 18 Trigger assembly

- Mount the remote trigger assembly harness block to the main housing assembly's upper trigger mount:

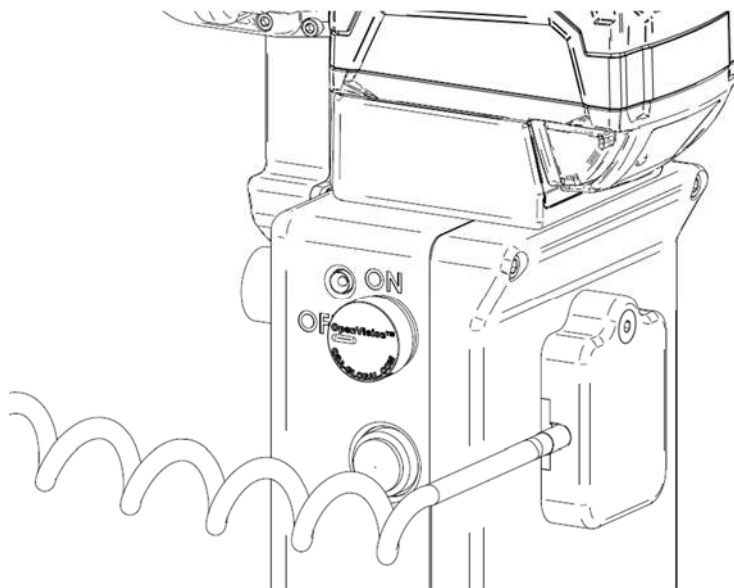


Figure 19 Trigger harness block

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- Mount the split rail slider onto the C-Arm, then attach the remote trigger mounting block onto slider:

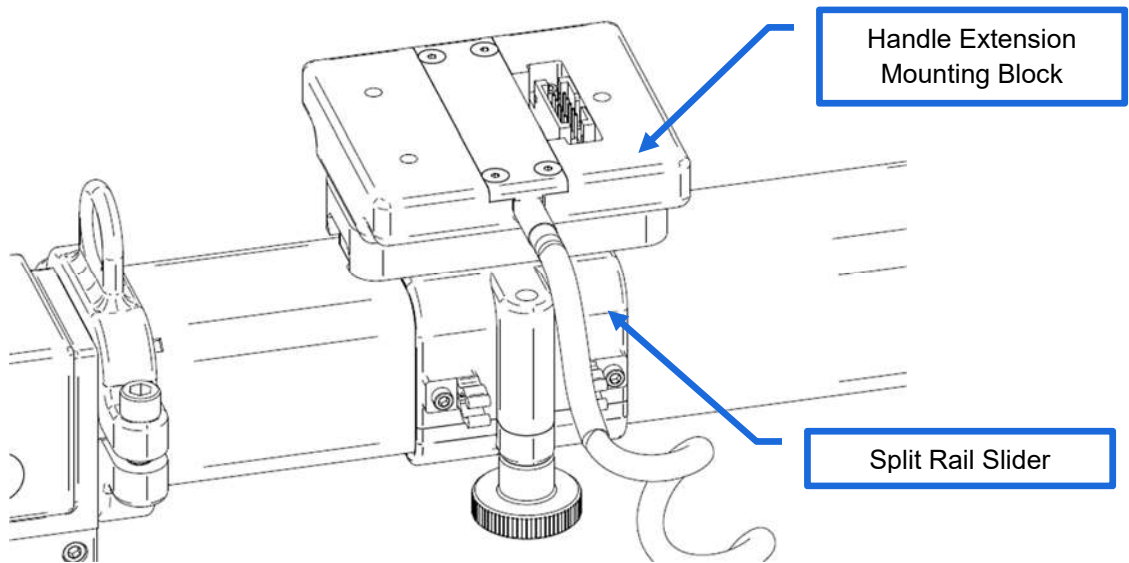


Figure 20 Handle Extension Mounting Block Attached

- Attach the trigger assembly to the extension mounting block using three allen head screws from before:

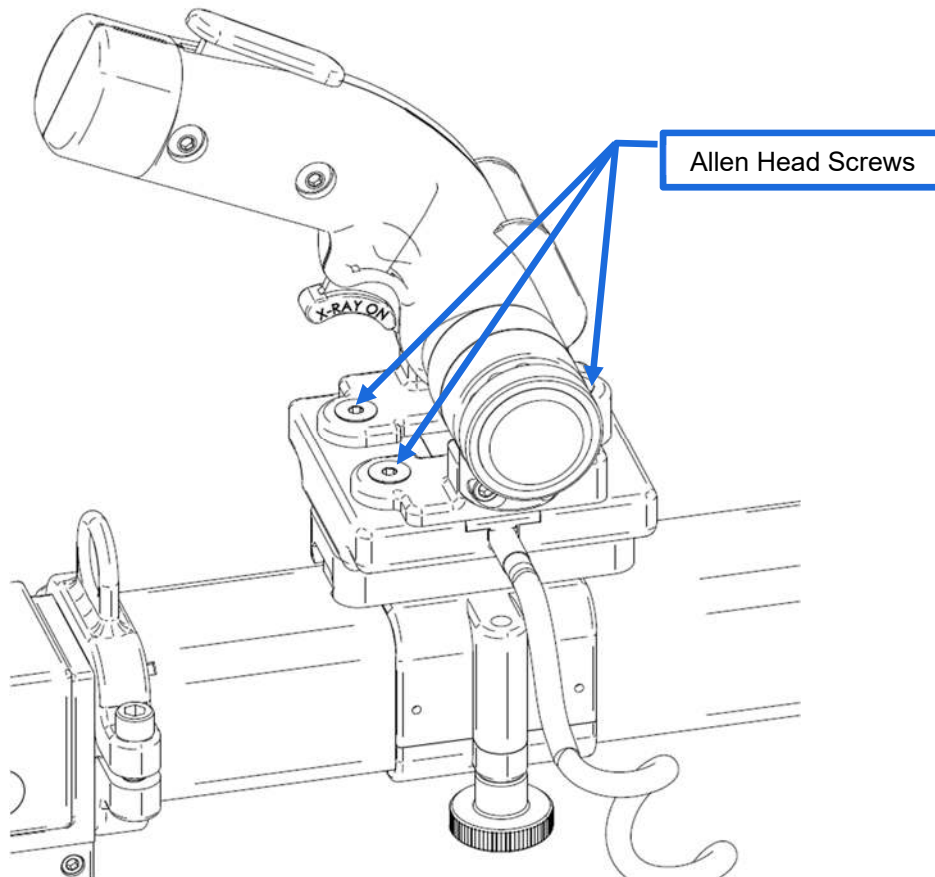


Figure 21 Trigger Attached Mounting Block

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Monitor

The monitor assembly (Item # 415410) is an optional accessory which mounts to the OVDX handle assembly (Item #415400) by the mounting post (Figure 22, Item #1).



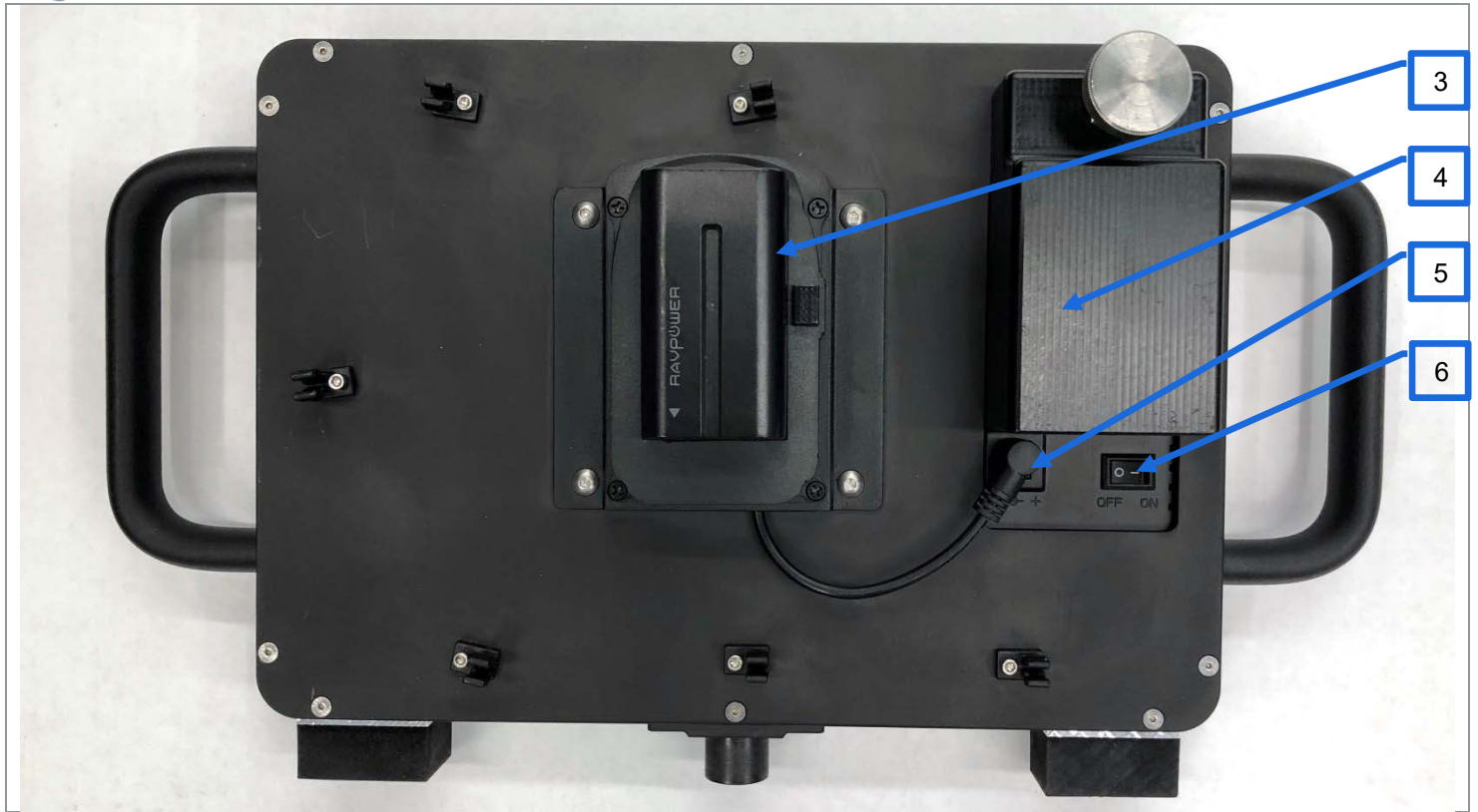
1	Mounting Post
2	Power/Charging Indicator

Figure 22 Monitor - Front View.

The OVDX monitor is powered by both an external and internal battery. The external battery charger (Figure 24) can charge two batteries. The internal battery is charged with either a 12-volt DC charger connected to the power input jack (Figure 23, Item #5), or with the external battery (as shown in Figure 23). Charging indicator will turn RED while charging (Figure 22, Item #2), and GREEN when monitor is on.

NOTICE

The monitor's DVR functionality is not compatible with the DX system. Image/video recording is handled directly within the DX system software.



3	External Battery
4	HDMI Strain Relief
5	Power Input Jack
6	Power Switch

Figure 23 Monitor - Rear View



Figure 24 Monitor's External Battery Charger

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Imager Shield

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

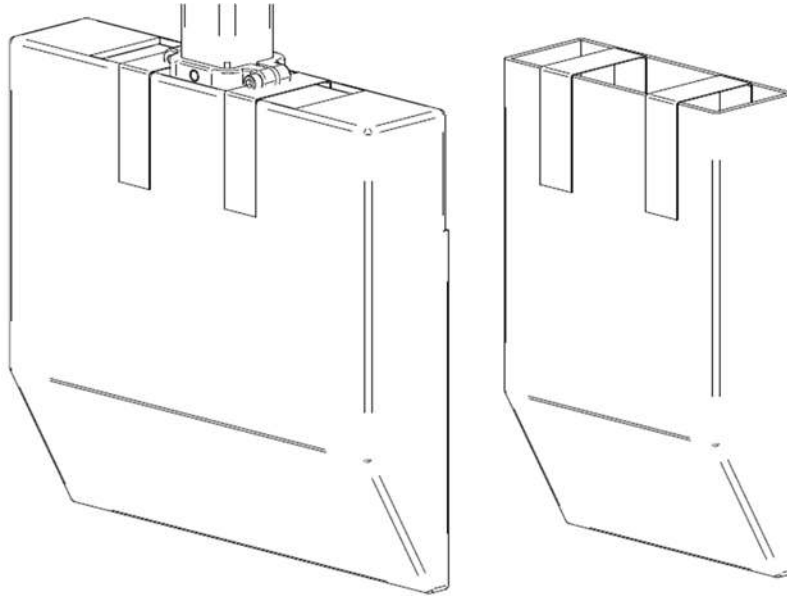


Figure 25 Imager shield installed (left), and imager cover (right, for reference)

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 DX system is fully extended. Figure 3 shows the worst-case effect of output radiation levels with and without the imager shield.

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MAINTENANCE.

The OVDX has been designed to require minimal maintenance by the operator; daily, visual inspections are necessary. Additionally, 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 OVDX.

CAUTION

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

CAUTION

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

The OVDX 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 OVDX. 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.

Error Code	Description	Corrective Action
1	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.
2	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.
3	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.
4	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: <ul style="list-style-type: none"> • Turn off unit • Place in cooler environment for 30 minutes • Turn unit on
5	Board Over Temperature	Main control board has overheated. Perform following actions to recover from this error: <ul style="list-style-type: none"> • Turn Off unit • Place in cooler environment for 30 minutes • Turn unit on
6	Imaging Camera Failure	Communication error and/or failure with targeting camera. If a restart does not clear error, the USB connection may have loosened. Remove imaging housing from Carbon Fiber Tube and check USB connection to housing and restart. If this does not correct the error, Contact your QSA Global, Inc. representative for repair options.
7	Targeting Camera Failure	Communication error and/or failure with targeting camera. Contact your QSA Global, Inc. representative for repair options.
8	Low Voltage	M18™ battery has insufficient charge; change battery.

Table 4 Error Codes

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QSA Global, Inc. Contact Information

Sales/Customer Service

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LaPorte, TX 77571
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Fax +1 281 476 9309

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All brand names and product names where used are acknowledged to be trademarks of their respective holders.

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APPENDIX 1: PARTS LIST.

Part #	Description
OVDX-NDT-70	OpenVision™ DX System, Complete
415400	OVDX Handle Assembly
415410	OVDX Monitor Assembly
415500	OVDX Trigger Handle Assembly
415600	OVDX Backscatter Shield Assembly
ELE088	HDMI Cable
ELE054	Milwaukee® M18™ Battery
313056	Controller Key
415140	Pirate Eye Head Mount Display
415510	Handle Extension Assembly
415230	Imager Shield Assembly

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