

DRX-Revolution Mobile X-ray System Hardware Guide



Carestream

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1 Overview

Preface

The information contained herein is based on the experience and knowledge relating to the subject matter gained by Carestream Health, Inc. prior to publication. No patent license is granted by this information. Carestream Health reserves the right to change this information without notice and makes no warranty, express or implied, with respect to this information. Carestream Health shall not be liable for any loss or damage, including consequential or special damages, resulting from the use of this information, even if loss or damage is caused by negligence or other fault of Carestream Health.

About this Guide

This guide uses Note, Important, and Caution messages to emphasize information or potential risks to personnel or equipment.

NOTE: Notes provide additional information, such as expanded explanations, hints, or reminders.

IMPORTANT: An Important message highlights critical policy information that affects how you use this manual and this product.



CAUTION:

Cautions point out procedures that you must follow precisely to avoid injury to yourself, others, damage to the system or any of its components, loss of data, or corruption of files in software applications. Disregarding the caution statement may lead to abnormal use.

Related Documentation

- *DRX-Revolution Safety and Regulatory Information*
- *DRX-Revolution Online Help*
- *DRX-Revolution User Release Notes*

2 Introduction to the DRX-Revolution Mobile X-ray System

Overview of the System

The DRX-Revolution System Mobile X-ray system is designed specifically for Digital Radiography (DR) with the CARESTREAM DRX-1 System detector, or with other wireless flat-panel detectors. The DRX-Revolution incorporates the tools required for acquiring medical diagnostic images outside of a standard X-ray room.

The DRX-Revolution is an all inclusive mobile X-ray system, providing:

- A high power 32 kW generator
- State-of-the-art drive system for movement and maneuverability
- User-friendly X-ray tube positioning in five axes of motion
- The industry's first telescoping column for better visibility while driving
- Storage for detectors and supplies
- Carestream's proven user interface and image processing tools

Description

The compact size of the DRX-Revolution allows patient treatment in many areas of a hospital including the operating room, emergency department, and intensive care units. It moves on many kinds of surfaces and can fit in elevators and maneuver in close proximity to a patient from many angles. Its collapsible column allows visibility while it is being driven down busy hospital corridors. The cart moves so a technologist can walk behind it, steering and controlling its speed while traveling from one location to another. Software is accessed from a primary monitor on the cart and a secondary monitor on the tube head.

Features

The DRX-Revolution allows radiographic exams of patients who cannot be transported to an X-ray room. The tube head assembly can be moved in any direction: horizontal, vertical, tilted, angulated, and rotated. It has storage space for equipment and supplies. An optional barcode scanner provides quick identification of patient wristbands, forms, and orders. All of these hardware features and options are described in this guide.

Intended Audience

The audience for this guide includes technologists, radiologists, service engineers, and quality assurance technicians.

Usability

The design and development of this diagnostic X-ray system incorporated a usability engineering process in accordance with IEC 60601-1-6: Medical Electrical Equipment, Part 1-6: General requirements for safety. Collateral Standard: Usability.

Training

This equipment is intended for use by appropriately educated and skilled radiological health care professionals who have received specific training on the operation and use of this equipment.

Only qualified, trained X-ray personnel should operate the System. Operation of the equipment by persons who have not been trained or who are unfamiliar with the functions and controls of the System may cause serious injury to the patient, serious injury to the operator, or equipment damage.

Safe Operation Precautions

Personnel operating and maintaining this equipment should be familiar with all aspects of operation and maintenance. To ensure safety, read the *DRX-Revolution Safety and Regulatory Information* carefully before using the system and observe all Cautions, Importants, and Notes located throughout the manual.

IMPORTANT: *For continued safe use of this equipment, follow the instructions contained in this operating manual.*

IMPORTANT: *Study this manual carefully before using the equipment and keep it at hand for quick reference.*

The equipment must be used only by qualified personnel and only after training in the specific operations. It is the operator's responsibility to ensure the patient's safety by visual observation, audio communication, proper patient positioning, and use of the protective devices.

Thoroughly check that there is no interference or possibility of collision between the patient and other equipment.

Maintain the equipment periodically to ensure continued safe use of the equipment. See "[Chapter 6 Maintenance and Safety Information](#)" for periodic maintenance recommendations.

The equipment must be repaired only by authorized service personnel.

For more information, see the *DRX-Revolution Safety and Regulatory Information*.

Environmental Requirements

This equipment and all components will perform to specifications when operated in normal use under the least favorable combination of the following temperature, humidity, and altitude specifications.

Environment			
Relative Humidity (non-condensing)	In-Use: 30– 65 % non-condensing	Storage: 10–86 % non-condensing	The receiving and storage areas must be dry and able to provide the proper humidity and temperature control required for the equipment.
Atmospheric Pressure	70–106 kPa	70–106 kPa	
Temperature	In-Use: 18 to 30 °C (64 to 86 °F)	Storage: –20 to 55 °C (–4 to 131 °F)	
Altitude	Equivalent to maximum 3,048 m atmospheric pressure.		

Acoustic Noise Emission

The sound pressure level is less than 70 db.

Product Classification

Product classification per IEC 60601-1,
Class I equipment/Internally powered.

3 **Parts Diagrams**

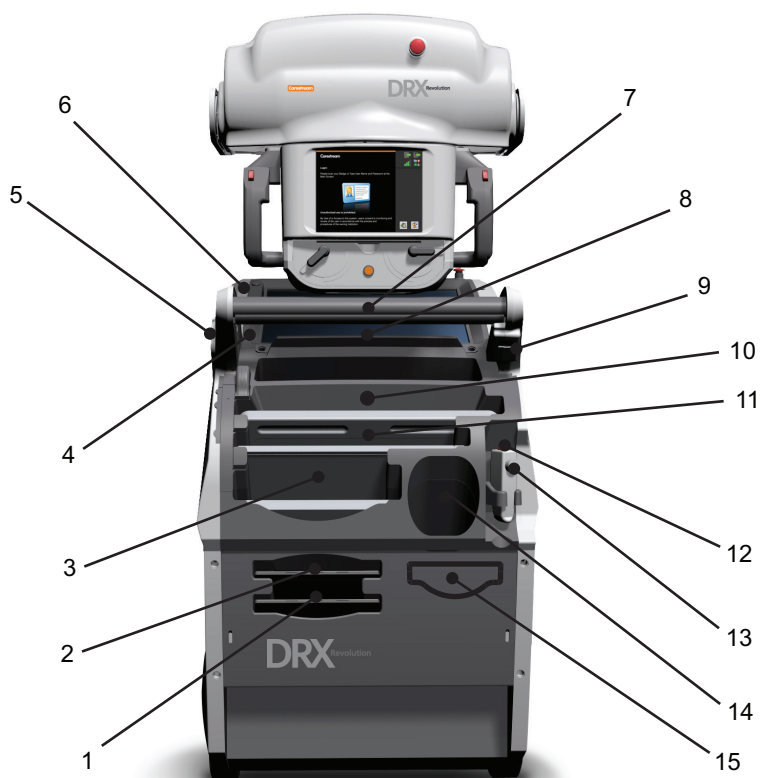
While most of the external parts will be intuitive to an experienced radiographer, please review the parts diagrams in this guide so you become familiar with the naming conventions used by Carestream Health, which are standardized throughout all of the documentation.

For a part's description, see “[Chapter 4 Component Descriptions](#)”.

For a part's specifications, see “[Chapter 7 Technical Specifications](#)”.

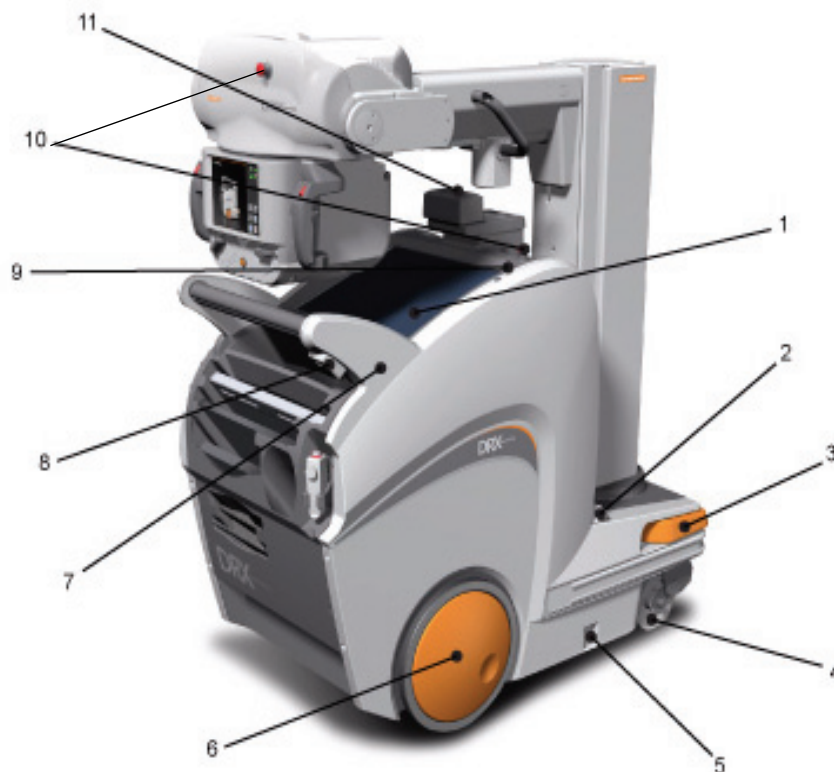
For a list of optional parts or features, see “[Optional Parts](#)” in Appendix A.

Cart



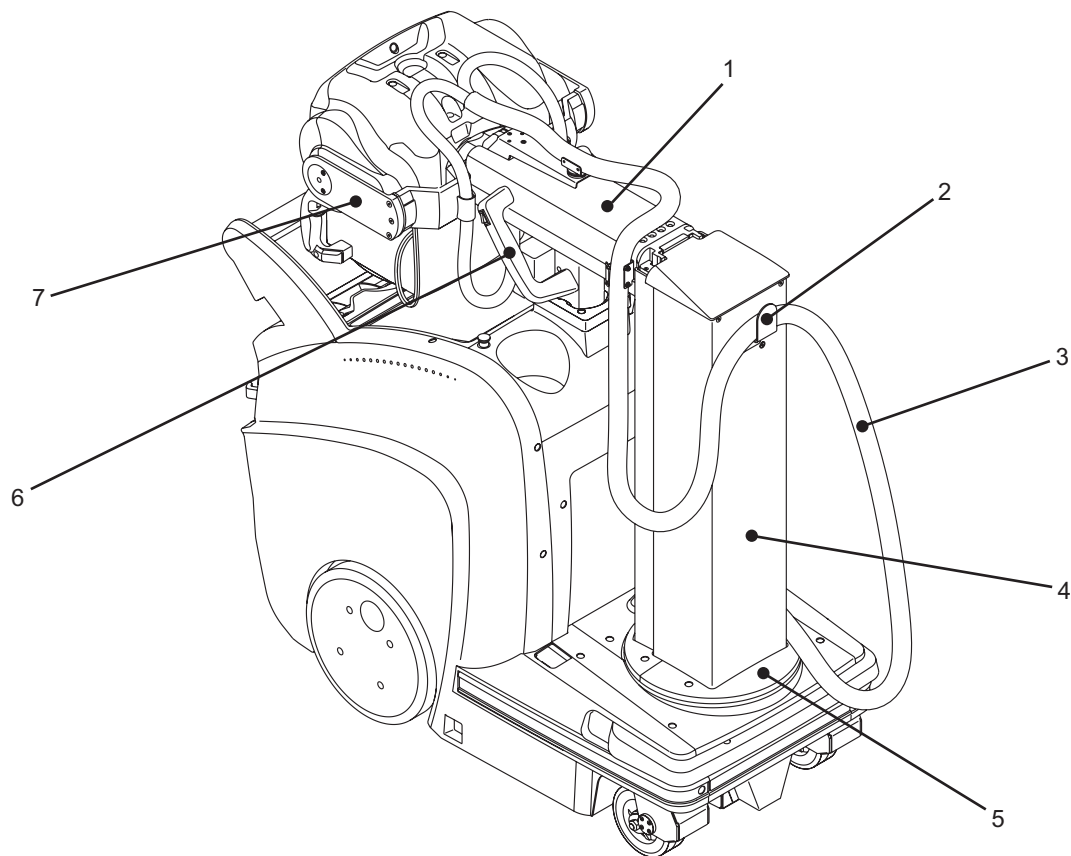
- | | | | |
|---|--|----|---|
| 1 | Detector battery charging and storage bin 1 | 9 | Standard built-in barcode reader |
| 2 | Detector battery charging and storage bin 2 | 10 | Storage bin for 35 x 43 cm DRX-1/DRX-1C Detector |
| 3 | Storage bin for future optional accessory | 11 | 35 x 43 cm DRX-1/DRX-1C Detector |
| 4 | Emergency brake release (inside the drive handle side panel) | 12 | Prep/Expose switch |
| 5 | Proximity badge scanner | 13 | Collimator light switch |
| 6 | Power status indicators and Prep/Expose light | 14 | Bag holder (protective bags for detector) |
| 7 | Drive handle | 15 | Storage for Ethernet cable, calibration filter, and detector tether |
| 8 | Storage for lead markers, papers, tape, paperclips, and latex gloves | | |

Cart (continued)



- 1 Primary monitor display
- 2 Retractable AC voltage power cord
- 3 Bumper sensor
- 4 Front caster (2)
- 5 AC voltage circuit breaker. The DC voltage circuit breaker is in the same location on the opposite side.
- 6 Motorized drive wheel (2)
- 7 Drive handle side panel
- 8 Barcode reader
- 9 Boom dock receiver
- 10 Emergency stop (2)
- 11 Base for wireless prep/expose switch (optional)

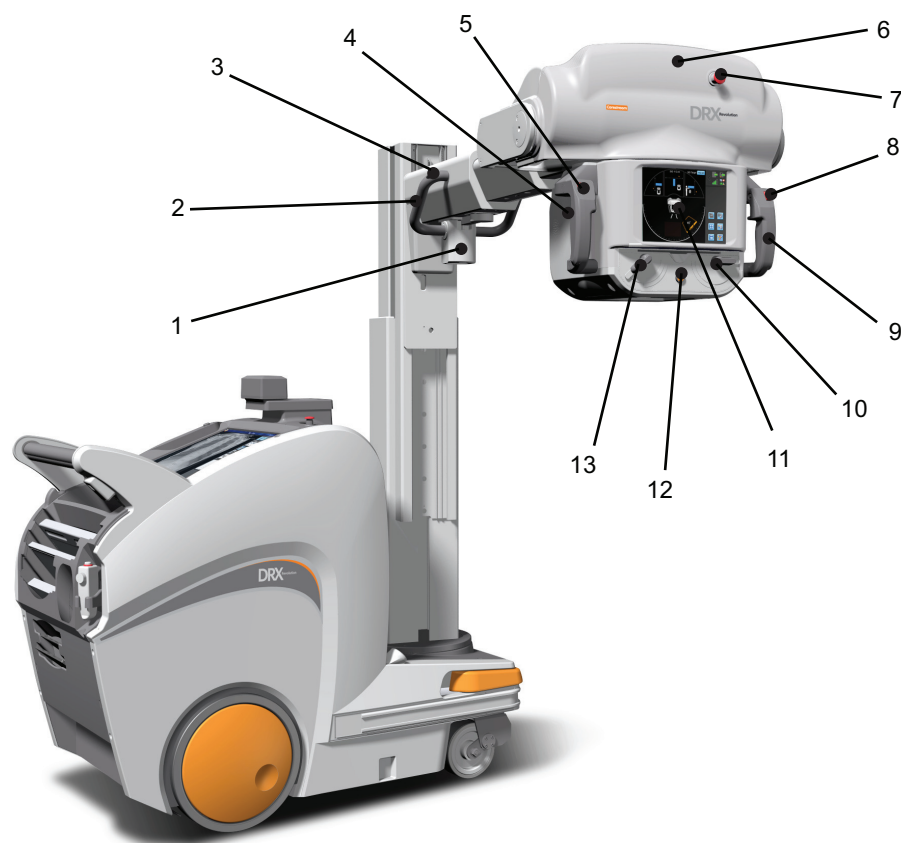
Crane



H239_0009HA

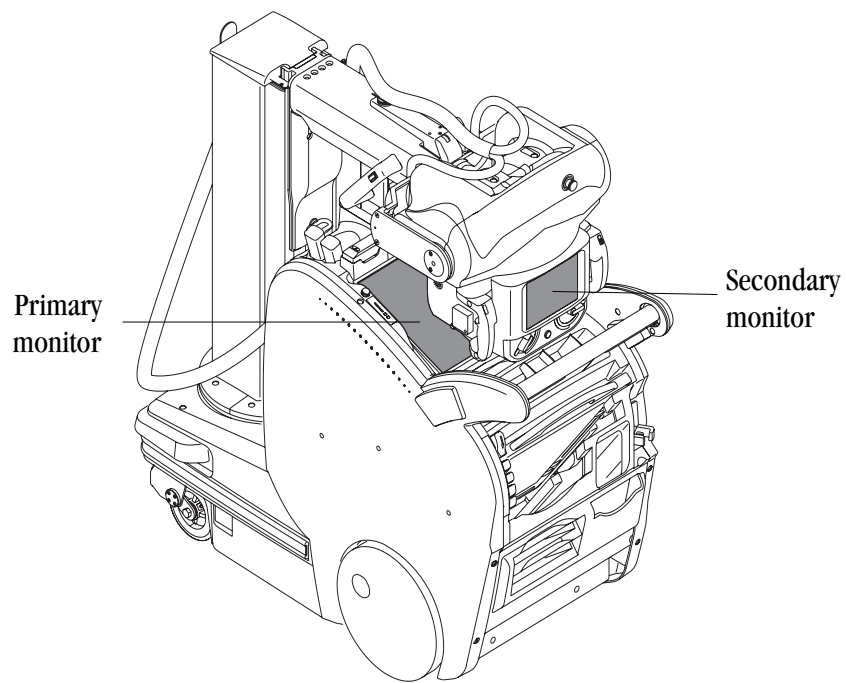
- 1 Boom
- 2 Lead apron hook
- 3 Cable (power and controls)
- 4 Column
- 5 Turntable
- 6 Boom handle (2)
- 7 Yoke

Tube Head Assembly



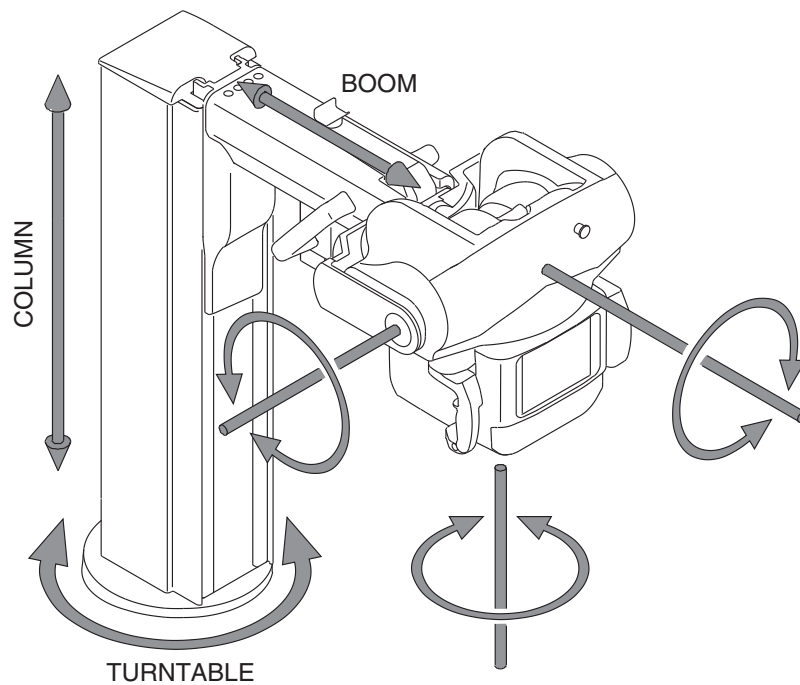
- | | | | |
|---|---|----|---|
| 1 | Boom dock tube | 8 | A button on the front of each handle can be used to release the brake on the collimator and secondary monitor and allow for rotational movement |
| 2 | Boom handle (2) | 9 | Collimator handle (one on each side) |
| 3 | Boom handle buttons (one on each handle) | 10 | Right collimator blade |
| 4 | One button on the back of each handle to release the tube head from its docking position, so you can raise and rotate the column, and extend the boom | 11 | Secondary monitor display |
| 5 | Collimator handle | 12 | Collimator light switch |
| 6 | X-ray tube head | 13 | Left collimator blade |
| 7 | Emergency stop | | |

Primary and Secondary Monitors



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Movements of the Boom, Column, Turntable, and Tube Head Assembly

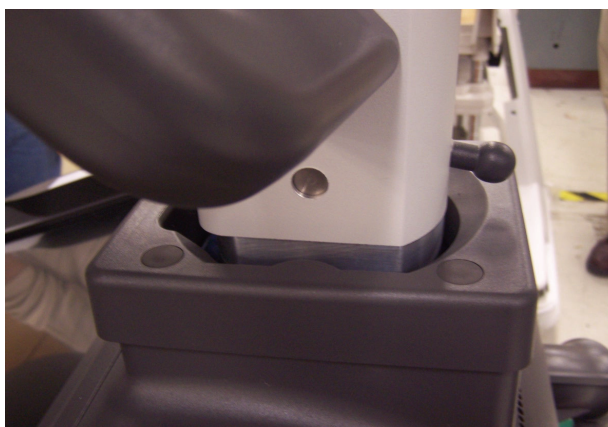


Subcomponents

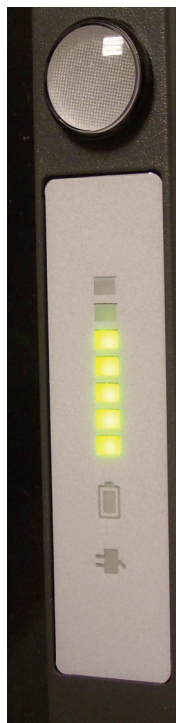
The following photos show details of some of the subcomponents that do not appear clearly in the illustrations.

Boom Docking Mechanism

The view on the left displays the boom dock in the docked position. The view on the right shows the boom dock receiver.



Power Display Indicators



A photo of the power display indicators (below) includes the round Ready/Prep light above. An explanation of the changing indicators and other symbols on this panel follows.

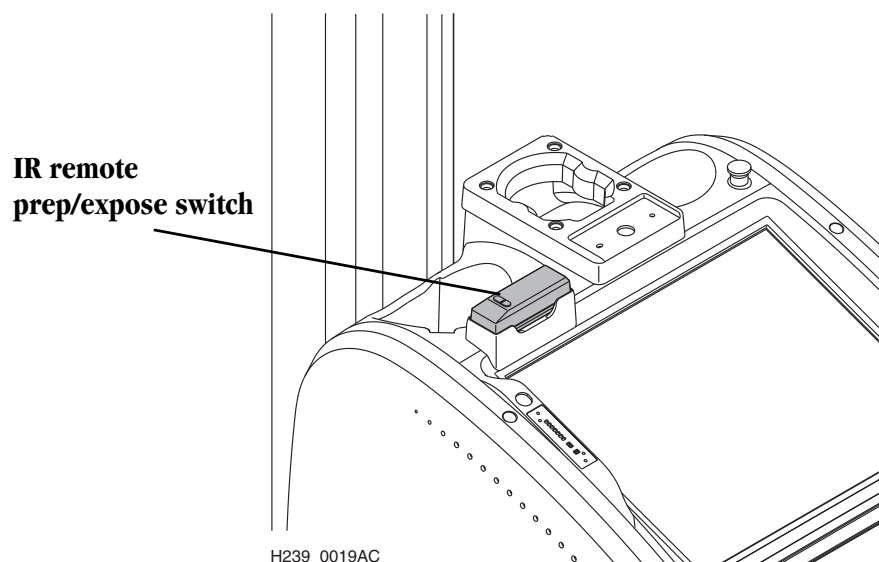
What is illuminated	What it means	Notes
7 green lights	The battery is fully charged. All exam types are available.	All image techniques are available.
3–6 green lights	Normal Operating Mode	All image techniques are available.
2 green lights and battery symbol	The batteries are low on power.	A minimum of two green lights must be illuminated to take an image, and the image must not require high technique.
Blinking battery symbol	The battery must be charged for further exams.	Take cart to charge station.
Blinking green lights	The battery is charging.	When fully charged, the lights will stop blinking.
Battery and plug symbol are alternately blinking	The DC circuit breaker is turned off.	Turn on the DC circuit breaker to use the system.
Nothing	The cart is turned off and not plugged in.	You can still drive the cart.
Plug symbol	The cart is plugged in.	Motion is inhibited.

Wireless Prep/Expose Switch



CAUTION:

Multiple units with the infrared (IR) remote prep/expose switch should not be used in the same area.

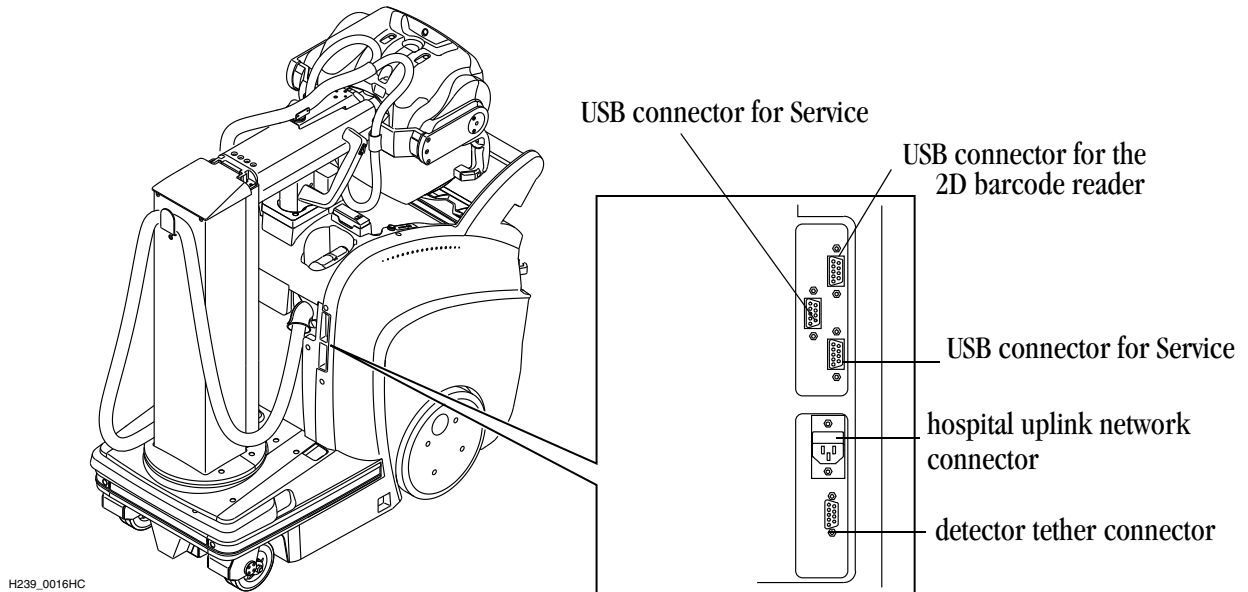


Brake Release on Boom Handle

A brake release switch on each boom handle allows you to move the column up and down, the boom in and out, and the turntable around.



USB, Network, and Tether Connectors



4 Component Descriptions

Components are listed alphabetically.

Component	Description
Battery storage and charging	The cart provides storage and charging space for two DRX batteries.
Bins	Storage bins are located in the back of the cart. <i>See</i> Detector.
Boom	The boom is an extendable, horizontal arm that holds the tube head assembly, two boom handles, and the boom dock tube.
Brakes	<i>See:</i> Bumper, Column, Drive handle, E-Stop.
Bumper	The bumper on the front of cart is touch sensitive. Forward motion is prevented when the bumper touches an obstacle. Reverse drive the cart to release the bumper brake.
Cart	The cart exterior includes a drive handle, detector, storage bins, prep/expose switch, wheels, bumper, LEDs and other light indicators, primary touchscreen monitor, boom dock receiver, proximity badge reader, and barcode reader. The cart has a zero degree pivoting radius. Inside, the cart contains batteries, a generator, circuitry, and motors.
Collimator	The collimator includes an LED that creates a light field, which represents the area on the patient to be X-rayed, two control knobs to operate the horizontal and vertical shutter openings, and a collimator brake release.
Column	The column is an extendable, motor-assisted, vertical component that lifts and lowers the boom. The column rotates right or left on a turntable 270 ° in each direction. To release the brake and raise the column or extend the boom, grip either or both of the collimator handles, or either boom handle, press and hold the button on the back of the handle(s), and lift or pull.
Connectors	<i>See:</i> Power components.
Crane	The crane includes the turntable, column, and boom.

Component	Description
Detector, upper storage bins, tether, and lock	The upper storage bins on the back of the cart are intended for a 35 x 43 cm DRX-1/DRX-1C digital flat panel detector and an optional grid alignment holder. To store the grid or detector, slide it straight into the bin so that it seats securely. The top storage bin provides charging for the grid holder battery. For security, these bins are locked. After an operator logs on, the bin lock is automatically released. To manually lock the bins, slide the lock down. If the power goes off, an emergency bin release and a detector tether are available. To operate the emergency bin release, insert the end of a paper clip into the pin hole to the left of the lock. The DRX-1 Detector can be used wirelessly or tethered. The tether cannot be used with the grid operation.  RISK OF ELECTRIC SHOCK: Exposures may be made with a tethered detector, but are <i>not</i> to be made with the machine plugged into the AC mains. The machine can be plugged in while making a <i>wireless</i> exposure only.
Docking tube and docking receiver	The docking tube on the boom fits inside of the docking receiver on the cart to lock the tube head assembly and crane. To release the tube from the receiver, press the buttons on the back of the boom or collimator handles and lift.
Drive handle	The drive handle steers and powers the drive wheels, allowing the cart to be self-propelled. The cart will not exceed its maximum speed of 5.6 kph (3.5 mph). Release the handle to engage the brake and stop the cart from moving. For driving instructions, see “Chapter 5 Operating the Machine”. The cart may be driven at normal speeds if it is unplugged from the wall socket, is locked in the docked position, and an operator is logged in. If the tube head is undocked, the cart may be driven at reduced speeds. If the power goes off, there is an emergency brake release so the cart can be manually moved by the operator. To release the emergency brake, press the small button on the inside of the left power handle side panel. If the operator is not logged in, the cart is immovable unless the emergency brake release is pressed, which allows the user to manually push the cart when the power is off.
E-Stop (Emergency Stop) knobs	There are two red emergency stop knobs: one on the X-ray tube and one on the cart. Press the knob to disable all drive motors. To release, turn the knob in the direction of the arrow.

Component	Description
Ethernet cable storage	There is a storage compartment for an Ethernet cable to connect to the hospital network, RIS, and PACS. Have an extra Ethernet cable for backup.
Filter	On the collimator, below the secondary monitor, there is a slot for a dual filter for added filtration. One filter is supplied to calibrate the DRX-1/DRX-1C Detector. You can also use your own filter. The filter storage is located on the back of the cart in the pocket on the lower right as you face the drive handle.
Grid alignment system	The optional grid alignment system assists the operator in properly positioning the tube head and detector in preparation for an exam. The system consists of a grid alignment transmitter and receiver. The transmitter is mounted on the tube head. The receiver is part of a grid holder assembly, which holds the grid and a DRX-1/DRX-1C detector.
Lead apron hook	A hook in the front of the column provides a place to carry a user-supplied lead apron.
Power components	Power components include cords (including the main, battery-charging, retractable cord); a generator; USB, network, and tether connectors, batteries, motors, AC voltage and DC voltage circuit breakers, a network cable, and a wireless access point. The batteries support the full functionality of the mobile cart without being plugged into a wall. There are separate electronic control boards for the cart, crane, battery, and grid display. A photo of the USB, network, and tether connectors is on page 3-11 of “ Chapter 3 Parts Diagrams ”.
Power status indicators	A column of small green LED lights on the top left of the cart indicate the charging status of the main battery. For a detailed description of these indicators, see page 3-9 of “ Chapter 3 Parts Diagrams ”.
PREP/EXP switch	When the Prep/Expose light is green, it indicates that all systems are ready to take an X-ray image. When it is yellow, an X-ray image is being taken.
PREP/EXP unit	This unit includes a red prep/expose button on top and a collimator light button on the side. A cord connects the unit to the cart. An infrared (IR) wireless remote is available as an option.
Proximity card reader	The proximity card reader scans an RFID badge to identify the operator for logon security. Carestream supplies optional proximity badges if needed, or you can use your own. Either way, they need to be configured to enable the unit.

Component	Description
Shelves for holding the detector in place while bagging and unbagging the detector	There are two shelves for holding the detector in place while bagging and unbagging the detector • One shelf is inside the 35 x 43 cm detector bin. The detector can be partially lifted from the bin (about three-quarters of the way out) and held in place on top of the shelf while a bag is put on or taken off. • Another shelf is at the bottom of the primary monitor, below the drive handle. The detector can be leaned against the side of the shelf and over the drive handle, while the bag is put on or taken off.
Storage for detector bags	Storage space is provided for detector bags. Protective bags can be used to cover the detector during patient exams. Clean bags may reduce the possibility of spreading contaminants among patients.
Touchscreen monitors (2)	A primary touchscreen, 48.26 cm (19.00 in.) is permanently positioned on top of the cart. A secondary touchscreen, 21.00 cm (8.40 in.) is situated on the tube head assembly and can be positioned as needed. The monitors display the PC-based software application that manages image acquisition, manipulation, and delivery in a health network. Both monitors display the detector battery life so the operator can see if the detector has enough battery charge prior to acquiring an image.
Tube head assembly	The tube head assembly is the entire unit located at the end of the boom. It includes the X-ray tube, secondary monitor, handles on the boom and collimator for movement, grid alignment transmitter, and the collimator. The secondary monitor allows the operator to change techniques and views at the tube head assembly. The angle of the X-ray tube is displayed on the secondary monitor. The two buttons on the front of the boom handle and the back of the collimator handles allow you to undock, move up and down, and rotate around the column. The front buttons on the collimator handles allow you to rotate the tube head in any direction (x, y, z). The tube head assembly must be docked when the cart is being driven. If it is undocked, it can be moved, but speed is reduced.
USB connectors	USB connectors are located on the front of the cart. If the network is not functioning, an image can be delivered from the DRX-Revolution to a PACS using a USB device. See “USB, Network, and Tether Connectors” on page 3-11 for a diagram of the connectors.
Wheels	There are two rear motorized drive wheels and two front caster wheels. Each of the rear wheels is controlled by a separate motor, which is activated when you press the left, right, or both sides of the handle.

Component	Description
X-ray Tube	Maximum Anode Heat Content = 300 kHU. Normal operation of the DRX-Revolution is considered 125 images in a 24-hour period. The tube has two focal spot sizes ~0.6 and 1.2 mm. • The smaller focal spot size allows better image detail for smaller patients/anatomy. • The larger spot size allows for use of higher tube limit (higher allowable maximum voltage) for better image quality when imaging larger patients.
Other	Optionally supports DAP with automatic population.

5 Operating the Machine

This chapter includes basic directions for driving the cart, docking and undocking the boom, and logging on and off.

Drive the Cart

Start	Squeeze the drive handle and push or pull the cart. The boom must be docked in order to drive it at full speed. It can be moved when undocked, but its speed is reduced.
Stop	Release the drive handle.
Go forward or reverse	Two-handed driving: With both hands on either side of the drive handle, squeeze the handle and gently push or pull using the motor to power the drive wheels. One-handed driving: Squeeze the center of the drive handle and push or pull.
Turn right or left	To turn right, apply more pressure to the left side of the drive handle with your left hand, and less pressure with your right hand. To turn left, do the opposite.
Control speed	The cart will keep pace with your walking speed, up to 5.6 kph (3.5 mph).

Dock and Undock the Boom

Dock	Fully compress the boom, align the boom dock tube over the boom dock receiver, and lower the crane until it locks in place. IMPORTANT: Make sure the boom is fully compressed before attempting to dock. When the tube head is docked, the display is turned off, and the Patient Work List is displayed on the secondary monitor.
Undock	To release the crane lock and raise the boom dock from the receiver, press the boom brake release buttons behind the boom handle or collimator handles. The primary monitor automatically “wakes up” when the tube head is raised.

Start up the Cart and Log In or Shut Down the Cart and Log Out



CAUTION:

Make sure that your hands are dry before touching the electrical components.

Start up Log in	This step assumes that the cart has been parked and docked and has been plugged into a wall socket to recharge the batteries. 1. Carefully remove the power cord from the wall socket by holding the plug housing and pulling it from the power outlet. Tug <i>slightly</i> on the cord and <i>slowly</i> release it to start the rewind mechanism. Do not pull on the cord to remove it from the wall. 2. Touch the secondary monitor screen on the tube head assembly. The system “wakes up” and the Logon screen is displayed.* 3. To log in, either enter your user name and password on the display or swipe your ID badge over the proximity reader.**
Shut down Log off	1. When you have completed your exams, dock the boom and return the cart to its parking/recharging location. 2. Grab the plug at the cart and <i>gently</i> pull out enough of the power cord to place the plug fully into an AC voltage wall socket without stretching or pulling on the cord. 3. After a predetermined time, the system automatically enters a screen saver mode, power is cut to the monitor light, and you will be automatically logged out. NOTE: You will remain logged in until another radiographer logs in or until you are automatically logged out by the system.

* If you swipe your badge while the primary monitor is still asleep, it will log you into the system and wake up the primary monitor. Then there is no need to wake up the primary monitor in order to log in.

** If you disconnect the power cable, it may wake up the primary monitor. Then there is no need to touch the screen.

6 Maintenance and Safety Information

This chapter contains hardware cleaning instructions, Cautions and maintenance information from Carestream Health. For complete information concerning Safety and Regulatory issues, see the *CARESTREAM DRX-Revolution Safety and Regulatory Information* that accompanies the publications for your system.

Cleaning Instructions

With Each Occurrence of Patient Contact

To ensure that the DRX-Revolution continues to provide quality performance, periodically clean the exterior.



CAUTION:

Do not spray cleaning solution directly onto the equipment. Moisten a cloth with a 70 % isopropyl alcohol solution and apply to patient contact areas after each contact.



CAUTION:

Isopropyl alcohol is a flammable solvent. Read and follow instructions in the Material Safety Data Sheet (MSDS)



CAUTION:

Do not use a flammable spray to clean the machine. If gas from the spray comes in contact with hot electrical components, fire or electrical shock may result.



CAUTION:

Do not use isopropyl alcohol when the machine is running, as it is a flammable liquid. If this is a concern, keep in mind that batteries always retain a charge.

IMPORTANT: *Do not let any liquid drip into the cart or its components.*

If spray cleaner is used, spray the cleaning material on a cleaning cloth, and then use the cloth to clean the machine.

Do not use volatile cleaning agents like ammonia. These may degrade or discolor the unit.

Do not use a regular vacuum as it generates static electricity that can damage the unit. You can use a battery-powered vacuum on the exterior except for on the touchscreen monitors.

Follow the instructions for cleaning each of these components:

- Monitors
- Detector/Grid
- Plastic Components
- Metal Column

Cleaning the Monitors A touchscreen monitor is a prime target for dust, finger prints, and bacteria. At the same time, a touchscreen monitor is very sensitive, so proper cleaning is important to maximize its performance and prolong its life.

IMPORTANT: Do not spray any liquids onto the screen directly, press gently while cleaning, and do not use a paper towel as it may cause scratches.

Power down the system before cleaning the monitor.

The easiest cleaning method is to use a screen cleaner kit that includes antistatic wipes. Spray a little of the cleaning solution on a wipe, and then rub it gently across the screen. If necessary, finish cleaning the touchscreen with a dry, lint-free cloth to wipe off any moisture.

Alternatively, wet a soft, lint-free or microfiber cloth with a solution of 70 % isopropyl alcohol. Make sure the cloth is damp but not wet. Wipe the screen in a gentle motion. If necessary, finish cleaning the touchscreen with a dry, lint-free cloth to wipe off any moisture.

Cleaning the Hardware



CAUTION:

Do not operate the equipment when you are cleaning the equipment.



CAUTION:

Do not spray cleaning solution directly onto the equipment. Moisten a cloth with a 70 % isopropyl alcohol solution and apply to the patient contact areas after each contact.



CAUTION:

Do not immerse the equipment in liquid.

Cleaning the Detector:

1. Disconnect the detector from its power source.
 - a. Remove the tether.
 - b. Remove the battery.
2. Moisten a cloth with a 70 % isopropyl alcohol solution.
3. Apply the moistened cloth to the equipment.

Cleaning the Battery Footprint

1. Wipe the well clean of dust or debris with a soft cloth.
2. Use a brush or vacuum to clean out the prongs in the battery compartment well, or contact Service for assistance.

Cleaning the Plastic Components

Most of the DRX-Revolution exterior is plastic. All of the components except the touchscreen monitors, which are glass, the grid, and the painted metal column, are plastic.

IMPORTANT: *Turn off the power to the cart before cleaning.*

Do not attempt to clean inside the machine or to remove the plastic panels.

Do not use aerosol sprays directly on or over the machine.

Basic Rules for Cleaning Plastic

Never use abrasive cleaning products such as abrasive sponges, steel wool pads, abrasive powdered cleaners, or harsh detergents. Plastic surfaces are easily scratched. This can ruin the finish. Do not use glass cleaner on plastic. While the damage may not be immediately visible, over time, glass cleaners will leave the plastic with an appearance that doesn't appear to be clean. Instead, use sponges, soft cloths, and mild detergents when cleaning plastic. With a damp, lint-free cloth or an electrostatic dust cloth, wipe the panels, handle, bins, knobs, and wheels. When moistening a cloth, it is best to use a solution of 70 % isopropyl alcohol. You can also use lint-free foam swabs moistened with rubbing alcohol or water for wiping hard-to-reach areas. Finish cleaning with a dry, lint-free cloth to wipe off any moisture.

Cleaning the Metal Column

Handle the painted metal column with care to avoid striking any object, which may chip the paint.

You can clean the column using any of these methods:

- Use a battery-powered vacuum with a soft nozzle to remove the dust and dirt. Pay particular attention to corners and side grooves, where buildup of dirt and residue can occur.
- Wash the surface with a soft, lint-free cloth dampened with warm water and a mild liquid detergent.
- Tri sodium phosphate (TSP) is made specifically to remove grease and grime from painted surfaces without harming the finish.
- Use a solution of 70 % isopropyl alcohol on a clean, soft cloth.

System Maintenance



CAUTION:

Do not attempt mechanical or electrical repair of the System. Contact your authorized Service Provider if any unit does not perform to your satisfaction.

Avoid performance issues and unplanned downtime with regularly scheduled inspection, calibration, and preventive maintenance checks. The equipment must be maintained in good operating order at all times to provide safe conditions for operating personnel and patients. It must also be maintained to prevent possible loss of patient or image data. To ensure continued safe performance of X-ray equipment, it is the owner's responsibility to supply or arrange for a periodic maintenance program. After installation, perform maintenance on the system per the schedule.

Semi-Annually

Run an X-ray calibration on the Detector Array monthly or as prompted by the software. The System must be serviced and repaired only by your authorized Service Provider.

Periodically or as Needed

Clean the equipment.

Recalibrate the touchscreen. Follow the on-screen instructions for calibrating the secondary monitor. See "Calibrate the Touchscreen" in the *DRX-Revolution Online Help* for information about calibrating the primary monitor.

Reporting Unusual Conditions

Report any unusual noise, difficulty of motion, squeaks, malfunctions, or other problems with the equipment immediately.

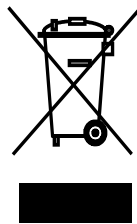
To facilitate repair if a failure occurs, provide specific information to the service representative. Note any unusual events prior to the failure, the type of procedure in progress, and specific failure information.

Replacing the Batteries

CAUTION:

The cart batteries will need to be replaced every two to five years. The batteries contain lead and pose a hazard to the environment and human health if not disposed of properly. Due to the toxicity of lead, the U.S. EPA Resource Conservation and Recovery Act (RCRA) and state solid and hazardous waste authorities consider a spent lead-acid battery a regulated waste. The customer must treat this battery as a hazardous waste if it is not recycled. A recycling infrastructure is widely available in the U.S. to manage this battery type.

Disposal



In the European Union, this symbol indicates that when the last user wishes to discard this product, it must be sent to appropriate facilities for recovery and recycling.

See <http://recycle.carestreamhealth.com> for additional information on the collection and recovery programs available for this product.

CAUTION:

This product contains lead. Disposal of components that contain these materials are regulated due to environmental conditions. For disposal or recycling information, contact your local authorities.

CAUTION:

The flat panel display in this system contains mercury. Disposal is regulated due to environmental considerations. Return the equipment to the manufacturer for proper disposal.

For recycling and disposal options in the European Union, visit the European Portable Battery Association (EPBA) web site at <http://www.epbaeurope.net/>. In other areas, contact local or regional solid waste authorities for recycling/disposal guidance.

IMPORTANT: *Contact your authorized Service Provider for service and replacement.*

Additional Safety Information

Cautions and Warnings



CAUTION:

Do not make any modifications to this machine. Doing so may result in personal injury or damage to the machine.

DANGER: USE OF CONTROLS OR ADJUSTMENTS, OR PERFORMING PROCEDURES OTHER THAN THOSE SPECIFIED, MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.

DANGER: CHARGE ONLY IN A WELL VENTILATED AREA.



RISK OF ELECTRIC SHOCK:

Do not use a flammable spray around the machine. If gas from the spray comes in contact with hot electrical components, fire or electrical shock may result.



CAUTION:

Exposures may be made with a tethered detector, but tethered exposures are **NOT** to be made with the machine plugged in to the AC mains. The machine can be plugged in while making a *wireless* exposure only.



CAUTION:

Do not use a flammable spray around the machine. If gas from the spray comes in contact with hot electrical components, fire or electrical shock may result.



CAUTION:

Do not place a vessel that contains water or other liquid on the machine. If liquid spills into the machine, first turn off the machine's main power switch and then unplug the power cord.



CAUTION:

If a thunderstorm begins, unplug the power cord in order to prevent electrical shock and fire due to a lightning strike. The user can operate the cart during a thunderstorm as long as the unit is indoors, and not plugged in.



CAUTION:

To keep foreign matter from getting on the machine, place a cover loosely over it when not in use. Do not cover the vent holes on the sides of the panels.



CAUTION:

Be sure to connect the power cord only to a power outlet that meets the specified voltage and current requirements. Also make certain the outlet is properly grounded. For power supply requirements, see “[Chapter 7 Technical Specifications](#)”.



CAUTION:

Do not store the machine in areas that are poorly ventilated, damp, humid, very dusty, exposed to direct sunlight, or subject to extreme temperature or humidity changes.



CAUTION:

Do not use the machine on an unstable surface, or one that is inclined more than 5 °. Install the machine only on a surface that can withstand the weight of the machine.

7 Technical Specifications

Components

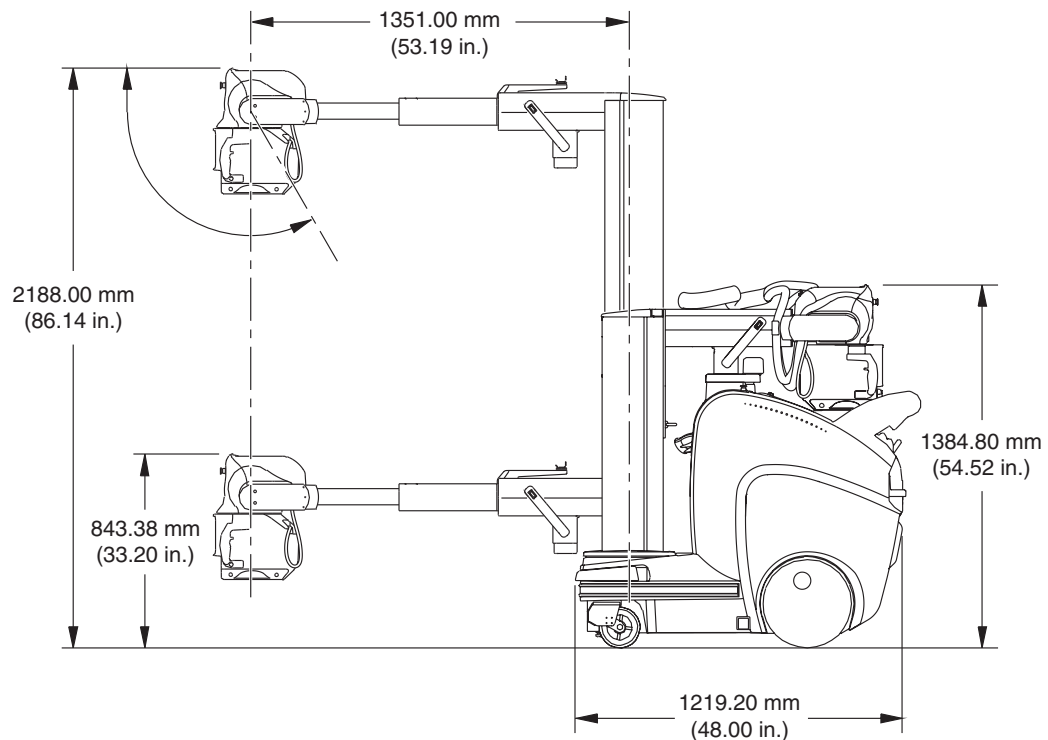
Components are listed in alphabetical order.

Component	Specification
Batteries	The battery life allows for driving one mile and taking 40 exposures without charging. This assumes fully charged batteries and exposure technique factors of 70 kV and 10 mAs. Operates for a minimum of four hours without turning off the main system computer components (assumes new batteries). When fully charged, the battery bank produces 240 V(dc) nominal. There are a total of 20 lead-acid batteries; each battery has 12 V and 12 A capacity. Electronics to track battery health and to recharge the batteries are included.
Cable	The large cable, that extends from the front of the cart and hangs on the lead apron hook, powers and controls the tube head assembly.
Cart	Docked speed (assumes new batteries) Forward 0 to 5.6 kph (0 to 3.5 mph) $\pm 15\%$ Reverse 0 to 3.2 kph (0 to 2 mph) $\pm 15\%$ Can stop and hold its position on an incline of 7° (12.3 %) Weight 567 kg (1300 lb)
Circuit breakers (2)	On the left side (facing the drive handle) is a DC voltage circuit breaker. This breaker controls all DC voltage power to the PC, generator, monitor displays, motion systems, and circuit boards. On the right side is an AC voltage circuit breaker. This breaker controls AC voltage to the cart when plugged into an outlet. The AC voltage is used only for the battery charging system. This circuit breaker has no effect when the cart is not plugged in.
Collimator	Projection radiography range of 40–150 kV. Single transverse and longitudinal cross-hairs on the output aperture. Rotates independently of the x-ray tube $\pm 90^\circ$. Accessory rails for the use of a Dose Area Product (DAP) measurement chamber and additional filters.
Collimator field light and visual aids	The collimator light field source provides an average luminance ≥ 160 lux at 100 cm. Refer to CFR, Title 21, Volume 8, 1020.31, (d)(2)(ii).

Component	Specification
Column	Rotates $\geq \pm 270^\circ$ from docked position
Desktop Computer Hardware Platform	Processor: Pentium 4 or higher OS: XP Memory: 1 GB minimum I/O: 1 Ethernet, 5 USB ports Random Access Memory (RAM) can store up to 400 images WLAN antenna (wireless access point) or LAN cable Computerized diagnostics
Detectors and rechargeable battery storage bins	Storage space for one 35 x 43 cm DRX-1/DRX-1C digital flat panel detector. Can be coupled to the grid frame assembly when inserted into bin. For detectors that are ISO40900 compliant (DRX-1, DRX-1C detectors). Solenoid tube bin lock release.
Generator	32 kW X-ray generator kV range 40–150 kV mAs range 0.1–320.0 mAs mA range 100–400 mA (not user selectable)
Tube Head Assembly (X-ray tube head, yoke, collimator, secondary monitor)	Movement force Vertical (zeta - z) ≤ 53 N Horizontal (gamma - γ) ≥ 3.5 lbf (15 N) Column rotation (beta - β) ≤ 20 N–m Tube angulation (alpha - α) ≤ 24 N–m Tube tilt (tau - τ) ≤ 18 N–m Holding force Vertical (zeta - z) ≥ 40 lbf (175 N) Horizontal (gamma - γ) ≥ 20 lbf (93 N) Column rotation (beta - β) ≥ 4 lbf (17 N) (alpha - α) $\geq \bullet 26$ N-m (230 in-lb) (tau - τ) $\geq \bullet 28$ N-m (250 in-lb)

Component	Specification
X-ray Tube and tube movements	Tube range 40–150 kV Anode heat capacity ≥ 300 kHU Focal spots = 0.6 and 1.2 mm Target angle = 14° Angulation range (alpha - α) $\geq \pm 180^\circ$ Tilt range (tau - τ) ≥ -10 to $+90^\circ$ (where zero = tube pointing straight down) When the boom arm is fully extended, the X-ray tube focal spot is 1016 mm from the column center. When the boom arm is fully compressed, the X-ray tube focal spot is 610 mm from the column center. When the column is fully extended vertically, the X-ray tube focal spot is 2050.0 mm (78.7 in.) above the floor. When the column is fully compressed, the X-ray tube focal spot is 686.0 mm (27.0 in.) above the floor, but not over the entire range of column rotation (beta - β).

Cart Specifications



H239_1020HC

8 Troubleshooting

Problem	Recommended Action
The system does not start up.	• Check the battery level indicators. • Make sure all applicable switches (circuit breakers) on the system are on. • If the problem persists, contact your authorized Service Provider.
During startup, one of the tasks in the Startup screen does not start.	• Power down the system and power up the system again. • If the failure occurs again, contact your authorized Service Provider.
The Operator Console powers up successfully, but reports a blocking error.	• Power down the system and power up the system again. • If the blocking error occurs again, contact your authorized Service Provider.
The Operator Console powers up successfully, but the application does not start.	• Power down the system and power up the system again. • If the problem persists, contact your authorized Service Provider.
You cannot log on.	• Make sure you are using the correct login and password. Note that passwords are case sensitive. • Check with your System Administrator or Key Operator. • If the problem persists, contact your authorized Service Provider.
None of the motorized movements are working.	• Check the Emergency Stop buttons in order to ensure that they are not engaged.

Service and Support

For technical support in the United States and Canada, contact the Center of Excellence (COE) at 1-800-328-2910.

For regions outside the United States and Canada, contact your local Shared Service Center (SSC).

General Customer Support for U.S. and Canada:

CARESTREAM HEALTH, INC.

150 Verona Street

Rochester, NY, 14608

United States

1-800-431-7278

Elsewhere in the world, contact Carestream Health, Inc. in your country.

Appendix A

Optional Parts

Optional Tools for the DRX-Revolution

- 2-D Barcode reader
- Anti-scatter grid
- Dose Area Product (DAP)
- Selected service diagnostic tools
- Wireless infrared remote exposure switch
- X-ray tube grid alignment (includes grid and frame assembly)

2-D Barcode Reader

In addition to the cart mounted barcode reader, a hand-held, two-dimensional (2D) barcode reader is available as an option.

Anti-scatter Grid

Specifications for the anti-scatter grid are as follows:

- Ratio is 8:1
- Line density is 80 lines per centimeter (approx. 200 lines/in.)
- Focus distance is 110 cm (approximately 44 in.)
- Dimensions of the grid are compatible for use with a 35 x 43 cm receptor (14 x 17 in.)
- Grid lines run parallel to the short side (35 cm or 14 in.) of the grid assembly

See the *DRX-Revolution Online Help* for instructions on using this feature.

Dose Area Product

DAP is available as an option for DRX-Revolution. The DAP is configured and calibrated via the monitor display, and optional accessory rails for the use of a DAP measurement chamber and additional filters. The X-ray tube will support DAP with automatic population. DAP meter specifications are the following:

Measurement	Specification
Upper limit of Response Range	0.8 nC/cGy-cm ²
Saturation	98 % at 400 V, 1 Gy/s
Energy Range	40–150 kV
Energy Dependence	5 % over the 40–150 kV range
Chamber Filter Effect	0.20 mm Al (70 kV) 0.25 mm Al (100 kV)

Selected Service Diagnostic Tools

See the *DRX-Revolution Service Guide* for instructions on using these tools.

Wireless remote exposure switch

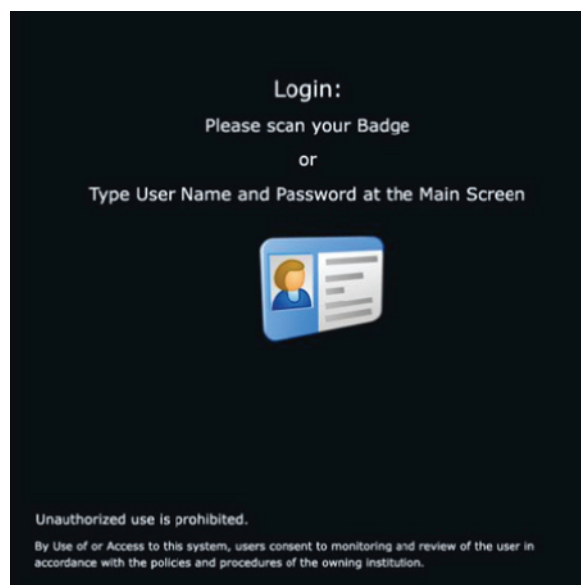
The X-ray tube will support an optional infrared wireless exposure switch. See the *DRX-Revolution Service Guide* for instructions on using this tool.

Appendix B

Hardware-Software Interfaces

IMPORTANT: *See the **Tube Head Software** section of the **DRX-Revolution Online Help** for information about using the Tube Head Software, and a guide to the icons displayed on the tube head screens. Go to the Primary monitor and touch the question mark in the upper right corner of the screen. Tube Head Software topics are located in the Table of Contents.*

Logon Screen



To log in using your proximity badge for the first time, follow these steps. (This procedure assumes you have already have a user account.):

1. Log in as usual using the touch screen.
2. Go to the **Utilities** menu.
3. Touch **Register Badge**.
4. Scan your badge by swiping it across the badge reader, which is a small rectangle on the left side (as you face the drive handle) that protrudes about 0.5 in. from the cart below the drive handle.
5. Wait for a beep.

6. When asked if you want to enter this change to your account, touch **OK**.
7. Enter your password.
8. **Save** your changes.
9. When asked if you want to associate the badge to your account, touch **OK**

Emergency Stop

The Emergency Stop or E-Stop indicator is displayed on the screen if the user has activated it. The indicator will no longer be displayed when the cart begins to move again.



Screen Saver

Touching either monitor *and* using any part of the cart, such as driving or using the prep/expose switch, will reset the Screen Saver timer and the Auto Logout timer. This prevents the system from automatically logging out a technologist while they drive to a patient's room.

Special notes on the Screen Saver:

- To save power, the power the primary monitor is disabled when the tube head assembly is docked. You cannot see the primary monitor when the tube head is docked.
- There is no Screen Saver for the secondary monitor. Instead, the cart will cut power to the backlight on this monitor to save on battery life. The system is activated by touching the secondary monitor.

Log out at Either Monitor

A technologist may log out by touching the **Log Out** button on the primary or secondary monitor display.

Detector/Grid Holder
Battery Indicator

A detector battery indicator displays the charge of the battery installed in the selected detector. If no detector is selected, an empty placeholder is displayed. It also indicates when the battery is being charged by showing a detector with tether. Touch this or any other battery indicator on the control panel to display the **Battery** and **Charging** screen.

	
Detector battery status	Grid holder battery status

Cart Battery Indicator

A cart battery indicator displays the charge of the batteries that run the console computer and the wheels. It also indicates when the battery is being charged (plugged in).

	Cart-Charging		Cart-Charging, 50 % battery power
	Cart-No battery power		Cart-Status unknown
	Cart-25 % battery power remaining		Cart-50 % battery power remaining

Drive Mode

	Drive-only mode
---	-----------------

The Key Operator can configure driving as follows:

- Allow driving only when the user is logged into the system.
- Allow driving, without logging in, by touching the Drive icon.
- Allow driving, without logging in, by touching the Drive icon and entering the drive code.

Tube and Grid Alignment System (Option)

The Tube and Grid Alignment System option provides a tool that assists the user to efficiently align the X-ray source to the grid/receptor for centering and perpendicularity at the correct focal distance.

The Tube and Grid Alignment System option:

- Displays the tube head and detector angles relative to gravity.
- Provides guidance for positioning the tube head assembly with three alignment indicators (vertical, horizontal, in/out) to achieve proper alignment at a selected Source to Grid Distance (SGD) (102–127 cm (40–50 in.)).
- Displays the current SGD.

NOTE: Two Grid Alignment systems operating within 6.0 m (20.0 ft) of each other may cause grid alignment interference.

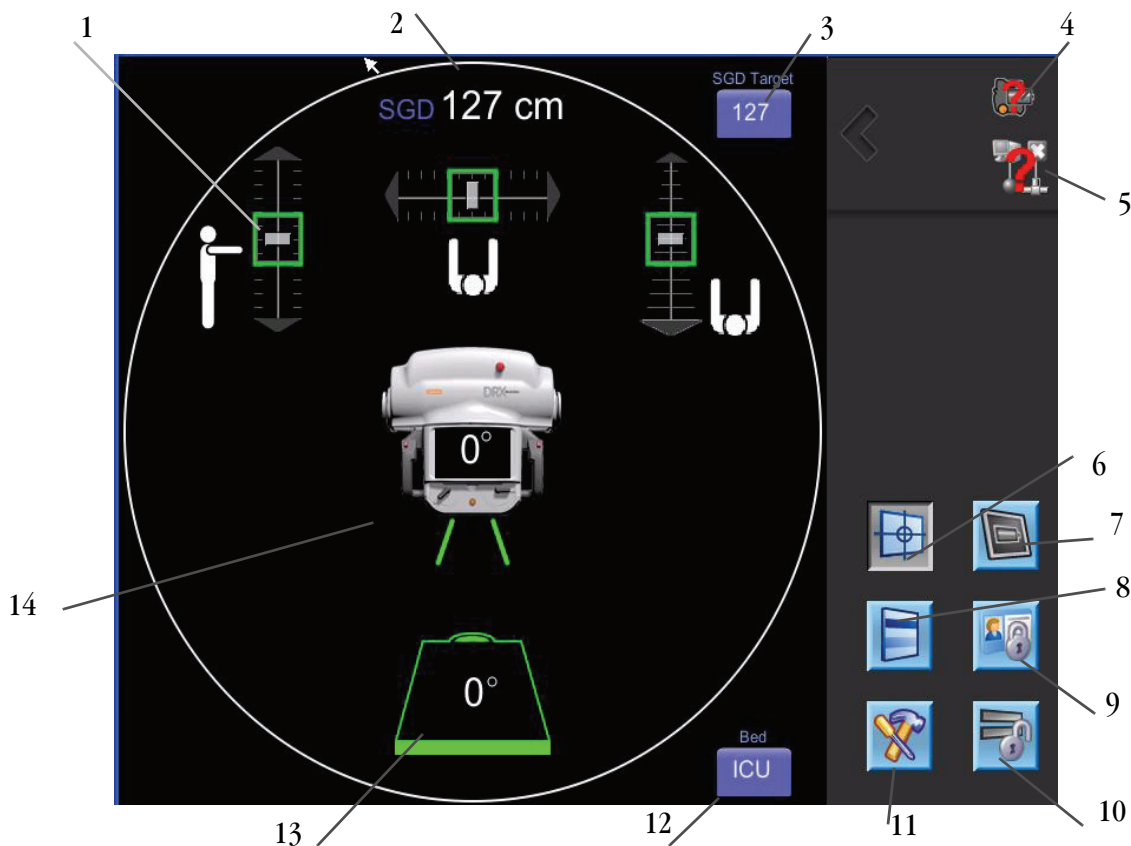
NOTE: The grid alignment system is optimized for use on beds that have non-metallic mattress supports in the patient chest region.



CAUTION:

It is possible that cases of extreme interference might prevent the grid alignment system from functioning properly. It is always the user's responsibility to ensure proper alignment before taking an X-ray.

Grid Alignment Screen



Key:

1	Grid Alignment indicator, showing grid aligned in the target square, after moving up/down, in/out, and left/right
2	Source to Grid Distance indicator
3	Source to Grid target; set by the user with a button touch
4	Cart battery indicator
5	Wireless statue indicator
6	Grid Alignment button; opens the Grid Alignment screen
7	Press to display the cart battery status screen. This screen is also displayed to hide the current screen when the user wants to protect the patient data from view.
8	Work List screen button; opens the Patient Work List screen
9	Logout button; the user touches to log out
10	Detector bin locked; prevents the detector from being removed
11	Utilities button, allows accesses to Key Operator and Service functions

12	Bed type indicator; The user can touch to select Intensive Care Unit (ICU) beds, or Trauma beds (ED).Image processing is optimized for either selection.
13	Detector angle indicator
14	Tube Head angle indicator

Grid Alignment Procedure

Setup

1. Insert the DRX-1 System Detector into the grid frame by placing the grid holder on a flat surface, with the bottom of the detector into the bottom tray of the grid holder, and snapping the detector in place at the top.
2. Position the grid frame on top of the mattress, behind the patient anatomy.
3. Enter the **Grid Alignment** screen on the remote display by touching the Grid Alignment button .
4. Confirm the target Source to Grid Distance (SGD), such as 102, 112, or 127 cm (40, 44, or 50 in.).
5. For optimum image processing results, choose the appropriate bed type from the **Bed Type** indicator, located at the bottom of the screen. Select either **ED** for a trauma gurney, or **ICU** if an intensive care unit bed is used.
6. Use the buttons on the back and front sides of the collimator handles to release the brakes and position the X-ray tube as you would for any exam. Use the tube angle and  detector angle indicators,  and the collimator light as guides for positioning.

NOTE: The grid alignment system is most accurate when the grid frame is positioned a minimum of 61 cm (24 in.) away from the cart and any other large metal objects, and at least 15.0 cm (6.0 in.) away from any edge of the mattress.

Procedure

NOTE: Carestream Health recommends that the grid holder always be used on top of a mattress that has a minimum thickness of three inches.

**CAUTION:**

Interference from nearby metal objects can affect the accuracy of the grid alignment system. It is always the user's responsibility to ensure proper alignment before taking an X-ray.

1. Use the buttons on the back side of the collimator handles to release the brakes for the boom, column, and turntable. There are three positioning indicators that will help align the X-ray to the grid frame at the target Source to Grid Distance (SGD).

- Up/Down
- Left/Right
- In/Out

All indicators are relative to you as you are facing the collimator and grasping the handles in front of you.

2. Move the tube head position as required to center each of the three indicators in the target squares. The arrows on each indicator will light up to provide guidance to help you move the tube so that the white bar stays in the center of each box. The boxes turn green when good alignment is achieved.
3. Point the collimator at the patient anatomy using the light, and collimate the beam down as you normally would for any exam.

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United States

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