Portable X-ray System for Small Area Radiographic Imaging

USER MANUAL
Disclaimer: NOMAD eXaminer is sold with the understanding that the user assumes sole responsibility for radiation safety (as well as any state, provincial, or local regulatory compliance) and that Aribex, Inc., its agents or representatives, do not accept responsibility for:

a) injury or danger to personnel from x-ray exposure,
b) image overexposure due to poor operating techniques or procedures,
c) equipment not properly serviced or maintained in accordance with instructions contained in this publication, and
d) equipment which has been modified or tampered with in any way.

DO NOT OPERATE THIS DEVICE UNTIL YOU HAVE READ THIS MANUAL and reviewed the accompanying materials.

See the Certificate of Conformance accompanying your device. A Radiation Safety Abbreviated Report is submitted and on file in order to register NOMAD eXaminer in accordance with DHHS Manufacturer Reporting Requirements, 21 CFR 1002.12.

Aribex and NOMAD are registered trademarks within the United States and other countries. NOMAD eXaminer, NOMAD Dental, and the ARIBEX and NOMAD logos are trademarks of Aribex, Inc. worldwide. U.S. patents issued: 7,224,769 and 7,496,178. United States and international patents pending. All other brand and product names are trademarks or registered trademarks of their respective companies.

The symbols used in this publication and used to mark the equipment have the following meanings:

- **Caution or Attention, review documentation**
- **Ionizing Radiation**
- **Electrical Shock Hazard**
- **Instructions for handling product at end of life**
- **Type BF Equipment (providing a degree of protection against electric shock, pertaining particularly to allowable leakage currents)**
# NOMAD® eXaminer

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Thank you for choosing the Aribex NOMAD® as your x-ray solution!

At Aribex we value your business and we would like to hear from you, because your feedback or suggestions are important to us. If you have comments, please email us: NOMAD@aribex.com

NOMAD eXaminer Features

- **Performance** – battery power source delivers dependable high voltage (60kV, true DC) and direct current (2.3mA).
- **Consistent Emission Radiation** – high-frequency, constant-potential x-ray generator provides high quality images, with a lower radiation dosage than many standard AC x-ray systems.
- **Radiation Protection** – operator shielded from source and backscatter radiation.
- **Simple Operation** – exposure time is the only setting requiring operator input, digitally displayed on the user-friendly control panel along with indicators for machine and battery status.
- **Lightweight and Ergonomic** – design provides complete flexibility and convenience.
- **Exposure Safety Feature** – cannot emit x-rays with insufficient voltage (low battery).
- **Engineered for Compatibility** – works with both film and digital imaging systems.
- **Authorized Service** – complete support and maintenance from Aribex and our authorized distributors.
1.0 Getting Started

1.1 Intended Use

The NOMAD eXaminer X-ray System is intended for general, non-medical use – materials imaging, industrial inspection, pathology/forensics, and veterinary care that requires small-area radiographic imaging. The use of NOMAD eXaminer on live humans is expressly prohibited by regulation.

1.2 Unpack, Check, and Register NOMAD

1. Unwrap individual components from the protective plastic and check for any noticeable signs of damage. The standard package system includes the following items:
   - NOMAD Device with a Backscatter Shield attached
   - 2 Charged Batteries
   - Battery Charger (the charger should be appropriate for local AC line voltage, actual color/style/model may differ)
   - Certificate of Conformance, Getting Started guide and Battery Charger manual, Warranty Card, and NOMAD Operator Training CD

2. Preliminary Checks:

<table>
<thead>
<tr>
<th>Item</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Labels</td>
<td>Verify that the device labels (Serial Number Label on lower side of unit in front of the handle and Warning Label on the lower side behind the handle) are legible and in place.</td>
</tr>
<tr>
<td>Other Labels</td>
<td>Verify that the serial number on the Warranty/Registration card matches the device serial number and the device carrying case serial number.</td>
</tr>
<tr>
<td>Collimator Cone</td>
<td>Inspect for damage. The lead lining must cover the entire interior surface.</td>
</tr>
<tr>
<td>Control Panel</td>
<td>Should be smooth and free of nicks, scratches, or damage.</td>
</tr>
<tr>
<td>Trigger Switch</td>
<td>Should move freely in when depressed and out when released.</td>
</tr>
<tr>
<td>Device Housing</td>
<td>Should be free of cracks or fractures.</td>
</tr>
</tbody>
</table>
Complete the product Warranty/Registration card and mail it with proper postage to Aribex today. Completing the card fulfills a condition of warranty coverage (see the inside back cover of this manual) and enables you to receive valuable product news and updates.

### 1.3 Charging the Battery

**NOTE:** Batteries are charged at the factory, and should be fully recharged before the initial use of the NOMAD. If the system has been in long-term storage prior to initial use, batteries will definitely require a proper charge first. In fact, it is recommended to fully recharge batteries every 3 months for long-term storage to avoid damage to any low battery. Actual color/style/model may differ.

1. Unwrap the power cord of the battery charger and connect it to an AC electrical outlet (110/120V or 220/240V, dictated by the country/region).

   Position the battery charger out of the way, but in a convenient place. A plug adapter may be used as needed; use only the supplied battery charger (for manufacturer and model info, see section 6.3, *Repair and Maintenance*).

2. Invert one of the batteries and carefully plug it into the charger (do not force the battery into the charger or damage to the battery may result). The red indicator light `галка` on the top of the charger will flash at a steady rate while the battery is charging.

   The required charge time varies (normally between 30 to 45 minutes). Battery and charger may become warm to the touch while charging, which is a normal condition.

3. When the battery is fully charged and ready to use, the indicator light `галка` will stop flashing and remain on continuously. Remove the charged battery and charge the second battery for future use.

4. Optimal battery life and performance occurs when the NiCad battery is fully discharged prior to recharging. (For more information review the accompanying battery charger Instruction Manual, also see section 5.0, *Battery Replacement.*)
2.0 Safety Precautions

2.1 Radiation Safety

This x-ray unit may be dangerous to operator and bystander unless safe exposure factors and operating instructions are observed.

Operators must follow all guidelines dictated by applicable occupational safety regulations and in-house radiation protection program, especially in regard to operators who are pregnant or expect to become pregnant.

Operators must be fully acquainted with safety recommendations and established maximum permissible doses.

Optimal operator radiation backscatter protection exists when:
   a) the operator remains within the cone-shaped backscatter protection zone immediately behind the backscatter shield,
   b) the backscatter shield is positioned at the outer end of the collimator cone,
   c) the backscatter shield is close to a subject when it is immediately in front of the cone.

Do not enable NOMAD until subject is positioned and operator is ready for the exposure, diminishing the likelihood of interruption and preventing inadvertent exposure of anyone to x-rays.

Do not attempt an exposure if anyone else is in the same room unless it is necessary that the subject be stabilized by another person. That person must then stay out of the direct beam and wear protective clothing.

Operation outside the protection zone (or with a diminished protective zone) requires proper precautions such as the use of lead aprons.
As shown in graphic representations, maximum protection (green area) from backscatter radiation (red area) exists when the NOMAD is positioned near the subject, is perpendicular to the operator, and the backscatter shield is fully extended toward the subject.

An exposure can be terminated for any reason by abruptly releasing the depressed trigger (see section 4.0, Operation).

Do not operate with the backscatter shield removed!

NOTE: In implementing a radiation protection program, please consult all applicable (state, provincial, and local) regulations governing radiation protection and the use of x-ray equipment, and ensure full compliance with any such regulations.

### Comparative Data for Whole Body Exposure (Annual)

<table>
<thead>
<tr>
<th>Exposure Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50mSv</td>
<td>Occupational Dose Limit</td>
</tr>
<tr>
<td>5mSv</td>
<td>Occupational Dose Limit Requiring Dosimetry</td>
</tr>
<tr>
<td>3.65mSv</td>
<td>Average Natural Background Radiation</td>
</tr>
<tr>
<td>2.19mSv</td>
<td>Average Occupational Radiation Exposure for Flight Crews</td>
</tr>
<tr>
<td>1.00mSv</td>
<td>General Public Dose Limit</td>
</tr>
<tr>
<td>0.20–0.70mSv</td>
<td>Range of Exposure for Radiation Workers Using Conventional X-rays</td>
</tr>
<tr>
<td>0.30mSv</td>
<td>Average Exposure Using NOMAD with F-Speed Film or Digital Sensor</td>
</tr>
<tr>
<td>0.12mSv</td>
<td>Average Exposure Using NOMAD with D-Speed Film</td>
</tr>
</tbody>
</table>

1) Standards for Protection Against Radiation, 10 CFR 20 (US Federal Standards), 1994 (see also NCRP Report No. 116)
2) NCRP Report No. 145 (National Council on Radiation Protection and Measurements), p7-9
4) Normalized average assumes 7,200 exposures per year, and the average length of exposure for D-speed = 0.50 seconds, F-speed = 0.25 seconds, digital sensor = 0.20 seconds
2.2 Usage

As a safety feature, NOMAD will not emit X-rays with insufficient battery voltage.

The NOMAD is also designed to avoid damage from overheating. The minimum duty cycle rating (the relationship between duration and frequency of exposures) is 1:60. Examples of optimal use:

<table>
<thead>
<tr>
<th>Duration</th>
<th>0.25s</th>
<th>0.46s</th>
<th>0.50s</th>
<th>0.99s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle</td>
<td>Every 15 sec</td>
<td>Every 28 sec</td>
<td>Every 30 sec</td>
<td>Every 60 sec</td>
</tr>
</tbody>
</table>

Do not operate NOMAD or the battery charger if either was immersed in liquid or subjected to an undue amount of moisture.

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1) Standards for Protection against Radiation, 10 CFR 20 (US Federal Standards), 1994 (see also NCRP Report No. 116)
2) “Radiation Exposure with the NOMAD Portable X-ray System”, Goren AD et al, Dentomaxillofacial Radiology, 37 (2008), p109-12; normalized average (includes leakage and backscatter radiation) assumes 7,200 exposures per year, and the average length of exposure for D-speed = 0.50 seconds, F-speed = 0.25 seconds, digital sensor = 0.20 seconds
2.3 Cleaning

1. Turn off the power and detach the battery before cleaning. Ensure the battery charger is unplugged before attempting to clean it.

2. Use a non-acetone based disinfectant wipe or a cloth to wipe the exterior surfaces of the NOMAD and charger.

**NOTE:** NOMAD and the accompanying battery charger are not designed to be subjected to any kind of sterilization procedure.

2.4 Security, Storage, and Transportation

- **NOMAD must be kept in a secure location**, such as a locked cabinet, when not in use to prevent unauthorized access.

- **The battery serves as the device security key.** When finished with NOMAD for the day, detach the battery and lock it in a separate location to prevent unauthorized use.

- Make sure NOMAD will not be knocked to the ground when not in use. Lay it on its side if necessary. Power will automatically shut off after a period of inactivity (approximately 2.5 minutes).

- Store or carry batteries so that metal objects cannot contact exposed battery terminals.

- Do not store the NOMAD, battery charger, or batteries in extreme conditions: below –20°C (–4°F) or above +40°C (+104°F), or above 95% relative humidity (non-condensing). This storage location should be cool, dry, and away from direct sunlight. For more info about storage and operational temperature limits, see section 7.1, *Basic Technical Specifications*.

- Some battery charge may be lost during extended inactivity (leading to fewer exposures between charging).
3.0 Setup and Check

3.1 The Backscatter Shield

In addition to the lead-lined cone, the backscatter shield provides additional protection to you, the operator, and features an adjustable position to permit exposures made at various angles.

1. Ideally, the shield should remain fully extended to the outer edge of the cone, especially if the subject to be imaged is immediately in front of the cone (see 2.1, Radiation Safety).

2. You may find that the backscatter shield needs to be adjusted to accommodate position indicating devices or angled exposures. If adjustments are needed, stand the NOMAD on-end on a stable surface and, while holding the backscatter shield perpendicular to the collimator cone (tube-shaped cone), gently glide the shield up or down along the cone using equal pressure to maintain a perpendicular alignment and avoid binding.

3. To keep the shield securely on the cone a retainer o-ring is permanently attached in the groove at the outer cone end. Do not attempt to remove this o-ring or to remove the backscatter shield, attempting to do so will result in damage to your device.

For long-term storage, it is recommended to fully recharge batteries every 3 months.
3.2 Attaching a Charged Battery

1. Properly orient and carefully insert the newly charged battery into the base of the NOMAD handle. A properly oriented battery should click into place without force (forcing the battery into position may damage the battery and/or the NOMAD). The clicking sound ensures the snaps on both sides of the handle bottom are fastened.

2. Make sure the battery is secure by giving it a tug. NOMAD can then be placed into service after checking for power (section 3.3).

3. Read the battery charger instruction manual for complete information on how to achieve the longest life and best performance from your batteries.

3.3 Checking for Power and Adequate Charge

1. After inserting a fully charged battery, press and release the POWER button. The numeric (LED) display should illuminate, accompanied by a single, long audible signal.

2. NOMAD checks for sufficient battery charge prior to a timed exposure, when ENABLE is pressed to ready the device.

3. If the battery is too low, the yellow LOW BATTERY indicator at the lower right of the control panel will flash (accompanied by an intermittent audible signal).

4. Once a battery is depleted, indicated by the LOW BATTERY alert, it must be recharged before use.
For continued use, insert the secondary, replacement battery (which should be charged in advance).

**NOTE:** See section 5.0, *Battery Replacement*, for more information.

### 3.4 Optional Checks

The NOMAD is factory calibrated and tested prior to release (see your *Certificate of Conformance*), so there are no adjustment options. However, the optional checks listed below may be performed by a qualified technician as desired.

*Test firing this x-ray unit may be dangerous to the testing technician or bystanders unless safe test exposure techniques are used such as the use a lead lined cap to cover the end of collimator or test firing in a protected area.*

**ON/OFF Switch:** Install fully charged battery to NOMAD device. Press the **POWER** button and verify the ON and OFF conditions.

**Increase/Decrease Switch (Up and Down Arrows):** With the device turned ON, press each of the Increase then Decrease buttons and verify that the exposure times as displayed on the LED display change appropriately.

**Enable Switch:** With the device turned ON and the LED display set at 50 (500ms), press the **ENABLE** button and verify functional conditions. Wait approximately 30 seconds, at which point the enabled condition should expire.

**Automatic Shut-Off:** Press the **POWER** button to turn the device ON and wait for it to automatically shut off after approximately 2.5 minutes of inactivity.

See section 6.1, *Alarms and Alerts*, for more information.
4.0 Operation

4.1 Powering Up

Press and release POWER button to turn NOMAD on (after approximately 2.5 half minutes of inactivity, NOMAD shuts off automatically).

When the power is turned on a single, long audible signal - and an illuminated numeric (LED) display indicate the unit has power.

4.2 Ensuring Battery Charge Is Adequate

If the LOW BATTERY indicator - flashes, accompanied by an intermittent audible signal -, see sections 3.3, Checking for Power and Adequate Charge and 5.0, Battery Replacement.

For other error conditions, please see sections 6.1, Alarms and Alerts or 6.2, Troubleshooting.

4.3 Ensuring the Right Exposure Time Is Set

When power is turned off, the most recent setting for exposure time is stored in memory and redisplays when power is turned back on. (However, if the battery is replaced, the display is reset to the 00 default value.)

To change exposure settings press the increase or decrease buttons (by tenths / hundredths of a second). A single, short audible signal - confirms input when a button is pressed/released. (For example, 08 LED setting = 0.08 seconds; 35 LED setting = 0.35 seconds.)
4.4 Positioning Subject and Enabling the Device

Properly position the subject and yourself before enabling NOMAD (to prevent accidental exposure).

Press and release **ENABLE** to ready the device; be sure to re-enable NOMAD if any subsequent changes are made to the time setting prior to exposure.

The flashing, green **ENABLED** indicator (intermittent, double beep) confirm that NOMAD is enabled. This continues for 30 seconds or until an exposure is initiated.

4.5 Initiating and Completing an X-ray Exposure

**NOTE:** An exposure can be prematurely terminated for any reason by abruptly releasing the depressed trigger.

To begin the exposure, squeeze the handle trigger (or press and hold **START**). The **ENABLED** indicator stops flashing, and the green **START** and yellow **X-RAYS ON** indicators illuminate.

To ensure complete exposure, keep the trigger or **START** button depressed until the audible, continuous-tone signal ends and both indicators are off.

4.6 Powering Down

Press and release **POWER** to turn NOMAD off. (NOMAD automatically shuts off after approximately 2.5 minutes of inactivity.)
5.0 Battery Replacement

A flashing, yellow LOW BATTERY indicator (control panel) and intermittent audible signal indicate the need for a freshly charged battery. NOMAD cannot emit X-rays with a low, depleted battery (insufficient voltage). Follow these steps to clear the LOW BATTERY alert.

1. Press and release POWER on the control panel to turn NOMAD off.

2. Grasp and depress the buttons on both sides of the battery to release it from the handle. You may have to put pressure at the very top of the buttons (nearest the handle). Then pull the battery away from the handle.

3. Carefully insert a newly charged battery into the base of the NOMAD handle. A properly oriented battery should click into place without force (forcing the battery into position may damage the battery and/or the NOMAD). A clicking sound ensures that the snaps on both sides of the handle bottom are engaged. Make sure the battery is secure by giving it a tug. When a battery is detached, any stored exposure time is erased from memory and must be reset when the unit is turned on again.

4. After the initial 1-hour recharge, the charger will switch to Tune-Up Mode, which continues 8 hours as cells in the battery are equalized. The battery is ready for use and can be removed at any time during this mode. Always unplug the charger from the power supply when it is not in service. For additional info, specifically about the charger, see the accompanying instruction manual for the battery charger.

5. Battery charge will diminish during extended inactivity – fully recharge batteries every 3 months during inactivity. Never place a low battery into long-term storage.

6. Each battery can go through the discharge/charge cycle approximately 200 times. When the battery charger senses a bad battery, it is spent and must be taken out of service. Do not attempt to charge damaged batteries. An authorized distributor, Aribex, and your local recycling center will accept spent or damaged batteries. Order new 14.4V batteries from Aribex or your authorized distributor. Do not use batteries from other sources, which invalidates the warranty.

Risk of Shock – There is high electrical current present at the battery charger terminals. Do not probe with fingers or conductive objects.
6.0 Keeping NOMAD Up and Running

6.1 Alarms and Alerts

The visual/audible alarm signals a programmed action designed to prevent harm to operator, bystanders, and/or NOMAD.

The visual/audible alerts confirm normal conditions or draw the operator’s attention to a required action.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Visual Indicator</th>
<th>Audible Signal</th>
<th>Function / Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overheating Alarm</strong></td>
<td>LED display begins flashing</td>
<td>Series of long beeps</td>
<td>Operation suspends if the device overheats; after cooling for approximately 5 minutes (or longer depending upon room temperature), power on (see Duty Cycle in section 2.2, Usage)</td>
</tr>
<tr>
<td><strong>Low Battery Alert</strong></td>
<td>Yellow LOW BATTERY indicator flashes</td>
<td>Slow series of short beeps</td>
<td>Replace the battery and reset exposure time (for information see section 5.0, Battery Replacement)</td>
</tr>
<tr>
<td><strong>X-ray Exposure Alert</strong></td>
<td>Green START and yellow X-RAYS ON indicators illuminate</td>
<td>Continuous tone (for the duration of the timed exposure)</td>
<td>At the end of the successful exposure, audible signal and indicators stop</td>
</tr>
<tr>
<td><strong>Incomplete Exposure Alert</strong></td>
<td>Green START and yellow X-RAYS ON indicators flash</td>
<td>Series of long beeps</td>
<td>Activates if trigger is released before the timed x-ray exposure finishes and ends automatically after 15 seconds or if power is manually turned off/on</td>
</tr>
<tr>
<td><strong>System Readiness Alert</strong></td>
<td>Green ENABLED indicator flashes</td>
<td>Slow series of short, double beeps</td>
<td>Activates when ENABLE is pressed/released; ends automatically after 30 seconds or when an exposure starts (trigger is depressed or START is pressed)</td>
</tr>
<tr>
<td>Condition</td>
<td>Visual Indicator</td>
<td>Audible Signal</td>
<td>Function / Resolution</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Invalid Input</strong></td>
<td>N/A</td>
<td>Two short beeps</td>
<td>Invalid input (for example, triggering prior to enabling) activates alert, which then ends automatically</td>
</tr>
<tr>
<td><strong>Error Alert</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Valid Input</strong></td>
<td>For numeric LED display, time setting increments or decrements</td>
<td>Single short beep</td>
<td>Valid when panel button is pressed/released</td>
</tr>
<tr>
<td><strong>Alert</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System</strong></td>
<td>LED display turns off</td>
<td>Two short beeps</td>
<td>X-ray emissions are not detected during timed exposure but the battery is OK</td>
</tr>
<tr>
<td><strong>Alert</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power OFF</strong></td>
<td>LED display turns off</td>
<td>Two short beeps</td>
<td>POWER button is pressed and released (while power is on)</td>
</tr>
<tr>
<td><strong>Alert</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power ON</strong></td>
<td>LED display lights up</td>
<td>Single long beep</td>
<td>POWER button is pressed and released (while power is off)</td>
</tr>
<tr>
<td><strong>Alert</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 6.2 Troubleshooting

If you encounter results and/or errors in the operation of NOMAD that are not explained in the previous sections, check the following table on user troubleshooting to determine the need for authorized service.

<table>
<thead>
<tr>
<th>Device Symptom</th>
<th>Potential Problem</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6.2.1 Image from x-ray exposure does not have sufficient contrast</strong></td>
<td>Underexposure (too light).</td>
<td>Increase the exposure time setting; or see Incomplete Exposure below.</td>
</tr>
<tr>
<td></td>
<td>Overexposure (too dark).</td>
<td>Decrease the exposure time setting, also check film expiration date (old film can produce dark grainy/foggy images).</td>
</tr>
<tr>
<td></td>
<td>Chemical developer (for film-based imaging).</td>
<td>Ensure chemical freshness and proper temperature.</td>
</tr>
<tr>
<td><strong>6.2.2 Image from x-ray exposure is blurred</strong></td>
<td>Combined movements of operator and subject during exposure produced too much distortion.</td>
<td>Check the exposure time setting and re-enable when operator and subject are again properly situated.</td>
</tr>
<tr>
<td><strong>6.2.3 Green ENABLED indicator stops flashing (and corresponding, short double beeps end) before an exposure is started</strong></td>
<td>NOMAD is no longer enabled. If an x-ray exposure is not initiated within 30 seconds of enabling, the System Ready condition will terminate.</td>
<td>Double-check the exposure time setting and re-enable when operator and subject are again properly situated.</td>
</tr>
<tr>
<td><strong>6.2.4 Green START and yellow X-RAYS ON indicators flash (with corresponding series of long beeps)</strong></td>
<td>Incomplete exposure – the depressed trigger was released before the timed exposure was able to complete.</td>
<td>This condition is cleared automatically within 15 seconds or by manually turning NOMAD off and back on. The exposure will likely need to be repeated.</td>
</tr>
<tr>
<td><strong>6.2.5 Yellow X-RAYS ON indicator does not illuminate</strong></td>
<td>No exposure – a subsequent Low Battery alert will signal whether a low battery is the source of the problem.</td>
<td>Follow proper procedures for replacing the battery; see section 5.0, Battery Replacement.</td>
</tr>
<tr>
<td></td>
<td>If within a few seconds, two short beeps are emitted and the system automatically shuts down, a different problem exists (see section 6.1, Alarms and Alerts).</td>
<td>NOMAD will require authorized service; see section 6.3, Repair and Maintenance.</td>
</tr>
<tr>
<td><strong>6.2.6 NOMAD automatically shuts down</strong></td>
<td>After about 2.5 minutes of inactivity, NOMAD emits two short beeps and shuts off automatically – the system has timed out.</td>
<td>Manually turn on NOMAD when you are ready to use the device.</td>
</tr>
<tr>
<td>Device Symptom</td>
<td>Potential Problem</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td>However, if while attempting an x-ray exposure two short beeps were emitted and shutdown occurred, a different problem exists (see section 6.1, <em>Alarms and Alerts</em>).</td>
<td>If this condition persists, NOMAD will require authorized service; see section 6.3, <em>Repair and Maintenance</em>.</td>
</tr>
<tr>
<td>6.2.7 There is no power to the NOMAD control panel</td>
<td>If pressing POWER several times does not cause the numeric (LED) display to illuminate, the attached battery is the likely problem.</td>
<td>Ensure battery is securely attached. Replace with a newly charged battery before continuing. Use the battery charger to determine if the first battery is spent and must be taken out of service, or if it can be recharged.</td>
</tr>
<tr>
<td></td>
<td>However, if while attempting an x-ray exposure two short beeps were emitted and shutdown occurred, a different problem exists (see section 6.1, <em>Alarms and Alerts</em>).</td>
<td>NOMAD will require authorized service; see section 6.3, <em>Repair and Maintenance</em>.</td>
</tr>
</tbody>
</table>

If you have additional questions or require help contact: support@aribex.com
6.3 Repair and Maintenance

NOMAD is a maintenance-free product, except for routine cleaning. To make sure the power is off while cleaning, detach the battery. It is unnecessary to detach anything else in order to clean the unit. Use a non-acetone based disinfectant wipe or a cloth to wipe the exterior surfaces of the NOMAD and charger.

The NOMAD and the battery charger are NOT designed to be user serviceable. Do not open the device housing, doing so will void the warranty.

Repairs can only be undertaken by trained service personnel. Direct all questions to an authorized distributor.

The following are factory serviceable parts and components:

- NOMAD eXaminer, main apparatus assembly – item 08500040
- Retainer o-rings – item 08500152
- Backscatter shield / inner o-ring assembly – item 08500047
- Batteries – item 08500119
- 110/120V AC battery charger w/ manual (DeWalt, model DW9116 or DC9310) – item 08500120
- 220/240V AC battery charger w/ manual (DeWalt, model DE9116 or DE9135) – item 08500151
- Hard-shell carrying case (accessory) – item 08500038

Instructions for handling product at end of life – Please, protect the environment and do not improperly dispose of any part of the NOMAD system, battery, or charger; contact an authorized distributor or Aribex, Inc. regarding assistance in returning the product for proper disposal.

If product return is required, contact Aribex for a Return Material Authorization (RMA) number and shipping instructions to return the product to the proper facility. If the product is under warranty, you will be required to provide the serial number from the label affixed on the underside of the NOMAD.

Be sure to include the RMA number on the package you are returning. Products without a RMA number cannot be serviced or given credit consideration.

Aribex will not assume responsibility for shipping damages; however, it will help you file a claim with the freight carrier. Please see warranty information at the end of this manual.
7.0 Technical Description

7.1 Basic Technical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum deviation from fixed factors</td>
<td>±5% (unless otherwise noted)</td>
</tr>
<tr>
<td>Total weight</td>
<td>4kg</td>
</tr>
</tbody>
</table>

**Environmental**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>–5°C to +40°C (+23°F to +104°F)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>10% to 80%, non-condensing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage and transportation</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>−20°C to +60°C (−4°F to +140°F)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>95%, non-condensing</td>
</tr>
</tbody>
</table>

**Classification / Specification Compliance**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60601-1 (Amnd 1 &amp; 2), 60601-1-3, 60601-2-7; 21 CFR 1020.30 &amp; 1020.31</td>
<td>Class II, Type BF</td>
</tr>
<tr>
<td>IPX specification</td>
<td>IP0; do not operate under wet conditions</td>
</tr>
<tr>
<td>Mode of operation</td>
<td>Intermittent operation</td>
</tr>
<tr>
<td>Conductive connection to subject</td>
<td>No conductivity with the applied part</td>
</tr>
</tbody>
</table>

For use in environments where no flammable anesthetics and/or flammable cleaning agents are present; **non-acetone** based disinfectant wipes or cloths.

**Electrical**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rechargeable NiCd battery</td>
<td>14.4V, 2A/hr</td>
</tr>
<tr>
<td>Low battery alert set point</td>
<td>11.6V</td>
</tr>
<tr>
<td>Battery current at 2.3mA, 60kVp output</td>
<td>16A</td>
</tr>
</tbody>
</table>

**X-ray Controls and Generator**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure time range</td>
<td>0.01–0.99 sec. (certified for 0.02–0.99 sec.)</td>
</tr>
<tr>
<td>Maximum duty cycle</td>
<td>1:60 (one 0.25 sec. exposure / 15 sec.)</td>
</tr>
<tr>
<td>Minimum inherent filtration</td>
<td>1.5mm Al</td>
</tr>
<tr>
<td>Maximum output power</td>
<td>140W nominal at 60kV, 2.3mA</td>
</tr>
<tr>
<td>Generator rating</td>
<td>2.3mA at 60kVp ±10%</td>
</tr>
<tr>
<td>Leakage technique factors</td>
<td>60kV, 2.3mA, 0.99 sec.</td>
</tr>
</tbody>
</table>
Measurement Base of Technique Factors
The kV is measured during pre-pot testing using a calibrated high voltage divider with a guaranteed accuracy of ±2%. Final performance measurements are made using a NERO mAx, model 8000 x-ray meter from Victoreen. Tube current (mA) is sensed across a series connected resistor with an accuracy of ±1% and measured using a digital multimeter, prior to encapsulation; NOMAD eXaminer has no provision for external measurement of beam current after final manufacture. Exposure time is measured from the moment x-rays are detected until they are no longer detected (which means "zero-crossing mode" is selected with no timer delay) using the NERO mAx 8000 x-ray meter.

Collimator Cone
- Minimum source to skin distance: 20cm (from focal spot to cone tip)
- Nominal dose output at cone tip (20cm): 3.28mGy / sec.
- X-ray field size and configuration: 6cm diameter circle
- Shielding: Lead-lined
- Backscatter radiation shielding: 0.5mm Pb-equivalent

7.2 Functional Diagram
7.3 X-ray Tube Specifications and Characteristics

The VTD70/0.4/12CP is also designed for intraoral dental imaging by an x-ray unit, and is available for nominal tube voltage with self-rectified or constant potential circuit – manufactured by Kailong; distributed in the U.S.A. by Vista Technology.

- Nominal tube voltage: 50–70kV
- Nominal focal spot (IEC 60336:1993): 0.4mm
- Maximum anode heat content: 4500J
- Maximum current continuous service: 1.5mA x 70kV
- Maximum anode cooling rate: 100W
- Nominal anode input power: 430W
- Target material: Tungsten
- Target angle: 12°
- Filament characteristics: 2.2–3.0A, 2.0–3.5V
- Minimum permanent filtration (IEC 60522:1999): 0.8mm Al / 50kV
Thermal Characteristics Chart

-4300J  

anode cooling curve

anode heating curves

J

0 500 1000 1500 2000 2500 3000 3500 4000 4500

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000

25kHz

Rating Chart

mA

0 1 2 3 4 5 6 7 8 9 10

25kHz

Cathode Emission / Filament Characteristics

mA

0 2 4 6 8 10 12

2.2 2.4 2.6 2.8 3.0

V

0 1 1.5 2 2.5 3 3.5 4

25kHz

50kV

60kV

70kV
7.4 EMC Data

Independent laboratory testing for electromagnetic compatibility for conformity to the Sub-clause 5.10 requirements of ISO/IEC 17025 "General Criteria for the Competence of Testing and Calibration Laboratories" was conducted by:

Nemko USA, Inc.
11696 Sorrento Valley Rd, Suite F
San Diego, CA 92121-1024
USA

The NOMAD eXaminer X-ray System is intended for use in the electromagnetic environment as specified. The following tables describe the tests performed and the status of the testing. The NOMAD uses RF energy only for its internal function. In addition, the housing includes conductive shielding; therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.

The test results show that the NOMAD is suitable for use in all establishments, including domestic establishments and those directly connected to public low-voltage power supply network that supplies buildings used for domestic purposes.

Test Specifications

Radio Frequency Emissions and Electromagnetic Immunity tests in accordance with requirements of EN 60601-1-2 as follows:

<table>
<thead>
<tr>
<th>Test Type</th>
<th>In Accordance with Document</th>
<th>Document Title</th>
</tr>
</thead>
</table>

NOTE: The tests documented in the table above are the only tests required for this product as it is a battery operated device and has no I/O cables. IEC 61000-4-4, 4-5, 4-6 and 4-11 are not applicable.
### Emissions Test Summary

<table>
<thead>
<tr>
<th>Specification</th>
<th>Frequency Range</th>
<th>Compliance Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 55011 (1991), Group 1, Class &quot;B&quot; Conducted Emissions</td>
<td>0.15 MHz – 30.00 MHz</td>
<td>N/A for a battery powered device</td>
</tr>
<tr>
<td>EN 55011 (1991), Group 1, Class &quot;B&quot; Radiated Emissions</td>
<td>30.0 MHz – 1000 MHz</td>
<td>PASS</td>
</tr>
<tr>
<td>EN 55014 (1993) – Discontinuous Disturbance Test</td>
<td>N/A</td>
<td>N/A for a battery powered device</td>
</tr>
<tr>
<td>EN 61000-3-2 (2000) – Power Line Harmonics</td>
<td>Up to the 40th Harmonic</td>
<td>N/A for a battery powered device</td>
</tr>
<tr>
<td>EN 61000-3-3 (1995), A1 (2001) – Power Line Flicker</td>
<td>≤4% Maximum Relative Voltage Change; Value of (D(T)) ≤3% for more than 200ms</td>
<td>N/A for a battery powered device</td>
</tr>
</tbody>
</table>

### Immunity Test Summary

<table>
<thead>
<tr>
<th>Specification</th>
<th>Minimum Test Level Required per EN 60601-1-2</th>
<th>Test Level Completed</th>
<th>Compliance Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 61000-4-2 (1995), A1 (1998), A2 (2000) – Electrostatic Discharge Immunity</td>
<td>Criterion B Air discharge up to ±8kV; contact discharge up to ±6kV</td>
<td>Criterion B Air discharge up to ±8kV; contact discharge up to ±6kV</td>
<td>PASS</td>
</tr>
<tr>
<td>IEC 61000-4-3 (2000), A1 (2002) – RF Radiated Fields Immunity</td>
<td>Criterion A Radiation field strength of 3V/m from 80 – 2500MHz (80% amplitude modulated @ 1 kHz)</td>
<td>Criterion A Radiation field strength of 3V/m from 80 – 2500MHz (80% amplitude modulated @ 1 kHz)</td>
<td>PASS</td>
</tr>
<tr>
<td>IEC 61000-4-5 (2001) – Lightning Surge Immunity</td>
<td>Criterion B Power line surges of ±2kV common, ±1kV differential mode</td>
<td>Criterion B Power line surges of ±2kV common, ±1kV differential mode</td>
<td>N/A for a battery powered device</td>
</tr>
<tr>
<td>IEC 61000-4-6 (1996), A1 (2000) – RF Common Mode Immunity</td>
<td>Criterion A 150 kHz – 80 MHz at 3 Vrms (80% amplitude modulated @ 1 kHz)</td>
<td>Criterion A 150 kHz – 80 MHz at 3 Vrms (80% amplitude modulated @ 1 kHz)</td>
<td>N/A for a battery powered device</td>
</tr>
<tr>
<td>IEC 61000-4-8 (1993), A1 (2000) – Power Frequency Magnetic Field Immunity</td>
<td>Criterion A Helmholtz coil at 50 Hz, to 3 amps (rms) per meter</td>
<td>Criterion A Helmholtz coil at 50 Hz, to 3 amps (rms) per meter</td>
<td>PASS</td>
</tr>
<tr>
<td>IEC 61000-4-11 (2001) – Voltage Dips and Short Interruptions</td>
<td>Criterion B and C Voltage Dips of &gt;95%, 30% and &gt;60%; Interruptions of &gt;95%</td>
<td>Criterion B and C Voltage Dips of &gt;95%, 30% and &gt;60%; Interruptions of &gt;95%</td>
<td>N/A for a battery powered device</td>
</tr>
</tbody>
</table>
7.5 Optional Calibration Checks

The NOMAD is factory calibrated and tested prior to release (see your Certificate of Conformance) and there are no adjustment options. However, the optional checks listed below may be performed by a qualified technician as desired.

Setup a calibrated Performance Meter (such as the Victoreen NERO™ mAx model 8000) according to manufacturer’s specifications to detect and report the following: X-ray Tube Voltage [kV Effective Mode], Radiation Time [ms Effective Mode], and Dose [mR Average Mode]. The filter card for the Test Detector should be in the 50–100kVp position.

**Measurement Method:** Final performance measurements are made using a NERO mAx, model 8000 x-ray meter from Victoreen. Tube current (mA) is sensed across a series connected resistor with an accuracy of ±1% and measured using a digital multimeter, prior to encapsulation; NOMAD has no provision for external measurement of beam current after final manufacture. Exposure time is measured from the moment x-rays are detected until they are no longer detected (which means "zero-crossing mode" is selected with no timer delay) using the NERO mAx 8000 x-ray meter. Accelerating voltage (kV) is measured at both peak (kVp) conditions and effective conditions (kVeﬀ), which is the equivalent kV as if the kV were constant through the whole exposure time. Linearity is calculated per IEC60601-2-7, 50.102.2a.

This x-ray unit may be dangerous to testing technician and any bystanders unless safe test exposure factors, such as placing the Test Detector in a lead lined box or the use of a protective lead apron are observed.

Enable the NOMAD and with the cone perpendicular to the Test Detector, make exposures into the Test Detector and capture the resulting data.

Compare the result with the factory release parameters (indicated in the chart below). For results outside these parameters, discontinue use and contact your dealer/distributor or Aribex.

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Acceptance Limits</th>
<th>Timer Settings and Corresponding Acceptable Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>20ms</td>
</tr>
<tr>
<td>kVp (eff) Accuracy</td>
<td>60kV ±10%</td>
<td>54 to 66</td>
</tr>
<tr>
<td>Timer Accuracy</td>
<td>Setpoint ±10%, +1ms</td>
<td>17 to 23</td>
</tr>
</tbody>
</table>

A duty cycle of 1:60 is required after each x-ray discharge to prevent over-heating damage to the x-ray tube.
LIMITED WARRANTY

COVERAGE. Aribex, Inc. warrants its x-ray equipment to be free from any defects in material or workmanship for a period of one (1) year from the date of purchase. Aribex, Inc. also warrants any accessories purchased from Aribex to be free from any defects in material or workmanship for the period of one (1) year from the date of purchase.

The liability of Aribex, Inc. is limited to repair or replacement of any parts that Aribex or its authorized resellers determine to be defective. Contact Aribex for a Return Material Authorization (RMA) number and shipping instructions. Parts proving defective shall be repaired or replaced free of charge (labor and domestic shipping included), if defective equipment is returned freight collect to Aribex or the location of the authorized service center. Equipment repaired or replaced under warranty shall continue to be warranted for the balance of the original warranty term. All warranty claims must be made not later than ten (10) business days following the expiration of the applicable warranty period.

LIMITATIONS OF COVERAGE. This warranty does not apply to equipment that is or has been abused, misused, or altered (including opening enclosure or tampering), improperly maintained, subjected to use beyond rated conditions, or damaged as a result of any carelessness or accidents. This warranty does not cover ordinary wear and tear or maintenance.

LIMITATIONS OF LIABILITY. Aribex, Inc. makes no other warranty, either expressed or implied, with respect to any equipment purchased from Aribex, including without limitation any implied warranties of merchantability or fitness for a particular purpose, whether or not Aribex may have been informed of the actual uses to which any of such equipment may be put. Aribex, Inc. shall not under any circumstance be liable for incidental, indirect, consequential, punitive or exemplary damages, including without limitation damages for delay or lost profits, and in no event shall liability of Aribex arising from the purchase, sale or use of the equipment, or breach of any warranty made above, exceed in the aggregate the purchase price paid therefore.
English is the original draft language for this manual.

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http://www.aribex.com