

MBD-2 (IM-278/U) Personal Dosimeter



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FCC Compliance Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Modifications: Any modifications made to this device that are not approved by Mirion Technologies Oy may void the authority granted to the user by the FCC to operate this equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

Precautions concerning the use of 3V Lithium Batteries

- Do not attempt to recharge or reenergize batteries.
- Exhausted batteries immediately shall be removed as soon as practical to prevent damage from leaking batteries
 - o If batteries have leaked (dry or wet white residue), use personnel protective equipment such as hand and eye protection to remove and clean.
- Do not dispose of batteries in fire.
- Do not dismantle batteries.

1. Preparation for Storage or Shipment

The following procedure is to be used if your MBD-2 must be stored or shipped for any reason. First, remove the main battery (Section 3.2.1.1). Pack the complete MBD-2 along with the proper maintenance documentation and turn it in to your Property Book Officer (PBO) for shipment. PBO confirms the MBD-2 is packed properly.

1.1 Preparation for Long Term Storage

In hot, humid climates, the MBD-2 should be carefully cleaned with a small amount of isopropyl alcohol on a clean cloth to remove any skin oils that could support fungal growth. Wipe down all visible surfaces.

2. Introduction

The MBD-2 Personal Dosimeter is a device which incorporates the benefits of passive radiation detection with active, self-reading and recording functionality. The MBD-2 has no pushbuttons, switches, speaker, or LED and requires no user intervention for operation. The MBD-2 is pre-configured for rapid issue from storage. The battery powered device includes on-board digital processing to provide a self-reading, accurate and reliable dose measurement on an integrated, non-reflective LCD display. Battery power level is reported on the display using an interactive icon found in commercial electronics. Radiation measurement data is recorded in device memory every 12 hours.

The MBD-2 provides radiation dose information to the wearer in the field. The MBD-2 displays the total deep absorbed dose $D(10)$ (sum of deep gamma and deep neutron) and is displayed in measurement units of cGy and Gy.

The MBD-2 uses Direct Ion Storage (DIS), Pin Diode and MOSFET detector technology passive detectors. The passive DIS radiation detectors are continuously responsive to radiation, with or without the field-replaceable main battery. The internal electronics provide self-reading measurement display, digital memory, data logging, on-board diagnostic testing during startup and NFC (Near Field Communication) read-only wireless communication. All data resides in non-volatile memory for dose-of-record processing so there is no any danger of losing stored data or configuration settings on main battery failure. The diagnostics measure and display battery conditions and fault conditions of the device.

The MBD-2 is a sealed device for durability and hardness. There are no serviceable internal parts. Maintenance parts are accessible and replaceable.

3. Description

3.1 Physical Description

The MBD-2 personal dosimeter system is designed to be worn on the wrist with a 15- inch hook and loop wrist strap. The MBD-2 can also be worn on the trunk of body (clipped to lanyard, pocket, etc.). In this use case, the proper MBD-2 orientation is the display facing away from the body.

The MBD-2 features a non-backlit LCD display, wireless (NFC read-only) communication, adjustable wristband, and replaceable batteries.

The main battery compartment is accessible through a removable, self-securing battery cover located on the back of the device. A sealed compartment below the main battery contains additional batteries used to provide power to the DIS detectors and real-time clock (RTC). The main battery compartment incorporates an O-ring seal to secure the battery from the external environment.



Figure 1: MBD-2 Personal Dosimeter System



- | | |
|-------------------------------|-------------------------------|
| 1. LCD Display | 3. C-Ring (2) for Wrist strap |
| 2. Screen Protector and Label | 4. Battery Compartment Cover |

Figure 2: MBD-2 Physical Features

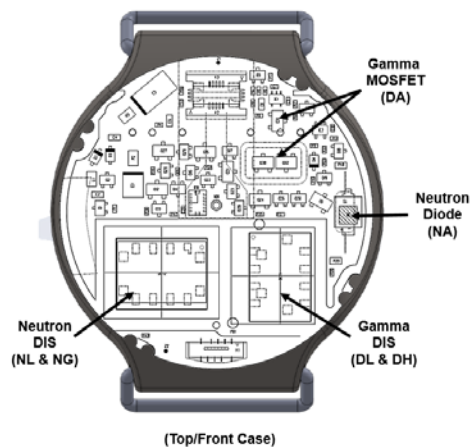


Figure 3: MBD-2 Board with Detector Placement (relative to case)

The MBD-2 includes six separate detector elements:

- Three (3) elements for gamma measurements,
- Three (3) elements for neutron measurements.

Each detector element is listed below in **Table 1, MBD-2 Detector and Range Table**. Displayed results including gamma (DA) or neutron (NA) accident detector elements are provided in centigray (cGy) measurement units.

Table 1: MBD-2 Detector and Range Table

Detector Type		Detector Code	Range
Deep - Gamma	DIS Low Range	DL	0.001 cGy – 60 cGy
	DIS High Range	DH	0.1 cGy – 600 cGy
	Tactical MOSFET	DA	1 cGy – 2500 cGy
Deep - Neutron	$\gamma + n$ DIS	NL	0.001 cGy – 60 cGy
	γ DIS	NG	0.001 cGy – 60 cGy
	Calculational Neutron Dose	NG/NL	0.01 cGy – 14 cGy Cf-252 Moderated 0.01 cGy – 36 cGy Cf-252 Unmoderated
	Tactical Pin Diode	NA	0.001 – 1250 cGy

4. Operation

4.1 Principle of Operation

When the main battery is installed, the MBD-2 will power on, activate the LCD display, initialize and perform diagnostics and operate according to its configuration. See **Section 4.4.2**.

During operation, the MBD-2 continuously displays total absorbed dose (as measured), battery status and periodic self-diagnostic checks. In the event of a device malfunction, an error message will be displayed on the LCD as shown in **Section 4.4.4, Common Display Messages**.

The MBD-2 will alert the wearer to the status of battery life by display battery icon and message, as shown in **Section 4.3.1.3, Battery Display Indication**.

When the main battery is depleted or removed, the MBD-2 detector elements continue to respond to a radiation field. The detector elements remain active as they are powered by two internal batteries. When restoring the main battery power, the MBD-2 will display the dose measurement(s) including any exposure received during the time it was without main battery power, however, the internal history will not account for the date and time of the measurements while the main battery power was off.

4.2 Installing the Wrist Strap

The Wrist Strap is a simple, durable accessory for affixing the MBD-2 to a wrist. The Wrist Strap uses hook and loop material with a C-shaped ring to facilitate easy donning and securing to an outer garment sleeve.

- a. Inspect the Wrist Strap seams for visibly loose stitching and frayed edges. Set aside any Wrist Strap that appears worn.



Figure 4: MBD-2 Wrist Strap

- b. Install the Wrist Strap by feeding the coarse “Hook” end through the bottom (6 o’clock position) C-ring.
- c. Loop the Wrist Strap through C Rings in the orientation as shown below – smooth side facing away from the back case as shown in **Figure 5: Wrist Strap Orientation and Assembly**.



Figure 5: Wrist Strap Orientation and Assembly

- d. Feed the Wrist Strap through its own ring to form a loop as shown below.
- e. Pull the strap all the way through until it stops at the black metal loop. Feed the course hook end back though the metal loop as shown below in **Figure 6, Preparing the Wrist Strap**.



Figure 6: Preparing the Wrist Strap

- f. Insert hand through the loop, pull the strap around itself and securely fasten as shown below in **Figure 7, Donning the MBD-2 and Securing the Wrist Strap**

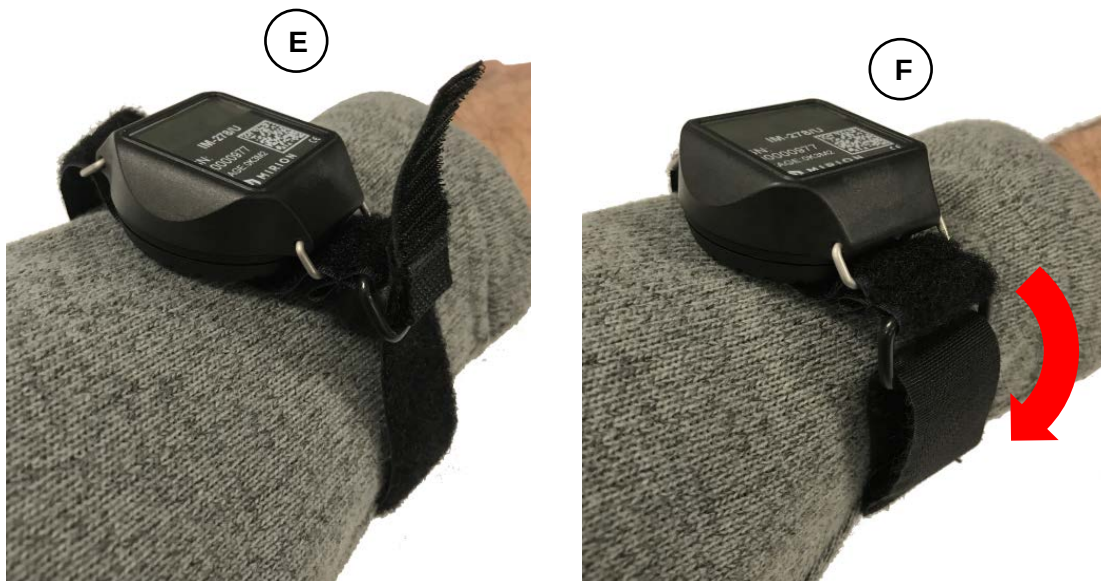


Figure 7: Donning the MBD-2 and Securing the Wrist Strap

4.3 Batteries

4.3.1 Removal/Replacement of the Main Battery

4.3.1.1 Main Battery Replacement

- a. Prior to replacing the battery, remove the wristband from at least one C-Ring so that the battery cover is accessible.

NOTE: Battery change should not take place under direct rain-like conditions as water inside the battery compartment may cause premature battery discharge.

- b. Turn the battery cover counter-clockwise to remove.



Figure 8: MBD-2 Battery Cover Removed

- c. Verify the presence of the O-Ring. Inspect for integrity. See **Section 6, Maintenance**, for additional O-Ring information.



Figure 9: O-Ring Location

- d. Remove the main battery
- e. Dispose the used battery in accordance with site requirements.

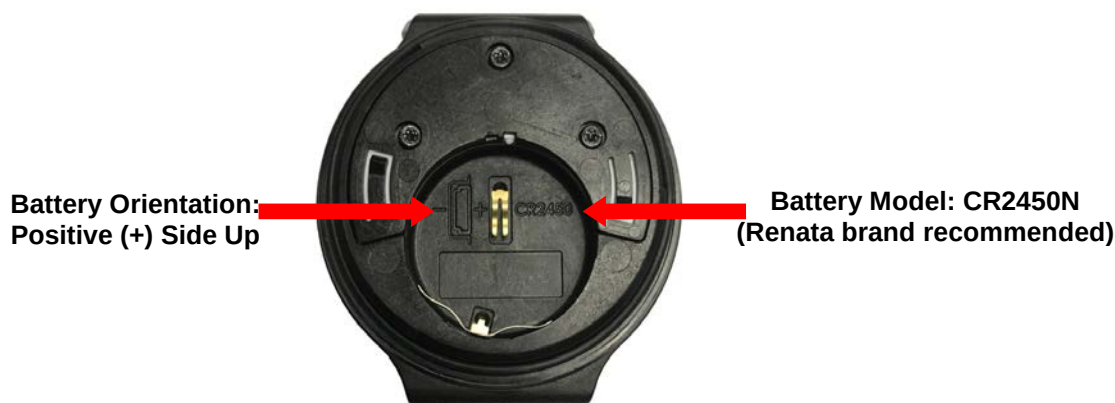


Figure 10: MBD-2 Battery Compartment and Markings

- f. The battery compartment features imprints of battery orientation and model number.
- g. Insert a new battery (Model CR2450, Renata brand preferred) into the compartment, positive (+) side facing up, as shown below in **Figure 11, MBD-2 Correctly Installed Battery Position**.



Figure 11: MBD-2 Correctly Installed Battery Position

- h. Confirm the presence of the O-ring prior to installing the battery cover. Ensure the O-Ring is not twisted, warped or worn and that it lays flush on the surface flange. Refer to **Section 6.1, O-Ring** for guidance.
- i. Install the battery cover by turning clockwise.

The MBD-2 case and battery cover are designed with thread stops, as shown below in **Figure 12, MBD-2 and Main Battery Cover Thread Stop**, to prevent wear and stripping of the threads and also ensure a secure fit.

When installed and turned clockwise, the battery cover will stop in place when the thread-stop is engaged.



Figure 12: MBD-2 and Main Battery Cover Thread Stops

4.3.1.2 **Battery Display Indications:**

The MBD-2 reports Main Battery power status with a standard battery icon:

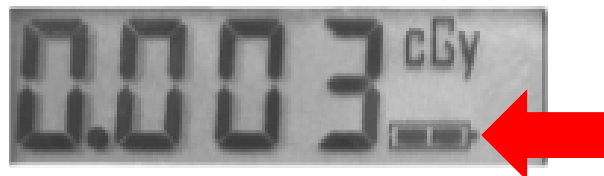


Figure 13: Battery Power Icon

The icon segments, as shown below in **Table 2, MBD-2 Battery Icon Segments**, represent the following power status:

Table 2: MBD-2 Battery Icon Segments

Segments	Status	Voltage
	100% to 51% range	Max to 2601 mV
	51% to 26% range	2600 to 2401 mV
	25% to 1% range	2400 to 2201 mV

When the battery voltage is below 25% (approximately ≤ 2400 mV), the MBD-2 will report battery low power status on the display in the following conventions as shown below in **Table 3: MBD-2 Battery Display Messages**:

Table 3: MBD-2 Battery Display Messages

Battery	Display Message	Condition
Main	PbAt permanent on display	Main Battery exhausted, replace
Detector	dbAt cycles display screen dbAt permanent on display	Detector Batteries are critically low (<25%) Detector Batteries are exhausted, replace
Real-Time Clock	No message	Change with Detector Batteries

Note: there is no Low Battery message for the Main Battery. The battery icon provides visual status.

4.4 Start-up and Diagnostics

4.4.1 Start-up

When the battery is installed, the MBD-2 powers on. There are no switches to power on or off the MBD-2.

4.4.2 Diagnostics

During start-up, the MBD-2 performs diagnostics and then becomes active with a live display.

Table 4 below describes the visual start-up operation:

Table 4: MBD-2 Start-up & Diagnostics

Start-up Operation and Effect	LCD Display Indication
All LCD Segments illuminate for 3 seconds	
Installed Firmware version (example)	
Diagnostics Check OPEr (Operating Mode)	
no.Er message indicates no errors have been identified.	
If the MBD-2 becomes operational following an Error during start-up, the PA.Er message will appear on the Display, indicating an Error was recorded.	
Initialization init	
Measurement display: Dose Value (measurement value). The Deep Total value displayed is a sum of the Gamma and Neutron dose measurements.	

NOTE: The MBD-2 may be stored with or without a main battery. When storing with a battery, background radiation will accumulate dose to the detectors and record data to memory.

4.4.3 Operation

The default LCD configuration displays Total Deep Dose (sum of Gamma and Neutron) and cGy measurement units.



Figure 14: MBD-2 with Active Display

4.4.4 Display Messages

The MBD-2 may display messages or characters on the LCD under certain conditions of operation:

Table 5: MBD-2 Display Messages

Message	Condition
Lo.t	Operating temperature is below the lower temperature threshold (-10°C)
Hi.t	Operating temperature is above the upper temperature threshold (+50°C)
PbAt	The Main Battery voltage is exhausted
dbAt	The Detector Batteries voltage is low or exhausted
PA.Er	A parameter error has been detected.
OF:t OF:G OF:n	One or more detectors is over-range or has been saturated

See **Section 7, Troubleshooting** for Display Message information.

5. Reading Data from the MBD-2

The MBD-2 is a read-only device. Measurement data that is recorded and stored in the MBD-2 memory can be transferred using a “smart” reader device (i.e.; smartphone with software application [“App”]).

Measurement data is saved in MBD-2 resident memory and the newest values over period of 15 days is maintained in the NFC chip memory. The MBD-2 is configured to perform two daily “reads”, where a dose or measurement record is saved to memory including a date and time stamp. These records are maintained on the MBD memory and the NFC memory chip until the space allotment is filled. Once the data is transferred, new data records are recorded into the available space (i.e.; cyclic memory).

“Instant” data can be transferred from the MBD-2. When a reader device communicates with the MBD-2 NFC chip, an instant read is initiated and the most current log data recorded will be transferred with current total dose measurement. This can take place only when there is dose value given on the display. So during ‘init’ phase or if the main battery is removed / exhausted, no current dose value is available.

When an external NFC reader device is used, the data is transferred from the dosimeter over the air in binary format. Using Mirion standard reader application, the results can be sent as text files and transferred from the Smartphone to a computer for further action.

Data formats and NFC protocol information is available in external documentation.

6. Maintenance

6.1 O-Ring

The O-Ring provides the battery compartment a barrier and protection from moisture and dust intrusion. The O-Ring should be:

- a. Confirmed to be in place whenever the main battery cover is opened
- b. Inspected for condition when replacing the main battery.

6.1.1. Inspection and Replacement

- a. Remove and inspect the O-Ring for indications of wear and degradation, to include, cuts, shedding, twisting, or uneven placement.



Figure 15: MBD-2 with O-Ring Removed

- b. Ensure surface area for the O-Ring is clean.



Figure 16: MBD-2 without O-Ring and Inspection

- c. Install the O-Ring on the flange. Run a fingertip around the top of the O-Ring to ensure it is seated properly as shown in **Figure 17, MBD-2 with Installed O-Ring** below.



Figure 17: MBD-2 with Installed O-Ring

6.2 Internal Battery (Detector & RTC) Replacement

The internal battery cover should be opened only under a controlled environment. Careful maintenance shall be ensured to prevent:

- misplacement of parts (screws securing the internal battery cover)
- contamination of the battery contact springs, which have direct access to the internal electronics.

- a. Remove the main battery cover and main battery in accordance with Step 3.2.1.1.
- b. The Internal battery cover has three “Torx” pattern, size T6 screws.

- c. Remove the screws and set the cover aside on a clean surface.

NOTE: the screws can be withdrawn without removal where the elastomer gasket material on the battery cover will hold the screw in place permitting removal, thus minimizing the risk of screw misplacement.

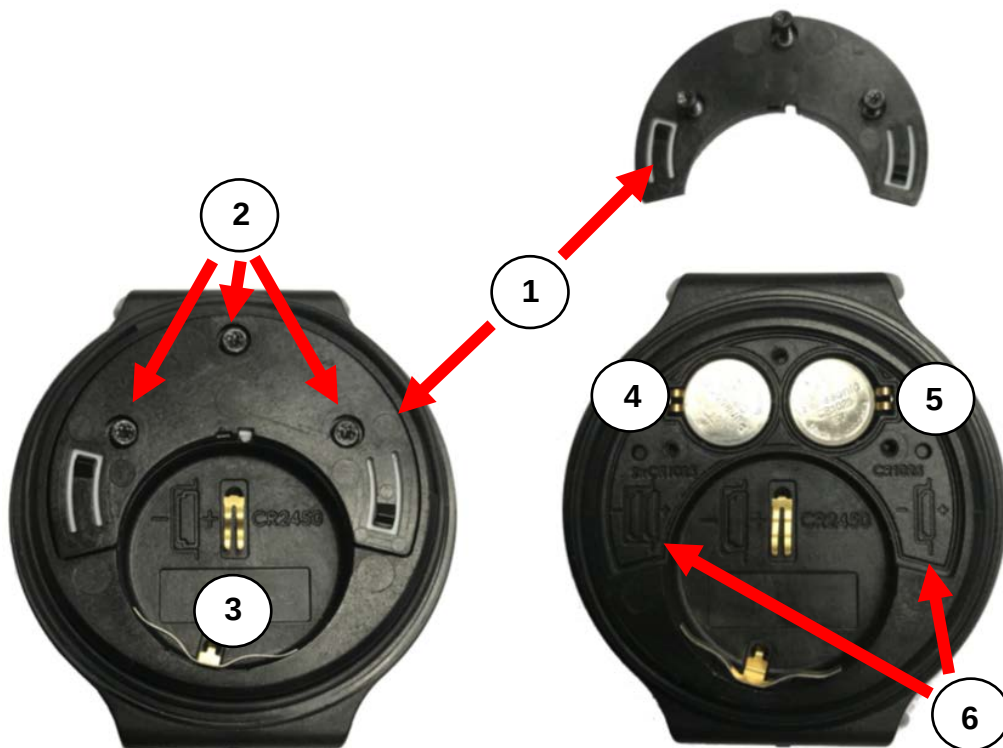


Figure 18: Internal Battery Cover and Compartment

- | | | | |
|---|--------------------------|---|---------------------------------------|
| 1 | Internal Battery Cover | 4 | Detector Battery CR1025, 2 each |
| 2 | Torx (T6) screw 3each | 5 | Real Time Clock (RTC) Battery, 1 each |
| 3 | Main Battery Compartment | 6 | Battery Orientation Markings |

- d. Replace two detector batteries and one RTC battery using Model CR1025, Renata preferred. Ensure battery orientation is Positive (+) side up. The internal battery case features imprints for battery orientation and model number.



WARNING

If the batteries appear to have leaked, i.e.; there is white residue on the battery and/or internal battery compartment surfaces; use personnel protective equipment (i.e.; gloves, safety glasses, etc.) as applicable.

- e. Dispose the used batteries in accordance with site requirements.

Note: the detector and real-time clock batteries shall be replaced together during scheduled maintenance.


WARNING

Both detector batteries must be replaced.

- f. Prior to installing the battery cover:
- Inspect the battery cover for cracks.
 - Inspect the gasket for wear or missing segments.


WARNING

The internal battery cover must be replaced if there is evidence of damage and/wear that would preclude protection of the internal batteries.

- g. Install the internal battery cover by positioning over the compartment and installing the three Torx head screws. The screws are secure when the battery cover is seated and flush with the case surface as shown below in Figure 19, Installing the Internal Battery Cover



Figure 19: Installing the Internal Battery Cover


WARNING

- Do not overtighten the screws as damage can occur to the battery cover and case threads.
- Use only the prescribed Torx T6 screw, use of screw types will damage the threads.
- Never use power tools to install the screws.

- h. Install the main battery in accordance with 3.2.1.1, steps f-h.

6.3 C-Rings

The C-Ring is 1.9mm thick stainless steel 'C' shaped loop which is affixed to the MBD-2 by two insertion holes on opposite ends of the device case. The C-Rings are used for attaching a wrist strap or other accessory. To remove and/or replace the C-Ring:

- a. Obtain a Snap-Ring plier or similar tool that will facilitate easy removal of the C-Ring. The adjustable tines on the Snap-Ring plier tool should be extended to allow expansion, when squeezed, so that it will be slightly wider than the width of the C-Ring.
- b. Lift one end of the ring from the insertion hole and angle away to remove the C-Ring as shown in Figure 3-3: MBD C-Ring Removal.

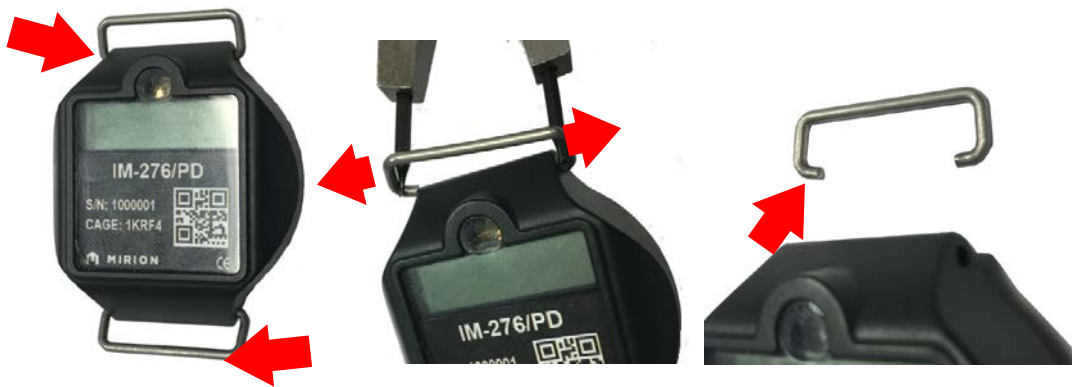


Figure 20: C-Ring Removal

- c. To replace the C-Ring, grip the loose C-Ring with the Snap-Ring plier tool. Ensure that when squeezing the Snap-Ring plier tool, the width of the C-Ring will be slightly wider than the case to facilitate easy replacement as shown in **Figure 21: C Ring Replacement**.
- d. Position one side of the C-Ring into the insertion hole, then the other side.
- e. Release the Plier tool so that the C-Ring is now secure.
- f. Swivel the C-Ring to ensure fit.



Figure 21: C-Ring Replacement

7 Troubleshooting

7.1 Display Messages

The MBD-2 will display messages or characters on the LCD display during certain conditions. This section describes the displayed messages, their meaning and how to correct:

7.1.1 Display Messages: Problems and Resolutions

Table 6: Display Message Table

Display Message	Problem / Resolution
Lo.t	Problem: Operating temperature is below the lower temperature threshold of -10°C. During this condition, the read-out process is not performed.
	Resolution: Move device to a warmer environment. This can be within a pocket, inside layers of a garment. Once the temperature is stabilized, the Lo.t message is removed.
Hi.t	Problem: Operating temperature is above the upper temperature threshold of +50°C. During this condition, the read-out process is not performed.
	Resolution: Move the device to a cooler environment
PbAt	Problem: If PbAt permanent on display, battery exhausted
	Resolution: Replace with a new CR2450 battery, Section 3.2 Batteries
dbAt	Problem: - If dbAt cycling on the display, less 25% life remains - If dbAt permanent on display, battery exhausted
	Resolution: Replace with 3 new CR1025 battery, Section 3.2 Batteries
PA.Er	Problem: A Parameter Error has been detected, Section 6.1.2 Error Code Table
	Resolution: Remove device from service. Return for Warranty Repair
OF:t OF:g OF:n	Problem: One or more detectors has reached saturation
	Resolution: - OF:t Overflow Total Dose: the total dose has reached/exceeded 3,750 cGy - OF:g Overflow Gamma: the gamma dose has reached/exceeded 2,500 cGy - OF:n Overflow Neutron: the neutron dose has reached/exceeded 1,250 cGy
---- (four dashes)	Problem: One or more detectors cannot report a measurement value(s)
	Resolution: Remove device from service. Remove and replace battery and observe display. If the problem persists, return device for Warranty Repair

7.1.2 Parameter Error Codes: Problem and Resolution

Table 7: Parameter Error Code Table

Parameter Error Code		Problem / Resolution
1	Result memory access failed	Problem: After a system reset, result memory is found to be inaccessible and the device resets itself. If no element measurement has been successful before three self-resets (see exception 7), the reset operation is disabled and the message 'Err' is displayed continuously.
		Resolution: Remove device from service.
2	Battery is Exhausted	Problem: The Main Battery voltage is too low (<2200 mV volts). No segment battery icon and PbAt display message permanently displayed.
		Resolution: Replace the Main Battery with model CR2450
3	REG UP Timeout	Problem: The time allowed for the read-out voltage to reach the target value has expired. The condition can be caused by a combination of sub-freezing temperature, low battery capacity and high internal resistance.
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.
4	AD Converter timeout has occurred	Problem: The device has reported an error due to the AD converter not completing internal readout conversion
		Resolution: Remove device from service for analysis. If error occurs only in cold environments, the condition should be reported so that device configuration can be modified to the environment and prevent recurrence.
5	ADC Failure has occurred	Problem: The device has reported an error when the AD converter has detected maximum voltage in the input line.
		Resolution: Remove device from service.
6	Device is starting after reset	Problem: When the battery is replaced, the device has performed an intentional hard reset from either: Watchdog Circuit has reset the micro controller, or; external flash gamma pulse has reset the device.
		Resolution: Information message, error message disappears after reset. If error message repeats, remove device from service
7	Device is resetting itself	Message: If following Error #6, indication of an intentional hard reset due to corruption of: parameter, data structure, calibration, DAC, element, BLE reset, watchdog, RTC, NFC and others,
		Resolution: Informational message, no action.

8	Detector Element has Overflown	Problem: The device has reported that one of more detector elements has exceeded maximum dose.
		Resolution: Requires a reset of the device. Remove device from service.
9	Recombination has Occurred	Problem: Recombination has occurred in an ionization chamber element a gamma flash or neutron burst event.,
		Resolution: Requires a reset of the device. Remove device from service.
A	DA Element has been Disabled	Problem: Device restarts from reset after a battery change.
		Resolution: If internal data memory is found to be corrupt, device will perform a self-hard reset to clean memory with clean data from flash memory. If error message occurs under normal use (no high dose or neutron exposure), remove device from service.
B	Display access failed	Problem: A The device has reported an error when attempting a display update
		Resolution: If display indicates corrupt or erratic segments, physical damage has occurred to the LCD. If there is no visual damage to the LCD, a possible corruption to the histogram data exists. If the problem is repeated without visual LCD damage, remove from service.
C	DAC value is out of bounds	Problem: the RAM memory has been corrupted
		Resolution:
D	Device temperature is too low	Problem: The device temperature is below the factory-set low limit of -10C. The read-out process is halted until the temperature increases
		Resolution: Move the device to a warmer environment and stabilize. The Lo-T message disappears.
E	Device temperature is too high	Problem: The device temperature is above the factory-set high limit of C. The read-out process is halted until the temperature decreases.
		Resolution: Move the device to a cooler environment and stabilize. The Hi-T message disappears.
F	NFC chip is not responding	Problem: The NFC chip is not responding due to an electronics failure.
		Resolution: Read-out is not possible. Remove device from service.

10	Shift register data transfer has failed	Problem: There is a failure in electronics or processor SPI peripheral and reporting an error.
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.
11	Dose battery is exhausted	Problem: The Dose battery (Internal Detector Batteries) voltage has decreased below the low limit. The default limit is 5500 mV. dbAt display message permanently displayed.
		Resolution: Replace internal dose batteries (3) with model CR1025.
12	Dose battery is too low	Problem: The Dose battery (Internal Detector Batteries) is reporting <25% above the voltage low limit (5500). dbAt display message alternates with dose value.
		Resolution: No action required until 11 above message, or, replace internal dose batteries (3) with model CR1025.
13	Incorrect result record type	Problem: An invalid type has been identified during a memory scan, indicating a failure or corruption in flash memory.
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.
14	Incorrect result reading position	Problem: The device could not determine the reading result position in the flash memory, due to a failure in flash memory access or corruption of memory contents
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.
15	Result record reading failed	Problem: The measurement result reading failed due to corruption of the result memory.
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.
16	(RESERVED)	
17	NFC device address has been invalid	Problem: The I2C address of the NFC chip has been invalid at device start-up. The chip has not been properly initialized by the manufacturer.
		Resolution: The problem is resolved by the NFC device firmware.
18	(RESERVED)	

19	Too early REG_UP	Problem: The REG_UP I/O line signal was detected too early due to a failure in the voltage block regulator.
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.
1B	Factory parameters applied	Problem: The measurement result memory does not contain a valid measurement result record due to empty or corrupt flash memory
		Resolution: Restart device by removing and re-inserting battery. If error message repeats, remove device from service.

8. Technical Specifications

8.1 Radiological Characteristics

Detector	Type	Designation	Range
DIS Low Range	Deep Gamma	DL	0.001 cGy – 60 cGy
DIS High Range	Deep Gamma	DH	0.1 cGy – 600 cGy
Tactical MOSFET	Deep Gamma	DA	1cGy - 2500 cGy
DIS $\gamma + n$	Deep Neutron	NL	0.001 cGy – 60 cGy
DIS γ	Deep Neutron	NG	0.001 cGy – 60 cGy
	Calculational Neutron Dose	NG/NL	0.01 cGy – 14 cGy Cf-252 Moderated 0.01 cGy – 36 cGy Cf-252 Unmoderated
Pin Diode	Deep Neutron	NA	0.001 – 1250 cGy
Energy Range	Photon Effective		60 keV to 3 MeV ($\pm 20\%$) IAW NVLAP Cat IA, II B, C
	Neutron Effective:		550V to 2.13 MeV ($\pm 20\%$)

8.2 Physical Characteristics

Dimensions:	2.08" x 2.2" x .91" (52.8 x 55.8 x 23.2 mm)
Weight:	2.0 oz. (57 gm) with batteries

8.3 Environmental Characteristics

Operating Temperature range:	-32°C to +52°C (dose accumulation)
Storage Temperature range:	-54°C to +71°C
Humidity:	Relative humidity of 95% at +60°C
Water Resistance:	IP-67
Drop Test:	1 m height on hard surface in case
RF-RI-EMI Emission:	RS101, RS103, RS105, RE102 compliant
Vibration/Sand/Dust, Salt Fog & Fungus:	Compliant IAW MIL-STD 810G

8.4 Electrical Characteristics

Main Battery (Field Replaceable):	(1) Renata CR2450, 3.6 volt, lithium coin cell
Autonomy:	800-1000 hours
Internal (Controlled replaceable):	(2) Renata CR1025 6 volt, lithium coin cell
Autonomy:	> 6years

9. Parts

Replacement parts for the MBD-2 can be identified in **Figure 22, MBD-2 Replacement Parts** below

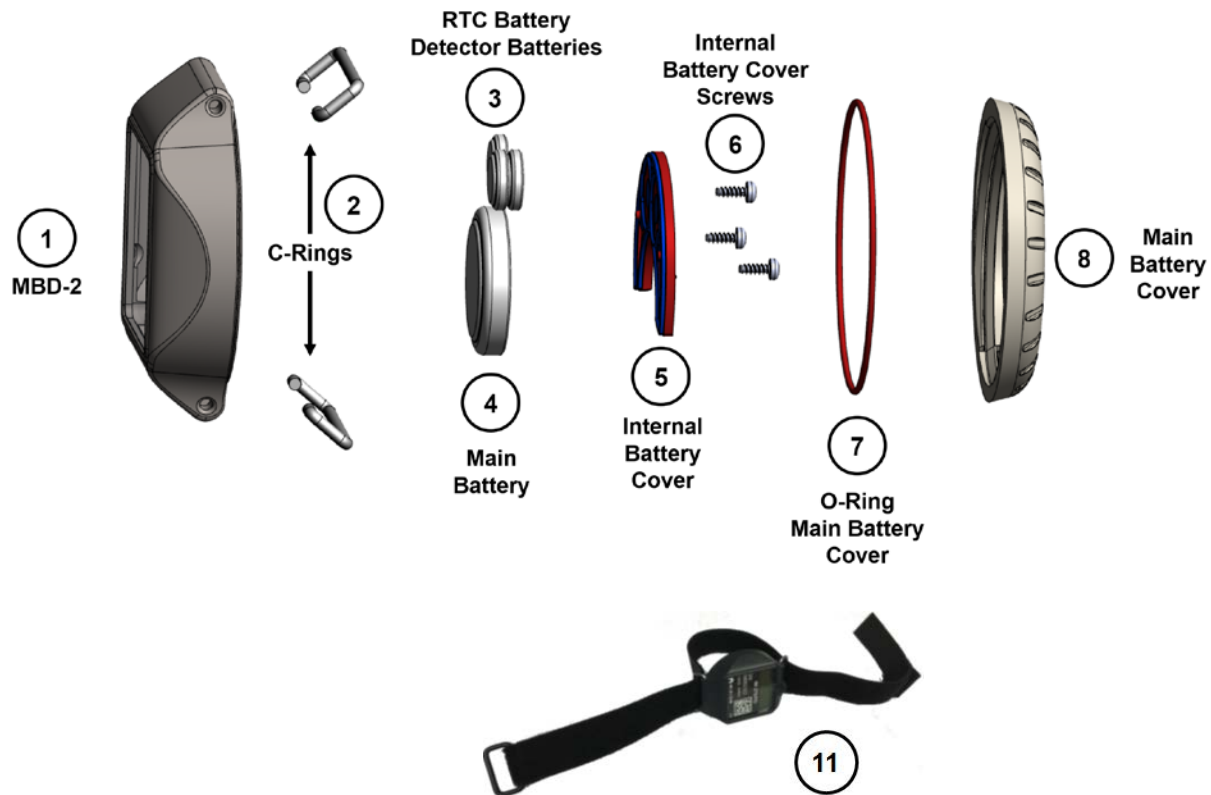


Figure 22: MBD-2 Replacement Parts

Item	Description	Part Number
1 MBD-2 Personal Dosimeter	MBD-2, complete unit only	RAF 1237 058
2 C-Ring (2)	C-Ring retainer for wrist band (each)	MBD-1003
3 Internal Batteries: Real-Time-Clock (1), Detector (2)	Renata CR1025N Lithium Coin Cell	MBD-2000
4 Main Battery	Renata CR2450N Lithium Coin Cell	D20-2000
5 Internal Battery Cover	Internal Battery cover with integrated gasket	2036 6808
6 Screws (3)	Screws, Torx, T6, Countersink head	2127 6039
7 O-Ring	O-ring for the Main Battery Compartment	2139 0079
8 Main Battery Cover	Battery Cover	2036 6807
9 Wrist Strap	Wrist Strap, hook & loop material	MBD-1004

10. Dimensional Drawing

[illegible]