Workplace Risk Management

Guillaume Girard, PhD.Eng
Tim Newman, M.D.

American Occupational Health Conference
May 6, 2015

Workplace Issues: Cardiac Conditions, Devices and Electromagnetic Interference

Discussion Topics

- Overview of cardiovascular diseases and implantable cardiac devices
- Electromagnetic fields and impact on health
- Electromagnetic field interference and cardiac devices
- Method to assess workplace EMF and individual risk
- An electric utility program / case review
- Summary
Cardiovascular Diseases and Implantable Cardiac Devices: Workplace Risk Management
Baltimore – May 6, 2015

Cardiovascular Diseases (CVD)*
- Population prevalence – 64 million Americans
  - Mortality – 38.5% of all deaths (1:2.6)
- Comparative risk of death due to conditions
  - CVD – 47%
  - Cancer – 22%
  - Accident – 3%
  - Diabetes – 2%
  - AIDS – 0.7%

* CVD = CHD, hypertension, stroke, congestive heart failure, congenital defects, rheumatic heart disease

Source: American Heart Association, 2004

Coronary Heart Disease: Impact on Workforce
- Prevalence
  - New coronary attacks ~ 700,000/yr
  - Recurrent coronary attacks ~ 500,000/yr
  - Coronary patients who recover ~ 88% RTW
  - Leading cause of premature permanent disability -19% of workforce
- Implantable cardiac devices utilization (1993-2008)
  - Cardiac pacemakers = 3 million
  - Implantable cardiac defibrillator (ICD) = 1 million
  - Number of implantable devices increase 5% each year
Cardiovascular Diseases and Implantable Cardiac Devices: Workplace Risk Management
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Cardiac Devices: Clinical Indications

- **Pacemaker**
  - Sick sinus syndrome (41%)
  - AV Block (33%)
  - Second degree block (13%)

- **Defibrillator**
  - Cardiac arrest
  - CHF with ejection fraction < 40
  - Ischemic cardiomyopathy
  - Dilated cardiomyopathy

- **Cardiac resynchronization**
  - Heart failure

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History of Cardiac Pacemakers

- **The first External Pacemakers - 1950s**
  - The "lead" was implanted into the heart and the other was connected to an AC-powered external pacemaker. Power failure was a constant concern.
  - First Battery-Powered External Pacemaker (1957) transistorized, battery-powered and wearable

- **First implanted pacemakers – 1960s**
  - Asynchronous pacing devices enclosed in epoxy
  - Few noise rejection circuits and no metal shielding
  - Transvenous leads used in the mid-1960s

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Evolution of Implantable Cardiac Devices

- **Mid-1970s: First Programmable Pacemakers**
  - Pacemaker programmed using radio-frequency signals.

- **Late 1970s: First Dual-chamber Pacing**
  - Programmable pacemaker that paced atrium and ventricle chambers

- **Mid - to late 1980’s:**
  - Pacemakers with a "rate responsive" feature (accelerometers)
  - Implantable cardiac defibrillators introduced

- **1990’s to date:**
  - Microprocessor based devices with titanium shield
  - Noise rejection circuits and algorithms
  - Input capacitors filter frequencies > 450 MHz
  - Bipolar sensors
Current Implantable Cardiac Devices

- Pacemakers or implantable pulse generators (IPG)
- Defibrillators or implantable cardioverter defibrillators (ICD)
- Cardiac resynchronization therapy (CRT)
  - Pacemaker (CRT-P)
  - Defibrillator (CRT-D)
- **Device longevity**
  - Pacer – about 7 to 10 years
  - Defibrillators – about 5 to 7 years

Active Implantable Medical Devices*

- Depression
- Parkinson’s/Tremor
- OCD
- OCD
- Dystonia
- Spasticity
- Chronic Pain
- Liver Cancer
- Gastroesophageal reflux disease (GERD)
- Urinary incontinence
- *Devices – life supporting vs. quality of life

Medical Devices: The Issue

- A substantial expansion of electronically-controlled medical “assist” devices;
- These devices are capable of returning a worker to a fully- (or near fully-) functioning status;
- In an aging workforce, a growing fraction may rely on medically deployed (worn externally or implanted) assist devices;
- A safety priority is to minimize any probability of interference from ambient EMF.
Electromagnetic Fields and Impact on Health

Electromagnetic Field Spectrum

Electric and Magnetic Field Sources

Natural and manmade – “invisible lines of force”

<table>
<thead>
<tr>
<th>Personal Items</th>
<th>Travel and Environment</th>
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</thead>
<tbody>
<tr>
<td>Kitchen, household items</td>
<td>Medical procedures</td>
</tr>
<tr>
<td>Projects / do-it-yourself items</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Entertainment items</td>
<td>Industrial</td>
</tr>
</tbody>
</table>

World Health Organization (WHO) classification of EMF as “possibly carcinogenic” due to observations in humans of an association between magnetic field exposures and childhood leukemia. Hundreds of studies over 30 plus years have not established EMF as a link to diseases or biologic mechanisms for diseases.

References:
1) EMF and your Health – EPRI (Electric Power Research Institute) www.epri.com
2) Sources of Electromagnetic Interference – Guillaume Girard, PhD.Eng 2015

Guillaume Girard, PhD.Eng and Timothy L. Newman, M.D.
US Standards: Electric / Magnetic Fields
IEEE Std 95.6™ - 0 to 3,000 Hz (3 kHz)

“...to protect against adverse effects in humans from exposure to electric and magnetic fields...developed with respect to established mechanisms of biological effects in humans from electric and magnetic field exposures...do not necessarily protect against interference of medical devices or problems involving metallic implants.”

IEEE Magnetic & Electric Field Exposure Limits

<table>
<thead>
<tr>
<th>Magnetic Field</th>
<th>Electric Field</th>
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</thead>
<tbody>
<tr>
<td>Frequency (Hz)</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>0.5</td>
</tr>
<tr>
<td>1000</td>
<td>0.1</td>
</tr>
<tr>
<td>10,000</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Exposure levels allowed by the standard are high for either a worker and general public and are above actual medical device standard immunity threshold.

Electrical Power Transmission & Distribution

Guillaume Girard, PhD.Eng and Timothy L. Newman, M.D.
EMF Monitor

- **CardioMan (EU product from Germany)**
  - Set on standard with lower warning level.
  - E, H and static field measured.
  - Expensive ($1200)

References: [http://www.cardioman.de/english](http://www.cardioman.de/english)

**Sources of Electromagnetic Interference**

- **Radiated** – invisible energy fields spread through space.
  - Emitted by many sources
    - Electric fields (E) – power lines, electric panels, transformers, TV towers
    - Variable magnetic fields (H) – AC powered motors, generators, welding equipment, and power tools
    - Static magnetic fields (B) – DC powered or battery power tools, welding equipment, electromagnets, or permanent magnets
    - Electromagnetic (E&H) – television, cell phone
- **Conducted** – direct contact with an electrical source (shock)
  - Faulty electrical equipment, improperly grounded
  - Current leak, stray current from power lines

References: [http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html](http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html)
Electromagnetic Interference - Cardiac Devices

<table>
<thead>
<tr>
<th>EMI Source</th>
<th>Electromagnetic Field Intensity Limit (rms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Frequency (50/60 Hz)</td>
<td>1000–10,000 V/m (6,000 V/m, outside nominal)</td>
</tr>
<tr>
<td>High Frequency (150 KHz &amp; up)</td>
<td>100 V/m</td>
</tr>
<tr>
<td>Static Magnetic Fields (DC)</td>
<td>10 gauss (UMR standard)</td>
</tr>
<tr>
<td>Modulated Magnetic Fields</td>
<td>80 A/m up to 10 KHz and 1 amp/meter for greater than 10 KHz</td>
</tr>
</tbody>
</table>

Source: Electromagnetic Interference (EMI), Medtronic Technical Services Standard Letter

Cardiac Device: Pacemaker

- **Pacer Types**
  - Unipolar/Bipolar

- **EMF Effect**
  - Sensing/ Pacing Inhibition (missed pacing beats)
  - Noise reversion to asynchronous pacing
  - Tracking, for dual chamber devices
  - Rate changes within programmed rate limits, for rate adaptive devices
  - Current induced into the lead system, that can trigger an arrhythmia
  - Activation of the reed switch (asynchronous pacing)
  - Extreme case, but very unlikely: microprocessor reset

Work site Implications for EMF and Pacer

- **Critical clinical factors:**
  - Patient dependence on device
  - Ability to tolerate Asynchronous pacing

- **General outcomes (observed):**
  - Sensing/ Pacing Inhibition (missed pacing beats)
  - 2-3 paces then light headed and fainting
  - Noise reversion to asynchronous pacing
  - Activation of the reed switch (asynchronous pacing)
  - Feel weird

Sources: Magnet, >735 kV power line, electromagnet, induction heaters, generator (high power) and welding.
Cardiac Device: Implantable Defibrillator

- **Types**
  - Bipolar or integrated Bipolar

- **EMF Effect**
  - Oversensing that manifests itself as: inhibition (missed pacing beats), and potential inappropriate delivery of therapy (unwanted shock)
  - Tracking, for dual chamber devices
  - Under sensing an arrhythmia
  - Current induced into the lead system, that can trigger an arrhythmia
  - Hall sensor activation (suspends detection)
  - Microprocessor reset unlikely

Work site Implications for EMF and ICD

- **Critical clinical factors:**
  - Prevention at risk or not for VF (imminent need)
  - Pacing dependent or required

- **General outcomes (observed):**
  - Withhold therapy (disable temporarily)
  - Unwanted shock delivery (8-10 sec. delay)

Sources: Magnet, arc welding, induction heaters, magnetic stapler, ballast in fixtures, walkie-talkie, current leakage

Electromagnetic Interference and Implanted Medical Devices

<table>
<thead>
<tr>
<th>Device behavior</th>
<th>ICDs / CRT-Ds</th>
<th>Pacing/ CRT-Ps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asynchronous pacing (pacing therapy provided independent of intrinsic cardiac activity)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Inhibition of pacing (pacing therapy not provided when needed)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Inhibition of tachyarrhythmia therapy (ATF/pulse shock therapy not provided when needed)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Inappropriate tachyarrhythmia therapy (ATF/pulse shock therapy provided when not needed)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Triggered ventricular pacing up to the Maximum Tracking Rate</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Induced ventricular arrhythmia and/or fibrillation</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Electrical reset</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>
Cardiac Devices – Sensing Characteristics

- A typical pulse generator has a sense amplifier “bandpass” from 10 Hz to several hundred Hz
  - Based on the frequency content of the physiological signal
- Designed to sense peak values of very low physiological signals
- Minimum sensing threshold is dictated by electronic technology and battery capacity limitations:
  - Sensitivity range:
    - 0.15 - 2.1 mV for ICDs
    - Sensitivity range:
    - 0.18 - 11 mV for pacemakers

Safety Risk Assessment: EMI and Cardiac Devices

- CDC / NIOSH standards will be based on a hybrid approach of European standards and current US information
  - Methodology to quantify safety risks of EMI, cardiac device and health condition
  - Standards to be published in 2015
- Stakeholders
  - Medical provider: clinical condition and type of device required
  - Safety / hygienist: EMI work site measurements and job requirements
  - Worker: overall comfort level with potential health / safety risks

Reference: Strategies for Managing Workplace Exposures to Lower Frequency Electric and Magnetic Fields (EMF)
Clinical Implication

- **Physician involvement**
  - Treatment and health condition
    - Device type and arrangement (bipolar, unipolar, CRM, neuro, diabetes)
    - Treatment: life supporting, quality of life... Patient dependence on device...
  - Specific device EMI limits
    - Setting program in the device (nominal, specificity)
    - Tolerance to intermittent or safety modes...
  - Physical work limitation
    - Ability to perform work with condition
    - Lifting stress imposed on leads or wires
  - Physician has final decision to recommend return to work

Industrial Hygienist (Employer)

- **Job description**
  - Ergonomics limitation
    - Work areas and potential exposure limitations
  - Site
    - EMF sources – utilizing industry standards
    - EMF survey of specific risk areas

- **Risk approach**
  - Documentation of risks and decision

  Provide essential documentation supporting safe return to work
Worker

- Comfort Level
- Understanding of Risks
- Input into Clinical and Industrial Hygienist Evaluation and factors determinations. (ex: site and work areas, tools, distances...)

ULTIMATE DECISION TO RETURN TO WORK

EMF Site Survey

- Perform Survey following OSHA guidelines
  - Priority on Measurements between DC-30MHz.
  - Measurement at 6” from sources or safety distance if exceeded.
  - Factors:
    - Job description (tools, actual interactions with sources)
    - Work areas (supervisor or line worker)
    - Proximity (distance from source)
    - Sources: field Type and Frequency

- Nominal Limits can be derived from standards or obtain from manufacturer.

Consolidated Standards (cardiac example)
Cardiovascular Diseases and Implantable Cardiac Devices: Workplace Risk Management
Baltimore – May 6, 2015

Risk Documentation and Determination

- Provide overview of Clinical, Hygienist and Worker
- Provide summary of decision and supporting evidence
- Complete electromagnetic interference mode and effect analysis
- Identify risks and mitigation plan
- Final determination

References: CDC / NIOSH Standards documents

Overview of Electric Utility Workforce

- Workforce – predominantly male, average age = 50
- Functional work requirement – medium – heavy labor jobs
  - Fossil plant, electrical lineman
  - Environmental factor – seasonal
  - PPE – tool belts, gloves, respirators
- Electromagnetic field exposure
  - Electrical lines, transformers
  - Generators, motors, welding
- Commercial Driver’s License (CDL) – Lineman
- Shiftwork in plants, storm duty in regions
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FE Assessment Process: Clinical Approach

Cardiac Condition with Pacer/Defibrillator

Assessment Guidelines:
- Cardio-pulmonary status
- Co-morbid conditions
- Cardiac function

Functional Work Capabilities
Work Requirements

FE Assessment Process: General Guidelines

Clinical Review
- DX/Date Onset
- Symptom Inventory
- Risk Factors
- Activity Review
- Functional Assessment

Medications
Diagnostic Tests
Hospitalization
Other Conditions
Family History

Work Environment and Job Specific Requirements
- Work level
- Climbing, work at heights
- Operate machinery
- Environmental exposure
- Electrical work (EMF)
- Driving (CDL)
- PPE – Respirator, clothing

FE Assessment Process: Responsibilities

- Clinical Evaluation
  - Cardiologist – primary responsibility
  - Company physician oversee
- Work site evaluation – Company
  - EMF Survey
  - Essential job duties
  - Job position – CDL, respirator, etc.
- Final Work Recommendation
  - Corporate physician review
Case Review: Cardiomyopathy / Ventricular tachycardia with Implanted cardiac defibrillator

- **Case History**
  - Young lineman (22 y/o) with presenting symptoms of palpitations, light headedness, chest pain during ski trip
  - Converted with Amiodarone; failed definitive ablation tx
  - Past med hx – atrial fibrillation age 16, family hx of hypertrophic cardiomyopathy

- **Final Diagnosis**
  - Arrhythmogenic RV cardiomyopathy (ARVC)
  - RVOT – Ventricular Tachycardia
  - Genetic mutation of plakophilin 2 (PKP2) gene

- **Treatment**
  - Implanted Cardiac Defibrillator Device

Medical and Workplace Risk Assessment

- **Medical Condition – ARVC**
  - Natural progression of condition – different for cardiomyopathy and ventricular tachycardia (limited medical info)
  - Medical Monitor by evaluation every 6-12 mos

- **Work Environment**
  - EMF study – low risk of inadvertent shock if work position at 6-24 in.
  - ICD limits: E field >1 kV/m; B field >10 gauss; H field >1 gauss
  - Applies to job of regular lineman work on 12 KV electric lines

- **Individual Judgment Capabilities**
  - Good results of Risk Management and Safety Assessment

- **Commercial Driver's License Qualification**
  - Did not qualify – ICD does not alter disease course and was used as primary prevention for VT
Final Outcome: ARVC case with ICD

- Permanent Job Restrictions
- Unable to perform essential job duties of lineman
  - No Work with energized lines
  - Can not climb poles
  - Can not work with or around hazardous machinery
  - Not qualified for CDL
- Job Transfer to Fossil Plant
  - Material handler / store keeper position

Summary

- Cardiovascular diseases and implantable cardiac devices require complex medical and safety decision making to assess individual health and safety risks in the workplace
- Electromagnetic field interference can occur by electrical and magnetic sources. These sources require specific measurements to determine an impact on the individual risk
- The method of workplace assessment of the individual with CV disease and an implanted cardiac device includes:
  - Medical condition evaluation
  - Work environment assessment
  - Individual judgment / worker safety awareness
  - Specific job requirements, i.e. CDL, and respirator
- CDL / NIOSH National Standards pending release

References
References

- EPRI January 2012 - EMF and Your Health
- Medtronic CRDM Technical Services Standard Letters
  - Electromagnetic Interference (EMI)
  - Arc Welding
- Medtronic – More Help for Heart Device Patients
- Boston Scientific – A Closer Look
- Guidant – Sources of Electromagnetic Interference (EMI)
- CDC / NIOSH Standards
What to do if you think an item is affecting your heart device

If you feel dizzy, feel rapid or irregular heartbeats, or receive a shock while using an item, then release whatever you’re touching or move away from it. Any temporary effect is unlikely to cause reprogramming or damage to your pacemaker or implantable defibrillator – your heart device should return to its normal operation. Of course, if your symptoms continue or do not improve, contact your doctor as soon as possible.

Answers to the most commonly asked questions

We’ve organized this guide to make it helpful and convenient for you to find the answers you’re looking for. It’s divided into four main categories:

1. Household Items/Hobby
2. Telecommunications and Office Equipment
3. Tools/Industrial Equipment
4. Medical/Dental Procedures

Each category is broken into sections, ranging from no known risk to special considerations, which provides you with the recommended minimum distance for the items or products listed. If the item you’re looking for isn’t on the list or you have a specific question about an item, contact Medtronic Patient Services at 1 (800) 551-5544, extension 41835, between 7:00 am and 6:00 pm Central Time, Monday-Friday.

We hope this guide makes it easier to find answers to your questions about items in your everyday environment.
Household Items/Hobby

Most household and hobby items are unlikely to affect your heart device when the items are in good working condition, used as intended, and the recommended distances are maintained. For items that transmit power through an antenna, it is recommended that you follow the noted distances between the antenna and your implanted heart device.

<table>
<thead>
<tr>
<th>No Known Risk</th>
<th>Minimal Risk</th>
<th>Special Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the item is used as intended and in good working condition there is no known risk:</td>
<td>Maintain at least a 6-inch distance between the item and your heart device:</td>
<td>Maintain at least the recommended distance between the item and your heart device:</td>
</tr>
<tr>
<td>• Battery Charger – for household batteries</td>
<td>• Cordless Headphone Sending Unit (TV/Stereo)</td>
<td>12-Inch Distance</td>
</tr>
<tr>
<td>• Casino Slot Machine</td>
<td>• Cordless Telephone – from antenna and charging base</td>
<td>• Car/Motorcycle – from components of ignition system</td>
</tr>
<tr>
<td>• CD/DVD/VHS Player or Recorder</td>
<td>• Electric Grocery Cart/Golf Cart – from motor</td>
<td>• Electric Fence</td>
</tr>
<tr>
<td>• Dishwasher</td>
<td>• Electric Kitchen Appliances – hand-held (electric mixer or knife)</td>
<td>• Electric Pet Containment Fence – from buried wire and indoor antenna</td>
</tr>
<tr>
<td>• Electric Blanket</td>
<td>• Electric Shaver – corded</td>
<td>• Transformer Box (green box in yard)</td>
</tr>
<tr>
<td>• Electric Guitar</td>
<td>• Electric Toothbrush Charging Base</td>
<td>2-Foot Distance</td>
</tr>
<tr>
<td>• Garage Door Opener</td>
<td>• Hair Dryer – hand-held</td>
<td>• Beach Comber Metal Detector – from search head</td>
</tr>
<tr>
<td>• Heating Pad</td>
<td>• Home Wireless Electronics – from antenna</td>
<td>• Induction Cooktop Stove</td>
</tr>
<tr>
<td>• Hot Tub</td>
<td>• Magnetic Therapy Products</td>
<td>NOT RECOMMENDED</td>
</tr>
<tr>
<td>• Ionized Air Filter</td>
<td>• Radio-controlled items – from antenna</td>
<td>• Ab Stimulator</td>
</tr>
<tr>
<td>• Transmitter</td>
<td>• Sewing Machine/Serger – from motor</td>
<td>• Electric Body Fat Scale</td>
</tr>
<tr>
<td>• Iron</td>
<td>• Small Magnet (household magnet)</td>
<td>• Magnetic Mattress Pad/Pillow</td>
</tr>
<tr>
<td>• Kitchen Appliances – small and large (blender, can opener, refrigerator, stove, toaster)</td>
<td>• Speakers</td>
<td></td>
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<tr>
<td>• Massage Chair/Pad</td>
<td>• Treadmill – from motor</td>
<td></td>
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<tr>
<td>• Medical Alert Necklace</td>
<td>• Vacuum Cleaner – from motor</td>
<td></td>
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<tr>
<td>• Microwave Oven</td>
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<tr>
<td>• Radio/CD Player</td>
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<tr>
<td>• Remote Control (CD, DVD Player, TV, VHS)</td>
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<td></td>
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<tr>
<td>• Salon Hair Dryer</td>
<td></td>
<td></td>
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<tr>
<td>• Shaver – battery powered</td>
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<tr>
<td>• Tanning Bed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• TV</td>
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</table>

If the item you are looking for is not on the list, please contact Medtronic Patient Services at 1 (800) 551-5544, x41835.
### Telecommunications and Office Equipment

Guidelines for safe operation of telecommunications and office equipment include such factors as transmitting power, frequency, and antenna type. For items that transmit power through an antenna, it is recommended that you follow the noted distances between the antenna and your implanted heart device.

<table>
<thead>
<tr>
<th>No Known Risk</th>
<th>Minimal Risk</th>
<th>Special Considerations</th>
</tr>
</thead>
</table>

- **If the item is used as intended and in good working condition there is no known risk:**
  - Copy Machine
  - Desktop/Laptop Computer
  - Fax Machine
  - Global Positioning System (GPS)
  - Low Voltage Residential Power Lines
  - Metal Detectors Archway – when walking through normally (airports, buildings, schools)
  - Pager – receiver only
  - Printer
  - Scanner
  - Theft Detection Systems – when walking through normally (libraries, stores)

- **Maintain at least a 6-inch distance between the item and your heart device:**
  - Airport Screening Wand
  - Amateur Radios, Ham Radios, Marine Radios, Walkie Talkies – 3 watts or less – from antenna
  - Cellular Phone – 3 watts or less – from antenna
  - OnStar™ Technology – from antenna
  - Security Badge Wall Scanner
  - Wireless Communication Items (computer, headsets, modem, Palm® Pilot, router)

- **Maintain at least the recommended distance between the item and your heart device:**
  - 12-Inch Distance
    - Citizens Band (CB) Radio – 5 watts or less – from antenna
  - 2-Foot Distance

If the item you are looking for is not on the list, please contact Medtronic Patient Services at 1 (800) 551-5544, ext. 41835.
Tools/Industrial Equipment

It is important that your power tools and/or equipment be in good working order and properly wired (three-prong plug, if applicable) and used as intended by the manufacturer of the product. It is recommended that corded electrical items be plugged into a safety outlet device called a ground fault circuit interrupter (GFCI or GFI).

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<td>Maintain at least the recommended distance between the item and your heart device:</td>
</tr>
<tr>
<td>• Calipers – battery powered</td>
<td>• Circular Saw – skill saw</td>
<td>12-Inch Distance</td>
</tr>
<tr>
<td>• Flashlight – battery powered</td>
<td>• Drills – battery and electric powered</td>
<td>• Car Battery Charger – 100 amps or less</td>
</tr>
<tr>
<td>• Laser Level</td>
<td>• Grinder (hand-held)</td>
<td>• Gasoline Ignition Systems – from components of ignition system</td>
</tr>
<tr>
<td>• Soldering Iron</td>
<td>• Hedge Trimmer – electric powered</td>
<td>• Gasoline Powered Tools – from components of ignition system (lawn mower, snowblower, weed whacker)</td>
</tr>
<tr>
<td>• Stud Finder</td>
<td>• Lawn Mower – electric powered</td>
<td>• Generators – 20 kW or less</td>
</tr>
<tr>
<td></td>
<td>• Leaf Blower – electric powered</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reciprocating Saw (Sawzall®)</td>
<td>2-Foot Distance</td>
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<tr>
<td></td>
<td>• Router</td>
<td>• Bench Mounted/Free Standing Tools – for motors 400 horsepower or less (air compressor, drill presses, grinder, pressure washer, table saw)</td>
</tr>
<tr>
<td></td>
<td>• Sander</td>
<td>• Jumper Cables</td>
</tr>
<tr>
<td></td>
<td>• Screwdriver – battery powered</td>
<td>NOT RECOMMENDED</td>
</tr>
<tr>
<td></td>
<td>• Soldering Gun</td>
<td>• Chainsaws ¹</td>
</tr>
<tr>
<td></td>
<td>• Weed Whacker – electric powered</td>
<td>• Welding Equipment¹</td>
</tr>
</tbody>
</table>

¹ Avoid using a chainsaw and welding equipment. If required to use, contact Patient Services for guidelines.

If the item you are looking for is not on the list, please contact Medtronic Patient Services at 1 (800) 551-5544, x41835.
Medical/Dental Procedures

Many medical procedures will not affect your heart device; however, certain medical procedures introduce electrical current into the body that may affect an implanted heart device. Before undergoing any medical procedure, it is recommended that you advise your treating doctor or dentist that you have an implanted heart device and consult with your heart doctor to evaluate any possible associated risk.

### No Known Risk

If the item is used as intended and in good working condition there is no known risk:

- Acupuncture – no electrical stimulus
- Bone Density Test (X-ray)
- Bone Density Ultrasound – on heel or hand
- Dental Drills
- Dental Ultrasonic Scaler/Cleaner
- Diagnostic X-rays (fluoroscopy)
- Electrocardiogram (ECG/EKG)
- Hearing Aid (in or behind ear)
- Laser Surgery
- Mammography
- Positron Emission Tomography (PET Scan)
- Sleep Apnea Machine

### Minimal Risk

Maintain at least a 6-inch distance between the item and your heart device:

- Diagnostic Ultrasound (Echocardiogram) – from transducer head
- Hearing Aid Transmitting Necklace Loop

### Special Considerations

Consult further with your physician before undergoing the following procedures:

- Acupuncture with Electrical Stimulus
- CAT or CT Scans
- Colonoscopy with Electrocautery
- Electrocautery
- Electrolysis
- High Energy Radiation Therapy
- Lasik Surgery
- Lithotripsy
- Radio Frequency Ablation
- Therapeutic Ultrasound – from transducer head
- Transcutaneous Electrical Nerve Stimulation (TENS)

**NOT RECOMMENDED**

- High Frequency (short wave) or Microwave Diathermy
- MRI/MRA (generally not recommended – have physician contact Medtronic Technical Services for specific situation)
- Transurethral Needle Ablation (TUNA®)

If the item you are looking for is not on the list, please contact Medtronic Patient Services at 1 (800) 551-5544, x41835.
Electromagnetic Interference (EMI) and Implanted Medical Devices

All electronic devices radiate energy in the form of electromagnetic radiation waves, which are the result of electrically and magnetically charged particles in motion. Electromagnetic waves vary in amplitude and frequency. Electromagnetic Interference (EMI) is the disruption of normal operation of an electronic device when it is in the vicinity of an electromagnetic field created by another electronic device.

**Potential impact of EMI on implantable device systems**

Some electrical equipment has the potential to interfere with the proper function of an implanted device system. Electromagnetic waves of sufficient amplitude and/or frequency, generated within the proximity of the implanted device system, may have the potential to mimic the electrical activity of the heart and inhibit needed therapy or be interpreted by the device as electrical noise potentially resulting in delivery of unnecessary therapy. These types of EMI should be avoided if possible as they can impact device performance and could potentially lead to the following device responses:

<table>
<thead>
<tr>
<th>Device behavior</th>
<th>ICDs / CRT-Ds</th>
<th>Pacemakers/ CRT-Ps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asynchronous pacing (pacing therapy provided independent of intrinsic cardiac activity)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Inhibition of pacing (pacing therapy not provided when needed)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Inhibition of tachyarrhythmia therapy (ATP/shock therapy not provided when needed)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Inappropriate tachyarrhythmia therapy (ATP/shock therapy provided when not needed)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Triggered ventricular pacing up to the Maximum Tracking Rate</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Inability to communicate with the device</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Induced ventricular arrhythmias and/or fibrillation</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Electrical reset</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

If the patient moves away from or turns off the source of EMI, the implanted device usually resumes its normal mode of operation. In rare instances, the impact to the device may be permanent such as memory corruption or reversion to Safety Mode operation.
Precautions for Patients in the Presence of EMI

Patients in the presence of electronic equipment who feel light-headed, detect an increased heart rate, hear beeping tones from their device, or experience a defibrillation shock, should immediately move away from electronic equipment and call their physician to report the episode.

Additional EMI information

See product labeling or refer to the following sources for additional EMI information:

· Device monitoring physician
· Boston Scientific CRM Technical Services
· Article: “What You Need to Know About Electromagnetic Interference (EMI)”
### Preliminary Assessment

**Work environment listed do not require further analysis.**

Computer and IT equipment, office equipment, mobile phones, and cordless phones two-way radios (< 2WmV) base stations for UHF cordless phones (non-wireless communication equipment and networks Electric hand held and portable tools Portable heating tools (Glue guns, heat gun, soldering iron) Battery chargers (small size battery only (AAA, AA, etc.) Electric and gas operated garden appliances Audio & video equipment (except broadcasting equipment) Battery powered equipment not including radio frequency transmitters Electrical room heating equipment Electricity supply networks in the workplace and electricity distribution and transmission circuits passing through or over the workplace up to 100 kV excluding generator systems Household appliances Computer and IT equipment including wireless communication Battery driven transmitters All medical equipment not using RF sources.

### EMF Field Survey

(Perform EMF survey of worker environment)

<table>
<thead>
<tr>
<th>Field Type and Frequency</th>
<th>Sources</th>
<th>Value</th>
<th>Distances</th>
<th>Limit</th>
<th>CFIL (Safe Distance)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Radiated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low frequencies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Hz - 150 kHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex: power lines, electric service panels, transformers, power plants, electrical substations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 kHz - 40 GHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex: Radio transmitter antennas, television transmitter antennas, cellular telephone antennas, hf welding equipment, dielectric heaters, radar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Magnetic Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Hz - 10 kHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex: Motors, generators, transformers, retail detectors, store security gates, AC/DC welding equipment, and power tools, electrical forklift, conveyor drive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Magnetic Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 10 kHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex: Radio transmitter antennas, television transmitter antennas, cellular telephone antennas, hf welding equipment, dielectric heaters, radar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static Magnetic Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex: permanent magnets, DC electromagnets, battery powered tools, DC welding equipment, uninterruptible power supply equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measurement must be performed per frequency range and peak (rms) value reported. Measurement distances of 6" or 36" is strongly recommended from sources.

If field exceed listed limit provide distance at which the field is within the limits or notify if potential risk.
# Safety Case Evaluation Forms for EMI with Medical Devices

## Clinical Input

| Physician Name |  |  |
|----------------|----------------|
|  |  |
| Medical device type: |  |
|  |  |

### Clinical Condition Summary

Ex: pacing dependent, don't tolerate asynchronous pacing....

## Industrial Hygienist Input

| Employer Name |  | Employer Contact Name |
|----------------|----------------|
|  |  |
| Employee Job title |  | Contact Name Number |
|  |  |
| Employee Job description | (Equipment, tasks, hours, industrial settings...) |  |
|  |  |
| Work Environment Equipment's List |  |  |
Start of Assessment

- Is there an employee with a Medical device or AIMD?
  - Yes
    - Uninfluence behavior history
      - Yes
        - Specific EMI Warning from Physician
          - No
            - No further action required
              - Document the Behavior and/or EMF Assessment Results.
                - Remind to follow Physician recommendation and Device manufacturer guideline.
                  - (Warning, Restrictions Area Reassignment if needed).
          - No
            - No
              - Physician Recommendation to return to work

- No
  - No further action required

Physician (Clinical severity)

EMF Medical Device & AIMD Work Assessment

Industrial Hygienist (Work environment and EMF Survey)

Worker Risk Comfort Level

EMF Medical Device & AIMD Work Assessment

Risk Level determination
The guidance provided in this letter is for healthcare providers and Medtronic representatives, and it applies to the following Medtronic devices types:

**IPG** – Implantable Pulse Generators (Pacemakers)
**ICD** – Implantable Cardiовеrter Defibrillators
**CRT-P** – Cardiac Resynchronization Therapy Pacemakers
**CRT-D** – Cardiac Resynchronization Therapy Defibrillators

**Overview**

This letter addresses the following welding types:

- Gas metal arc welding (GMAW), sometimes referred to by its subtypes;
  - metal inert gas (MIG) welding
  - metal active gas (MAG) welding,
- Shielded metal arc welding (SMAW) is also known as stick welding or manual metal arc welding (MMA)
- Gas tungsten arc welding (GTAW), commonly known as tungsten inert gas (TIG) welding

**Guidelines & Potential Impacts**

The random nature of electromagnetic energy generated during welding makes it difficult to predict the effect on a Medtronic IPG & CRT-P and ICD & CRT-D. The arc, welding cable, and the welding machine produce and carry the current associated with the welding operation. This current produces the magnetic field that may influence the operation of the implanted device. As per Medtronic Label, it is recommended that individuals with Medtronic IPG & CRT-P and ICD & CRT-D avoid welding if possible; however, welding at low currents poses a low risk of affecting either device. Acetylene or other nonelectric welding where suitable will eliminate the risk of interference with the device.

**MAGNETIC FIELD:** The random nature of the currents and the resultant magnetic fields associated with the welding operation may cause Medtronic IPG & CRT-P inhibition or delivery of a continuous sequence of stimuli at a normal low rate (noise reversion). The Medtronic ICD & CRT-D may respond to these random currents by delivering an inappropriate therapy while inhibiting the pacemaker portion of the Medtronic ICD & CRT-D. It is also possible that the magnetic field associated with a DC welding device could disable the Medtronic ICD & CRT-D detection therapy for as long as the welding current is present. NOTE: There is no apron or vest that will effectively shield the Medtronic IPG & CRT-P and ICD & CRT-D from these magnetic fields generated by the welding.

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How to contact U.S. CRDM Technical Services:
Pacemakers: (800) 505-4636, ICDs: (800) 723-4636, Instruments: (800) 638-1991. Email: tshelp@medtronic.com

This information is verified for devices approved in the U.S. and may differ by country.
For product-specific information on device operation and indications for use, reference the appropriate product labeling.
CONDUCTED CURRENTS: A momentary electrical shock may occur, if the insulation is faulty, or if the active rod or wire is touched. This momentary external shock may cause a short pause in the pacemaker or pacemaker portion of the Medtronic ICD & CRT-D. The Medtronic IPG & CRT-P and ICD & CRT-D may detect conducted current even if the person welding does not feel it. This sub threshold current, if detected for several seconds, may cause noise reversion or inhibition in the pacemaker. In rare instances, this conducted current may trigger pacing, but not at rates above the upper rate limit. An ICD & CRT-D could detect the current as a fast heart rhythm, causing it to deliver an inappropriate therapy. Any effects caused by welding interference will end when the arc is broken. Physicians who have a patient desiring to weld or who will be in close proximity to a welder should consider the potential effects of inhibition, reversion, and/or triggering of the device on their patient.

Suggested Precautions
If an individual, in consultation with their physician, chooses to weld, the following recommendations may reduce the risk of interaction for conventional electric welders. The issuance of these recommendations does not imply endorsement. Rather, it recognizes that patients who do weld can reduce the likeliness of an interaction. Welders over 160 amps, spot welders, induction welders, and similar industrial equipment require additional precautions; contact Medtronic Technical Services for information.

1. Ensure that all items are in good working order and properly grounded.
2. Limit welding currents to less than 160 amps.
3. Work in a dry area with dry gloves and dry shoes.
4. Keep the welding arc a minimum of 2 feet (60 cm) from the device.
5. Connect the ground clamp to the metal as close to the point of welding as possible.
6. Arrange the work so the handle and rod will not contact the metal being welded if they are accidentally dropped.
7. Twist the cables around each other. Route the cables and place the welding machine away from the welder.
8. Do not weld with rapid, repeated, short bursts. Wait a few seconds between each weld. When having difficulty starting a weld on a dirty surface, do not strike the rod in a rapidly repeated manner. Wait several seconds between each attempted strike.
9. Step away from the area if feeling light-headed, dizzy, or if a shock has been delivered.
10. Do not work on a ladder or in a cramped, confined location.
11. Do not work alone. Work only in the presence of a person who understands these recommendations.
EMF Around You

Table 1 – Exposure to 50 or 60 Hz magnetic fields from electric appliances can vary greatly depending upon how close it is to the body. Intensity falls off dramatically with distance. Source: Zaffanella, 1992, NIEHS, 2002, and EPRI, 2010.

<table>
<thead>
<tr>
<th>Appliances</th>
<th>Magnetic Field (mG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 ft</td>
</tr>
<tr>
<td>AC Adapter</td>
<td>0 – 7.5</td>
</tr>
<tr>
<td>Baby Monitor</td>
<td>0 – 2</td>
</tr>
<tr>
<td>Compact Fluorescent Bulb</td>
<td>0 – 0.1</td>
</tr>
<tr>
<td>Digital Clock</td>
<td>0 – 8</td>
</tr>
<tr>
<td>Dimmer Switch</td>
<td>0 – 0.8</td>
</tr>
<tr>
<td>Electric Stove</td>
<td>1 – 5</td>
</tr>
<tr>
<td>Gaming Console</td>
<td>0 – 0.5</td>
</tr>
<tr>
<td>Hairdryer</td>
<td>0 – 70</td>
</tr>
<tr>
<td>Laptop Computer</td>
<td>0</td>
</tr>
<tr>
<td>LCD TV</td>
<td>0 – 2.5</td>
</tr>
<tr>
<td>Microwave</td>
<td>1 – 200</td>
</tr>
<tr>
<td>Plasma TV</td>
<td>1.4 – 2.2</td>
</tr>
<tr>
<td>Portable Heater</td>
<td>1 – 40</td>
</tr>
</tbody>
</table>
Sources of Electromagnetic Interference (EMI)

For Pacemakers, Implantable Cardioverter Defibrillators (ICDs), and Heart Failure Devices (CRT-Ds)

Your implanted device is designed to work properly in the presence of most appliances and equipment. Most things you handle or work near every day will not cause a problem. But, some strong electrical or magnetic fields may affect your:

- Pacemaker
- Implantable cardioverter defibrillator (ICD)
- Heart failure device (cardiac resynchronization therapy defibrillator or CRT-D)

**Note:**

If you have an ICD, some strong magnetic fields may cause your device to make beeping tones. If you hear beeping tones from your device you should:

- Immediately move away from the object that may be causing the beeping tones.
- Call your doctor to report the beeping tones.

Attention heart failure patients: Your CRT-D is a special type of implantable cardioverter defibrillator (ICD). All information about interference that applies to ICDs also applies to your heart failure device (CRT-D).

The guidelines in this document will help you understand which items are safe and which to stay away from. This document includes the most common items that cause interference, but may not include every item that you handle or work near.

**Note:**

If you have an ICD, some strong magnetic fields may cause your device to make beeping tones. If you hear beeping tones from your device you should:

- Immediately move away from the object that may be causing the beeping tones.
- Call your doctor to report the beeping tones.

Talk to your doctor if you have more questions about an appliance, tool, medical procedure, or piece of equipment. Be sure to ask your doctor if you should follow any special instructions not listed here. You can also call Boston scientific Technical Services at 1-800-CARDIAC (1-800-227-3422).

**Sources of Electromagnetic Interference Listed by Category:**

- Personal Items
- Kitchen and Household Items
- Do-It-Yourself Items
- Entertainment Items
- Travel and Environment
- Medical Procedures
- Miscellaneous

www.bostonscientific.com
**Personal Items**

### Safe

**Copy machines** - There are no known or reported interactions.

**Cordless phones** - There are no known or reported interactions. However, you should avoid placing your household cordless phone receiver directly over your implanted device.

**Electric blankets** - There are no known or reported interactions.

**Electric razors** - There are no known or reported interactions.

**Fax machines** - There are no known or reported interactions.

**Hair dryers** - There are no known or reported interactions.

**Hand-held massagers** - There are no known or reported interactions. Do not place directly over your implanted device.

**Heating pads** - There are no known or reported interactions.

**Pagers** - There are no known or reported interactions.

**Patient alert devices** - There are no known or reported interactions.

**Personal computers** - There are no known or reported interactions.

**Personal digital assistants (PDAs)** - There are no known or reported interactions.

**Radio-controlled clocks and watches** - There are no known or reported interactions. These watches and alarm clocks automatically adjust themselves to a time-norm signal transmitted by radio signal. The watches serve only as receivers.

**Tanning beds** - There are no known or reported interactions. Depending on how long it has been since implant, your doctor may recommend putting something over the implant site to protect the incision.

**Tattoos** - There are no known or reported interactions.

**Thermolysis (hair removal)** - There are no known or reported interactions.

### Precaution

**Cell phones** - In certain cases, a cellular phone could affect an ICD or pacemaker’s operation if it is closer than 6 inches (15 cm) to the implanted device. This interaction is temporary, and moving the phone away from the implanted device will return it to proper function. To reduce the chance of any interaction, follow these precautions:

- Maintain a distance of at least 6 inches (15 cm) between the cellular phone and the implanted device; if the phone transmits more than 3 watts, increase the distance to a minimum of 12 inches (30 cm)
- Hold the cellular phone on the opposite side of the body from the implanted device
- Don’t carry a cellular phone in a breast pocket or on a belt if it places the phone within 6 inches (15 cm) of the implanted device

These precautions apply only to cellular phones, not to household cordless phones.

### Avoid

**Body-fat measuring scales** - Not recommended for use by patients with a pacemaker or an ICD.

**Electrolysis (hair removal)** - Not recommended for use by patients with a pacemaker or an ICD.

**Magnetic mattresses/chairs** - Not recommended for use by patients with a pacemaker or an ICD. Several magnetic-mattress/chair manufacturers recommend not using if you have a pacemaker or an ICD.
## Kitchen and Household Items

### Safe

- **Blenders** - There are no known or reported interactions.
- **Can openers** - There are no known or reported interactions.
- **Clothes dryers** - There are no known or reported interactions.
- **Convection ovens** - There are no known or reported interactions.
- **Electric brooms** - There are no known or reported interactions.
- **Electric knives** - There are no known or reported interactions.
- **Electric ovens** - There are no known or reported interactions.
- **Food processors** - There are no known or reported interactions.
- **Gas ovens** - There are no known or reported interactions.
- **Microwave ovens** - There are no known or reported interactions.
- **Pest control systems** - There are no known or reported interactions. Some manufacturers of pest control systems advertise the use of magnetic or ultrasound waves to repel rodents. They operate below levels that would affect implanted devices.
- **Portable space heaters** - There are no known or reported interactions.
- **Sewing machines** - There are no known or reported interactions.
- **Toasters** - There are no known or reported interactions.
- **Vacuum cleaners** - There are no known or reported interactions.
- **Washing machines** - There are no known or reported interactions.

### Precaution

**Induction ovens** - Induction ovens can create large magnetic fields that could potentially deactivate or temporarily inhibit an ICD. Pacemakers could have an issue with “magnet rate” pacing. Effects are only temporary. Recommend maintaining at least a 12-inch (30-cm) separation between the oven and your implanted device.

### Avoid

None
Do-It-Yourself Items

Safe

None

Precaution

**Arc welding equipment** - Recommend maintaining at least a 24-inch (61-cm) separation between the cables, arc, transformer, and your implanted device.

- Keep all cables straight, close together, and extending away from the body
- Wear dry, nonconductive gloves
- Do not weld alone
- Do not weld with rapidly repeating short bursts; wait a few seconds between welds
- If you experience symptoms of faintness, dizziness, nausea, etc., stop immediately and step away from the area or turn off the equipment

Use extreme caution if welding energy exceeds the following values:
- 100 amps for TIG/MIG welding
- 250 amps for AC arc welding
- 250 amps for plasma welding
- 350 amps for DC arc welding

**Battery-powered, cordless power tools** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Car engine repair** - Alternators create magnetic fields, which could potentially deactivate or temporarily inhibit an ICD. Pacemakers are also affected by magnetic fields, but any effect will be temporary by moving away from the source of the magnetic field. Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device. Avoid leaning directly over the alternator of a running car engine.

**Chain saws** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Drills** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Electric screwdrivers** - Recommend maintaining at least a 12-inch (30-cm) separation between the screwdriver and your implanted device.

**Hedge clippers** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**High-power generators** - Recommend maintaining at least a 36-inch (3 feet/91 cm) separation between the generator and your implanted device.

**Jigsaws** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Lawn mowers** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Leaf blowers** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Running motors and alternators** - Alternators create magnetic fields, which could potentially deactivate or temporarily inhibit your ICD. Pacemakers are also affected by magnetic fields, but any effect will be temporary by moving away from the source of the magnetic field. Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device. Avoid leaning directly over the alternator of a running car engine.

**Small motor repair** - Alternators create magnetic fields, which could potentially deactivate or temporarily inhibit your ICD. Pacemakers are also affected by magnetic fields, but any effect will be temporary by moving away from the source of the magnetic field. Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device. Avoid leaning directly over the alternator of a running car engine.

**Snow blowers** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Soldering guns** - Recommend maintaining at least a 12-inch (30-cm) separation between the soldering gun and your implanted device.

Avoid

**Jackhammers** - Mechanical pressure of large hammers can damage your implanted device and/or leads. The device may sense electromagnetic interference from small hammers, thus generating inappropriate therapy. Not recommended for use by patients with pacemakers or ICDs.
## Entertainment Items

### Safe

- **AM/FM radios** - There are no known or reported interactions.
- **CD/DVD players** - There are no known or reported interactions.
- **Hot tubs/Jacuzzis** - There are no known or reported interactions. Patients with heart conditions often will have medical restrictions. Patients should contact their doctor for medical approval. Your medical condition may not permit this activity; however, it will not harm your implanted device.
- **Laser tag** - There are no known or reported interactions.
- **Remote controls (TV, stereo, garage door, video equipment, cameras)** - There are no known or reported interactions.
- **Televisions** - There are no known or reported interactions.
- **VCRs** - There are no known or reported interactions.
- **Video games** - There are no known or reported interactions.

### Precaution

- **Bingo wands** - Recommend maintaining at least a 6-inch (15-cm) separation between the wand and your implanted device.
- **CB/police radio antennas** - Recommend maintaining at least a 24-inch (61-cm) separation from your implanted device.
- **Remote controls with antennas** - Recommend maintaining at least a 12-inch (30-cm) separation between the antenna and motor and your implanted device.
- **SCUBA diving** - Patients with heart conditions often will have medical restrictions. Patients should contact their doctor for medical approval. Boston scientific devices are tested up to 1.36 atmospheres gauge pressure, which is 2.36 atmospheres absolute pressure. 2.36 atmospheres absolute pressure = diving depth of 45 feet (14 m). Please contact Boston scientific Technical Services at 1-800-CARDIAC (1-800-227-3422) for details about your specific device model.
- **Slot machines** - Recommend maintaining at least a 12-inch (30-cm) separation from your implanted device.
- **Stereo speakers** - Recommend maintaining at least a 12-inch (30-cm) separation from your implanted device.

### Avoid

- **None**
# Travel and Environment

## Safe

**Amusement parks/roller coasters** - There are no known or reported interactions.

## Precaution

**Airport security systems** - Before boarding an aircraft, you will be asked to walk through a metal detector archway that emits a small amount of electromagnetic energy. This will not affect your implanted device. However, the metal of the device may cause the security archway to sound an alarm. The security archway will not harm your implanted device. In this case, tell security staff that you have an implanted device and show them your Medical Device Identification card.

Security staff may then request to use the hand-held wand type of metal detector. If possible, ask to be hand-searched instead of using a handheld wand. If a wand must be used, inform the security staff that you have an implanted device. Ask them not to hold the metal detector near the device any longer than is absolutely necessary; or, ask for an alternative form of personal search. A hand search is recommended.

If you have an ICD, airport security wands could temporarily affect your device. If you have any concerns about your exposure to electromagnetic interference, call your doctor.

*Note:* If you have an ICD, some strong magnetic fields may cause your device to make beeping tones. If you hear beeping tones from your device, you should:

- Immediately move away from the object that may be causing the beeping.
- Call your doctor to report the beeping.

**Residential power generators** - Recommend maintaining at least a 36-inch (3 feet/91 cm) separation between the generator and your implanted device.

**High-voltage lines** - No device interaction if traveling in the vicinity of high power lines. If your job requires you to be next to high power lines, check with your company’s safety board to gain clearance to work in that area. If you live next to high power lines, please consult your doctor.

**Radio frequency transmitters** - Recommend maintaining at least a 12-inch (30-cm) separation between the motor and your implanted device.

**Theft detection systems** - Interference has been noted when in close proximity to the detection poles. Recommendations:

- Walk through the systems at a normal pace, without pausing or lingering near the equipment
- Be aware that systems may be hidden or camouflaged in many commercial establishments, in entrances and exits where they are not readily visible
- Do not stay near the system or metal detector longer than is necessary, and do not lean against the system

**Theft tag deactivation** - The special tags attached to store merchandise as part of theft detection systems are deactivated at the checkout counter by either running the merchandise over a scanner or using a hand-held deactivator. This deactivator works via magnetic fields. Some tag deactivation systems have been shown to cause interference with ICDs at close range. Recommend maintaining a distance of at least 20 inches (51 cm) between the tag deactivator and your ICD.

**Transformers** - Recommend maintaining at least a 12-inch (30-cm) separation between the transformer and your implanted device.

**TV or radio towers** - No device interaction if traveling in the vicinity of TV or radio towers. If your job requires you to be near or on TV or radio towers, check with your company’s safety board to gain clearance.

## Avoid

**None**
**Medical Procedures**

**Safe**

CT scans - There are no known or reported interactions.

Dental drills - There are no known or reported interactions.

Diagnostic x-rays - There are no known or reported interactions.

Electrocardiogram (ECG) - There are no known or reported interactions.

Ultrasound - There are no known or reported interactions.

**Precaution**

Electrocautery - This equipment is used during surgical procedures to stop blood vessels from bleeding. It should be used only when your implanted device is turned off.

High-energy radiation - Therapeutic radiation treatment for cancer can affect your implanted device and will require special precautions. If you should need radiation treatment, talk with your doctor about any special precautions to protect your implanted device.

TENS - TENS is prescribed by doctors or chiropractors for control of chronic pain. A TENS unit can affect your implanted device and will require special precautions. If TENS must be used, talk with your doctor about any special precautions to protect your implanted device.

**Avoid**

Diathermy - This procedure uses an electrical field to apply heat to tissues in the body and could damage your implanted device. ICDs should be turned off during this procedure. If diathermy must be used and you have either a pacemaker or an ICD, talk with your doctor about any special precautions to protect your implanted device.

Magnetic resonance imaging (MRI) - This diagnostic test uses a strong electromagnetic field. MRI scans can severely damage your pacemaker or ICD and should not be performed on a patient with an implanted device. Hospitals keep MRI equipment in rooms marked with signs that indicate magnets are inside. Do not go inside these rooms.
# Miscellaneous

## Safe

**Air purifiers** - There are no known or reported interactions.

**Electric invisible fences** - There are no known or reported interactions.

**House arrest devices** - There are no known or reported interactions. However, recommend maintaining at least a 12-inch (30-cm) separation from your implanted device.

**Polygraphs** - There are no known or reported interactions.

## Precaution

**Magnetic fields (general)** - Magnetic fields greater than 10 gauss will affect both pacemakers and ICDs. If you have any concerns about your exposure to electromagnetic interference, call your doctor.

*Note:* If you have an ICD, some strong magnetic fields may cause your device to make beeping tones. If you hear beeping tones from your device, you should:

- Immediately move away from the object that may be causing the beeping.
- Call your doctor to report the beeping.

## Avoid

**Stun guns** - Not recommended for use by patients with a pacemaker or an ICD.

## Footnotes

1. “Safe” solely refers to the implanted device’s electromagnetic interference with the items listed when used properly in accordance with their given intent. Check with your doctor for any additional restrictions that you may have with respect to these items.

2. Caution should be used when near the items listed. Check with your doctor for detailed information before use.

3. Consult your doctor. The general category of items is listed in the table. For specific branded items, consult the original manufacturer for any interaction with implantable cardioverter defibrillators (ICDs) and pacemakers.