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Task 2: Examination of Specifications and Standards Relating to the Susceptibility of Medical Electronic Devices to Transient Electrical Overstress

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OAK RIDGE NATIONAL LABORATORY

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Instrumentation and Controls Division

TASK 2: EXAMINATION OF SPECIFICATIONS AND STANDARDS RELATING TO THE
SUSCEPTIBILITY OF MEDICAL ELECTRONIC DEVICES TO TRANSIENT
ELECTRICAL OVERSTRESS

J. M. Googe
R. A. Hess
P. D. Ewing
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Date Published: May 1988

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ABSTRACT

This study was undertaken to address the U.S. Army's concern for the safe operation of the Harry Diamond Laboratories (HDL) electromagnetic pulse (EMP) simulation facilities, which in turn led to concern for the safety of medical electronics equipment in general and medical electronic device wearers in particular. The main concerns of this study are the standards and regulations that address the susceptibility of these types of electronic devices to transient electrical overstress. The study revealed no standards, regulations, or industry-wide guidelines that deal with the susceptibility of medical electronics to EMI from radiative sources. The standards sought in this task do not exist, nor have any reached the stage of development to be accessible in the literature. Furthermore, the agencies that usually publish such standards have none ready for release at this time. In the course of this study it was found that the process of forming a community of interested professionals is under way but has not advanced to the point where it can provide acceptable industry standards and regulations.

EXECUTIVE SUMMARY

This study was undertaken to address the U.S. Army's concern for the safe operation of the Harry Diamond Laboratories (HDL) electromagnetic pulse (EMP) simulation facilities, which in turn led to concern for the safety of medical electronics equipment in general and medical electronic device wearers in particular. The main concerns of this study are the standards and regulations that address the susceptibility of these types of electronic devices to transient electrical overstress.

An on-line information retrieval service provided by the Oak Ridge National Laboratory (ORNL) libraries was used extensively in this study. This service allowed interactive search and retrieval of information from more than 200 bibliographic data bases. After review of the findings from the data base search, contact was made with those institutions and authors thought to be closely related to the concerns of this study.

The literature is rich with papers on electromagnetic interference (EMI), EMP, and related topics, but little of it deals with the susceptibility of medical electronics to transient electromagnetic fields. Further, the search revealed no standards, regulations, or industry-wide guidelines that deal with the susceptibility of medical electronics to EMI from radiative sources. Since standards or regulations of the type sought were not found, references judged to be most closely related to medical electronics susceptibility were identified and are included in the bibliography (Appendix 3).

The standards and regulations that do exist establish limits on radiated energy from electronic equipment of all types and are applicable to all medical instruments. It should be noted that design practices to reduce radiated emissions will also reduce the susceptibility of an instrument to outside sources of EMI. However, EMI susceptibility is not defined or codified in existing standards.

The standards sought in this task do not exist, nor have any reached the stage of development to be accessible in the literature. Furthermore, the agencies that usually publish such standards have none ready for release at this time. In the course of this study it was found that the process of forming a community of interested professionals is under way but has not advanced to the point where it can provide acceptable industry standards and regulations.

1. INTRODUCTION

This study was conducted to address the U.S. Army's concern for the safe operation of the Harry Diamond Laboratories (HDL) electromagnetic pulse (EMP) simulation facilities, which in turn led to concern for the safety of medical electronics equipment in general and medical electronic device wearers in particular. The main concerns of this study are the standards and regulations that address the susceptibility of these types of electronic devices to transient electrical overstress. In the past decade the proliferation of electronic systems that not only emit but are susceptible to radio frequency (rf) energy has received a great deal of attention by both industry and government.¹

Medical instrumentation utilizes electronic devices, circuits, and systems common to all classes of instrumentation and therefore responds to electromagnetic (EM) excitation in the same way as non-medical electronics. This study surveyed information about the medical electronic industry in order to find standards, regulations, or guidelines that pertain to the design of medical electronics. The standards, regulations, and guidelines found were then reviewed to determine whether they addressed the Army's concern for the susceptibility of medical electronics to electromagnetic interference (EMI). (EMP is only one type of EMI that is of concern to the Army.)

Electromagnetic pulses (EMPs) are produced by the explosion of nuclear weapons and by other means such as lightning, switch transients in lights, tv high-voltage supplies, and pulsed radar. The magnitudes and frequency spectra of the EMP field produced depend on the size of the weapon and the position of the explosion in the atmosphere. An explosion at high altitudes generates EMP (HEMP) with electric fields greater than 50 kV/m and a broadband frequency spectrum. The HEMP propagates through the atmosphere as EM plane waves, covering a very large area. The HEMP and its associated electrical transients affect the operation and safety of all electrical and electronic systems through the well-known mechanisms by which electromagnetic fields interact with physical systems.²⁻⁴

The effects of EMP have been studied for more than four decades, and procedures and techniques have been devised to harden devices, circuits, and systems against EMP.⁴ Simulators have been built for experimental evaluation and study of the effects of EMP on electronic systems, and verification of hardening techniques.

EMP fields are similar to fields of other EM sources. Lightning is similar to EMP, with the exception that fields produced by lightning are believed to have smaller magnitudes and narrower frequency spectra.⁴ Electromagnetic fields from radio, television, and radar transmitters have frequency spectra that partially overlap the EMP spectrum. However, these fields are periodic, whereas EMP is a single

pulse. Also, EMP differs from other EM fields in magnitude, wave shape in the time domain, and spectral shape in the frequency domain. However, the physics of EMP and EM fields are the same, as is the methodology for shielding against such fields.² Most of the concern discussed in the open literature focuses on modeling EM environments and on the methodologies for designing electronic systems to operate in these postulated environments.⁵

2. APPROACH

The objective of this study was to locate and evaluate current and pending standards, regulations, and specifications that pertain to the transient electrical overstress susceptibility of medical electronic devices. Therefore, the following definitions by M. H. Ropacholi, Chief Scientist of Australia's Royal Adelaide Hospital,⁶ were helpful in directing the search:

"A standard is a general term incorporating both regulations and guidelines, and is defined to be a set of specifications or rules to promote the safety of an individual or group of people. A regulation is promulgated under a legal statute and is referred to as a mandatory standard. A guideline generally has no legal force and is issued for guidance only - a voluntary standard. Standards can specify maximum exposure limits and other safety rules for personal exposure, or provide details on the performance, construction, design or functioning of a device."

An on-line information retrieval service provided by the Oak Ridge National Laboratory (ORNL) libraries was used extensively in this study. This service allowed interactive search and retrieval of information from more than 200 bibliographic data bases. Summaries of some of the data bases used in this study are contained in Appendix 1, which was taken from the Directory of Online Databases.⁷ The following data bases were searched in this study:

BRS STDS Database
Energy Database, Department of Energy
Defense Technical Information Center (DTIC) Database, Department
of Defense
Dialog Information Services database
National Technical Information Service Database
Federal Register Database
INSPEC (Corp. IEE) Database
MEDLINE Database
Occupational Safety and Health (NIOSH) Database
COMPENDEX Database
EI ENGINEERING MEETINGS Database
LC MARC Database
BIOSIS PREVIEWS Database
STANDARDS AND SPECIFICATIONS Database
CHEMICAL ABSTRACTS Database, STN International CA File

Appendix 2 contains selected abstracts on the effects of EMP on cardiac pacemakers. After a review of the findings from the database search, contact was made with those institutions and authors whose work was thought to be closely related to the concerns of this study. The outcome of the review and the telephone contacts is discussed below.

3. FINDINGS

The literature is rich in papers on EMI, EMP, and related topics, but little of it deals with the susceptibility of medical electronics to transient electromagnetic fields. Further, there were no standards, regulations, or industry-wide guidelines that dealt with the susceptibility of medical electronics to EMI from radiative sources. Since standards or regulations of the type sought were not found, references judged to be most closely related to susceptibility of medical electronics were identified and are included in the bibliography (Appendix 3).

In the course of this study it was found that the process of forming a community of interested professionals is under way but has not advanced to the point where it can provide acceptable industry standards and regulations.⁸⁻¹³

4. DISCUSSION

References and correspondence from the Association for the Advancement of Medical Instrumentation (AAMI) provided the most revealing evidence as to the state of affairs concerning regulations and standards for medical electronics.¹⁴ The AAMI develops standards and recommended practices through a system of committees representing a national cross section of interested parties. Among the AAMI publications is the *Standards Monitor*,¹⁵ which reviews standards and recommended practices and solicits public comment and interaction. The AAMI Committee on Electrical Safety is the body most likely to generate standards concerning EMI susceptibility. The chairman of the AAMI Electrical Safety Committee, Dr. William S. Staewen (Clinical Engineering Director at Sinai Hospital of Baltimore), provided information supporting the findings that no standards or regulations on the susceptibility of medical electronics to transient electromagnetic fields currently exist or are pending.¹⁶

Under contract to the Federal Drug Administration (FDA) in the mid-1970s, the AAMI prepared a draft pacemaker standard⁹ with a section (Sect. 3.4.8) on EMC performance requirements. Several drafts of this standard were circulated but none were approved by the committee, the AAMI, or the FDA.¹⁷ However, the material in this defunct document is of interest because it is one of the few existing documents that addresses the subject by defining an environment or exposure level, a test method, and a performance requirement.

The literature most relevant to this study has been produced by the community of electronic designers interested in shielding equipment against the environment as established by FCC Regulations (Parts 15 and 18) and DOD Military Specifications (MIL-STD-461C and 462). Much of this literature has been published by the Institute of Electrical and Electronic Engineers (IEEE) Transactions for Electromagnetic Compatibility (EMC). This publication, which was established in 1958, celebrated its 25th anniversary by publishing an index of the transactions for 1959 through 1982.⁸ The IEEE Transactions on Medical Electronics and numerous other related professional periodicals focusing on this subject were also searched. No standards, regulations, or guidelines dealing with susceptibility of medical electronics were found in these publications.

Generally, the standards and regulations issued by the Federal Communications Commission (FCC) deal with EM emissions from electronic equipment.¹⁸ Department of Defense (DOD) military specifications deal with both emissions from and susceptibility to EM fields.^{19,20} These documents are generally used by electronic design engineers to establish design parameters required for government procurement. An industry consisting of educational institutions, equipment manufacturers, testing laboratories, and professional specialists works on compliance with EMI standards and regulations. However, these

standards and regulations are applicable only to equipment being procured by the government and do not address the medical industry. MIL-STD-461C covers the requirements and test limits for measurement of EMI characteristics of electronic equipment, and MIL-STD-462 gives the test methods to be used in doing the tests required by MIL-STD-461C. The test specification and the limits to which the tests are performed are determined by the EM environment in which the electronic equipment must operate. Not all tests called out in MIL-STD-461C are required by all equipment; rather, the amount of testing required is dependent on how and where the equipment is being used. A manufacturer of medical electronic equipment might use some or all of these tests to assure that his equipment operates properly in a particular environment, but there are no regulations to require that this is done.

The Underwriters' Laboratories (UL), Inc., in addition to having published standards that are listed in the catalog of Industrial Standards,²¹ recently advertised a new EMI compliance testing service in a letter signed by UL's EMI Service Coordinator.²² In a conversation with UL personnel, it was stated that the services provided are limited to FCC Parts 15 and 18 compliance, and that UL is not prepared to test or discuss EMI susceptibility testing or standards.

The UL has prepared a proposed First Edition of the Standard for Home Health Care Signaling Equipment, UL 1637 (P).²³ The draft of UL 1637 was first presented in a bulletin dated May 27, 1983, and another draft was issued in October 1985. These drafts describe electrical transient tests for both internally and externally induced transients and extraneous transients. The externally induced transient is described as a 6000-V peak transient with a rise time of less than 0.5 μ s produced by a transient generator or surge generator whose design is specified in UL 1637 (P). This surge generator is connected directly to the power input line of the device under test. The extraneous transients in UL 1637 (P) are to be generated by a Jacob's ladder spark gap device placed near the device under test. The device under test (the signaling unit) is required not to generate false signals when subjected to extraneous transients from the spark gap transmitter. This proposed standard has not been adopted, nor is it expected to be adopted in the near future.

Representatives of the Electronic Industries Association (EIA) of Japan, which is charged with developing guidelines for designing medical instruments with respect to EMI, visited Sinai Hospital, Baltimore, and provided material to the hospital staff that describes the technical requirements EIA is considering for Japanese industry standards.²⁴ These requirements deal with EMI emissions and not with susceptibility. The results of a survey by another Japanese investigator, Dr. Noriaki Ono,²⁵ are more relevant as they concern mutual interference by medical electronic equipment in the hospital environment. However, thus far, this survey has not led to development of standards for the susceptibility of medical electronics.

The Guide to Biomedical Standards,²⁶ 13th Edition, is a directory of U.S., international, and foreign standards that control or regulate medical equipment and hospitals. This publication contains a considerable amount of information but does not include any standards specifically directed at controlling the EMI susceptibility of medical electronic devices.

A standard for cardiac monitors has been issued by the American National Standards Institute (ANSI). This standard, designated ANSI/AAMI EC13-1983,¹⁰ does not deal with EMI susceptibility. The following section from ANSI/AAMI EC13-1983 is included here to illustrate the approach of the Formulating Committee toward the EMI problem.

A3.26.2. 60-Hz Tolerance. The QRS detection circuitry of the monitor should reject a reasonable amount of the most commonly encountered noise in the clinic; otherwise, improper heart rate detection would occur in too many instances. The 100-uV p-p minimum reflects a signal-to-noise ratio of 5:1.

Noise at frequencies other than power line frequency-random noise-results from several factors, including the myoelectric potentials from the patient. Random noise is generally lower in amplitude than 60-Hz noise and can be reduced substantially by the use of proper recording techniques. Slow baseline variations can almost always be eliminated by proper electrode application. Unfortunately, there are few hard data available regarding the amplitude and frequency distributions of random noise over a wide spectrum of patients and environment, and therefore a realistic test method could not be developed.

On this basis, the committee decided not to attempt to specify performance in the presence of random noise. The performance requirement for 60-Hz noise tolerance will give some assurance of the device's capability in this regard. Voluntary disclosure of 60-Hz and/or random noise tolerance capability by the device manufacture is encouraged, provided that a description of the random noise tolerated by the instrument is included to allow testing for verification; the basis for the particular noise characteristic chosen should be described.

The International Organization for Standardization (ISO), a worldwide federation of national standards, has issued ISO 5841, "Implants for Surgery - Cardiac Pacemakers".¹³ This standard does not address EMI susceptibility.

The major topics treated in the literature on EMI susceptibility are those of biological effects. The technically advanced nations of the world are trying to establish safe levels of non-ionizing radiation for various living organisms under somewhat more normal conditions than those associated with the EMP environment^{12,27}. As these studies mature and some consensus of safe limits is reached, it is reasonable to expect standards and regulations for living subjects to follow. These standards will be helpful in establishing limits for electronic medical instrumentation and devices that will be required to operate in the same environment.

The potential adverse effects of electromagnetic radiation on all types of cardiac pacemakers has been recognized for years. The various types of pacemakers and their susceptibility to EMI is reported in the literature.¹³ The pacemaker is the only medical electronic device to receive a high level of interest, but no standards or regulations concerning susceptibility of pacemakers to radiated energy have been adopted. A very good section on "Implanted Electronic Cardiac Pacemaker Interference" is in Chapter 13 of Biological Effects and Health Implications of Radiofrequency Radiation.²⁸ It concludes that there have been only ten documented cases of implanted pacemakers affected by EMI. None of the cases was serious and none fatal. This is directly attributed to the improved shielding and filtering incorporated into the design of modern pacemakers by manufacturers.

5. CONCLUSIONS

There are no specific standards, regulations, or industry-wide guidelines dealing with the susceptibility of medical electronics to EMI from any radiated source. The standards and regulations that do exist establish limits on radiated energy from electronic equipment of all types and are applicable to all medical instruments. It should be noted that design practices to reduce radiated emissions will also reduce the susceptibility of an instrument to outside sources of EMI. However, EMI susceptibility is not defined or codified in existing standards.

The standards sought in this study do not exist, nor have any reached the stage of development to be accessible in the literature. Furthermore, the agencies that usually publish such standards have none ready for release at this time. The process of forming a community of interested professionals is under way but has not advanced to the point where it can provide acceptable industry standards and regulations.⁸⁻¹³

In the absence of standards, regulations, and guidelines, a possible source of information on the susceptibility of medical electronics to transient electromagnetic fields is manufacturer's design criteria. Since this information is not available in the open literature, to determine what EMI criteria are used by manufacturers in the design of medical electronics would require a visit to each manufacturer. This information would probably be documented in detail by large companies that have in-house quality assurance (QA) programs, because such programs tend to at least address the concern of EMI susceptibility of the equipment under design. Smaller companies may not have this information fully documented. Whether a company will divulge the criteria they use in their design is an open question, since some companies may consider design criteria to be proprietary information. The determination of manufacturer design criteria was beyond the scope of this study but could be the subject for a future study whose results, however, probably would be limited in scope and value.

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APPENDIX 1

Summaries of Selected Data Bases

Source: Directory of Online Databases, Vol. 8, No. 3,
Cuadra/Elsevier, New York, 1987.

‡ BIOSIS PREVIEWS[®]**Type:** Reference (Bibliographic)**Subject:** Life Sciences**Producer:** BioSciences Information Service (BIOSIS)**Online Service:** BRS; BRS After Dark; BRS/BRKTHRU; BRS/Colleague; Central Institute for Scientific and Technical Information; CISTI, Canadian Online Enquiry Service (CAN/OLE); Council of Scientific Research, Scientific Documentation Center; DATA-STAR; DIALOG Information Services, Inc.; DIMDI; ESA-IRS; The Japan Information Center of Science and Technology (JICST); STN International; University of Tsukuba (no longer available through Knowledge Index and Mead Data Central, Inc.)**Conditions:** CISTI accessible only in Canada; access through University of Tsukuba limited to affiliates of the University of Japan.**Content:** Contains about 5 million citations, with abstracts, to the worldwide literature on research in the life sciences: microbiology; plant and animal science; experimental medicine; agriculture; pharmacology; ecology; biochemistry; bioengineering; and biophysics. Covers original research reports, reviews of original research, history and philosophy of biology and biomedicine, and documentation and retrieval of biological information. Also covers patents in such areas as immunological testing, food processes, and fishing. For each patent record, includes inventor's name and address, patent title and number, patent classes, date granted, and assignee. Approximately 9000 periodicals, as well as books, patents, monographs, conference proceedings, research communications, and symposia are screened. Corresponds in coverage to *Biological Abstracts* (BA) and *Biological Abstracts/RRM* (BA/RRM) (formerly *BioResearch Index*).

NOTE: Abstracts from July 1976 to date (from BA on Tape) are available online through BRS, DATA-STAR, DIALOG, DIMDI, ESA-IRS, and STN International. Abstracts from 1976 to date are available through Central Institute for Scientific and Technical Information. Abstracts from 1982 to date are available through CISTI.

Language: English**Coverage:** International**Time Span:** CISTI, DIALOG, ESA-IRS, STN International, and Tsukuba, 1969 to date; BRS, BRS After Dark, BRS/BRKTHRU, BRS/Colleague, DATA-STAR, and DIMDI, 1970 to date; Central Institute for Scientific and Technical Information, 1978 to date; JICST, 1979 to date; Council of Scientific Research, 1984 to date.**Updating:** About 20,000 records from BA a month; about 20,000 records from BA/RRM a month.**CA SEARCH[®]****Type:** Reference (Bibliographic)**Subject:** Chemistry**Producer:** Chemical Abstracts Service (CAS)**Online Service:** BRS; BRS After Dark; BRS/BRKTHRU; BRS/Colleague; CISTI, Canadian Online Enquiry Service (CAN/OLE) (CAS); DATA-STAR (CHEM); DIALOG Information Services, Inc. (CA SEARCH); ESA-IRS (CHEMABS); The Japan Information Center of Science and Technology (JICST) (CA SEARCH); ORBIT Search Service (CAS); STN International (CA FILE); TECH DATA; Telesystemes-Questel (CAS)**Conditions:** CISTI accessible only in Canada**Content:** Contains citations to the worldwide literature in chemistry: organic, analytical, physical, applied, macromolecular, biochemical, and chemical engineering. Covers journal articles, monographs, conference proceedings, technical reports, dissertations, and patents. Contains bibliographic information and keyword index entries from the printed *Chemical Abstracts* and CAS-assigned subject terms and Registry Numbers.

NOTE: Through DIALOG, Telesystemes-Questel, ORBIT, and STN, users can retrieve systematic names by transferring retrieved Registry Numbers to the REGISTRY NOMENCLATURE AND STRUCTURE SERVICE (see). Backfiles of citations only are available through BRS (for 1970-1976) and CISTI (for July 1973-1976) under the name CA CONDENSATES.

NOTE: On STN International, contains some abstracts from 1967 to mid-1975 and all abstracts from mid-1975 to date.

Language: English**Coverage:** International**Time Span:** DATA-STAR, DIALOG, ESA-IRS, ORBIT, STN International, and Telesystemes-Questel, 1967 to date; BRS, BRS After Dark, BRS/BRKTHRU, BRS/Colleague, CISTI, and JICST, 1977 to date.**Updating:** BRS, BRS After Dark, BRS/BRKTHRU, BRS/Colleague, and CISTI, about 40,000 records a month; DATA-STAR, DIALOG, ESA-IRS, JICST, ORBIT, STN International, and Telesystemes-Questel, about 19,000 records every 2 weeks.**‡ COMPENDEX[®] (Computerized Engineering Index)****Type:** Reference (Bibliographic)**Subject:** Engineering**Producer:** Engineering Information, Inc.**Online Service:** BRS; BRS/BRKTHRU; BRS/Colleague; Centre de Documentation de l'Armement (CEDOCAR); CISTI, Canadian Online Enquiry Service (CAN/OLE) (EI); DATA-STAR; DIALOG Information Services, Inc.; ESA-IRS; Knowledge Index (ENGINEERING LITERATURE INDEX); ORBIT Search Service; STN International; TECH DATA (no longer available through Pergamon InfoLine)**Conditions:** CISTI accessible only in Canada**Content:** Contains about 1.7 million citations, with abstracts, to the worldwide literature (excluding patents) in engineering and technology. Fields of engineering include: civil, water and waterworks, sanitary and waste, fuel, bioengineering, geology and mining, petroleum, metallurgical, mechanical, industrial, aerospace, automotive, marine, railroad, electrical, electronics and communications control, chemical, and agricultural. Related subject areas covered include construction materials, properties and testing of materials, transportation, pollution, ocean and underwater technology, nuclear technology, fluid flow, heat and thermodynamics, computers and data processing, light and optical technology, sound and acoustical technology, food technology, applied physics, instruments, measurements, and information science. Conference review records contain conference code numbers which are links to complete coverage of all individual papers in *EI ENGINEERING MEETINGS* (see). Corresponds to *The Engineering Index Monthly*.**Language:** Primarily English, with about 30% of the documents in other languages; all abstracts in English.**Coverage:** International**Time Span:** ESA-IRS and STN, 1969 to date; DIALOG and ORBIT, 1970 to date; CISTI, 1970 to date, with abstracts from 1982 to date; CEDOCAR, 1973 to date; Knowledge Index, 1975 to date; BRS, BRS/BRKTHRU, BRS/Colleague, DATA-STAR, and TECH DATA, 1976 to date.**Updating:** About 12,000 records a month**Ei ENGINEERING MEETINGS[®]****Type:** Reference (Bibliographic)**Subject:** Conferences & Meetings; Engineering**Producer:** Engineering Information, Inc.**Online Service:** Centre de Documentation de l'Armement (CEDOCAR) (Ei ENGINEERING MEETINGS); CISTI, Canadian Online Enquiry Service (CAN/OLE) (EiM); DATA-STAR (EiEM); DIALOG Information Services, Inc. (Ei ENGINEERING MEETINGS); ORBIT Search Service (EiMET); STN International (MEET)**Conditions:** CISTI accessible only in Canada**Content:** Contains about 435,000 citations, with abstracts (since January 1985); to published proceedings from approximately 2000 engineering and technical conferences, symposia, meetings, and colloquia held worldwide. Each meeting is referenced in a main record; all papers are referenced individually. Each record includes a complete bibliographic reference, conference sponsor and location, language, date held, and assigned index terms. Covers a wide variety of engineering disciplines including civil, environmental, geological, bioengineering, electrical and electronics, mechanical, nuclear, agricultural and food, metals and mining, industrial management, petroleum and fuel, control devices and principles, communication engineering, applied mathematics and physics, information science, automotive, and aerospace. Beginning in July 1982, review abstracts of conferences are also contained in COMPENDEX (see).**Language:** Primarily English**Coverage:** International**Time Span:** July 1982 to date, with selected coverage of meetings from 1979 to June 1982**Updating:** About 9000 records a month; total of about 2000 meetings a year.*Source: Directory of Online Databases, Vol. 8, No. 3, Cuadra/Elsevier, New York, 198

FEDERAL REGISTER ABSTRACTS®**Type:** Reference (Bibliographic)**Subject:** Legal & Regulatory-U.S. Federal**Producer:** National Standards Association**Online Services:** BRS (to be available in 1987); BRS After Dark (to be available in 1987); BRS/BRKTHRU (to be available in 1987); BRS/Colleague (to be available in 1987); DIALOG Information Services, Inc. (FEDERAL REGISTER ABSTRACTS); ORBIT Search Service (FEDREG)**Content:** Contains abstracts of each document published in the *Federal Register* (FR). Covers regulations and proposed rules to the *Code of Federal Regulations* (CFR), legal notices, Public Law notices, hearings, meetings, Executive Orders and other Presidential documents carried in the *Federal Register*. Elements of information in each record also include citations to FR page numbers, CFR titles and parts, docket numbers, and other reference material. All records are tagged to identify the document's status, i.e., rule, proposed, notice, etc. Corresponds to the daily CSI *Federal Register Abstracts*.**Language:** English**Coverage:** U.S.**Time Span:** March 1977 to date**Updating:** About 700 records a week**INDUSTRY & INTERNATIONAL STANDARDS®****Type:** Reference (Bibliographic)**Subject:** Engineering; Standards & Specifications**Producer:** Information Handling Services (IHS)**Online Services:** BRS; BRS/BRKTHRU; BRS/Colleague; TECH DATA**Content:** Contains citations to over 78,000 standards produced by U.S., other national, and international agencies and industry standards societies. Also contains references to standards of all societies included in the National Bureau of Standards voluntary engineering standards database. References can be retrieved by document number, title, subject classification (IHS locator code), society, document type, and American National Standards Institute (ANSI) approval indicator. Each record contains a reference to the cartridge and frame location in IHS's VSMF (Visual Search Microfilm Files), which contains the full text of the document.**Language:** Primarily English, French, and German**Coverage:** International**Time Span:** All currently active standards, with earliest data from 1920**Updating:** Every 60 days**INSPEC®****Type:** Reference (Bibliographic)**Subject:** Computer Science; Engineering; Library & Information Science; Physics**Producer:** Institution of Electrical Engineers (IEE)**Online Services:** BRS; BRS After Dark; BRS/BRKTHRU; BRS/Colleague; Centre de Documentation de l'Armement (CEDOCAR); CISTI, Canadian Online Enquiry Service (CAN/OLE); DATA-STAR; DIALOG Information Services, Inc.; ESA-IRS; The Japan Information Center of Science and Technology (JICST); Knowledge Index; ORBIT Search Service; STN International; TECH DATA; University of Tsukuba (no longer available through INKADATA)**Conditions:** CISTI accessible only in Canada**Content:** Contains about 2.8 million citations, with abstracts, to the worldwide literature in physics, electronics and electrical engineering, computers and control, and information technology. Primary coverage is of journal articles and papers presented at conferences, although significant books, technical reports, and dissertations are also included. Topics covered in physics include: mathematical and theoretical physics; electromagnetism and optics; quantum field theory and elementary particle physics; nuclear physics; atomic and molecular physics; gases, fluid dynamics, and plasmas; structural, thermal, mechanical, electrical, magnetic, and optical properties of condensed matter; geophysics; astronomy and astrophysics; and related interdisciplinary topics. Topics covered in electronics and electrical engineering include: circuits and electronics, electron devices and materials; electromagnetics and communication; instrumentation and measurement; and energy and power systems and applications. Topics covered in computers and control include: systems and control theory; control technology; computer programming and applications; and computer systems and equipment. Information technology topics include applications of modern communications and computing to the production, transmission, storage, and interpretation of visual, oral, and digitally encoded information. Hardware coverage includes microcomputers and related peripherals. Corresponds to these publications: *Physics Abstracts*, *Electrical & Electronics Abstracts*, *Computer and Control Abstracts*, and *IT FOCUS: Information Technology Update for Managers*.**Language:** English**Coverage:** International**Time Span:** BRS, BRS After Dark, BRS/BRKTHRU, BRS/Colleague, DIALOG, ESA-IRS, ORBIT, STN, TECH DATA, and Tsukuba, 1969 to date; DATA-STAR 1970 to date; CISTI, 1970 to date with abstracts from 1982 to date; CEDOCAR, 1972 to date; Knowledge Index, 1977 to date; JICST, 1981 to date.**Updating:** About 16,000 records a month**MEDLINE****Type:** Reference (Bibliographic)**Subject:** Biomedicine**Producer:** National Library of Medicine (NLM)**Online Services:** Australian Medicine Network; BRS; BRS After Dark; BRS/BRKTHRU; BRS/Colleague; DATA-STAR; DIALOG Information Services, Inc.; DIMDI (MEDLARS); The Japan Information Center of Science and Technology (JICST); Knowledge Index; Mead Data Central, Inc. (as a MEDIS database (see)); MIC-KIBIC; National Library of Medicine; PaperChase; TECH DATA**Conditions:** Subscription to Mead Data Central required**Content:** Provides access to the worldwide biomedical literature, including research, clinical practice, administration, policy issues, and health care services. Contains references to articles from 3200 journals published in the U.S. and about 70 other countries. Also covers chapters and articles from selected monographs through 1981. Author abstracts (from 1975) are available for about 60% of the citations. Corresponds in part to coverage of *Index Medicus*, *Index to Dental Literature*, and *International Nursing Index*.**Language:** English**Coverage:** International**Time Span:** DIMDI and PaperChase, 1964 to date; Australian Medicine Network, BRS, BRS After Dark, BRS/Colleague, DATA-STAR, DIALOG, Knowledge Index, MIC-KIBIC, and NLM, 1966 to date; JICST, 1972 to date.**Updating:** About 25,000 records a month**MILITARY & FEDERAL SPECIFICATIONS & STANDARDS®****Type:** Reference (Bibliographic)**Subject:** Defense & Defense Industry; Standards & Specifications**Producer:** Information Handling Services (IHS)**Online Services:** BRS; BRS/BRKTHRU; BRS/Colleague; TECH DATA**Content:** Contains citations to over 80,000 active and historical non-classified standards and specifications of the U.S. government. Includes references to Military Standards and Specifications, Federal Standards and Specifications, Joint Army-Navy Specifications, Military Standard Drawings, and Qualified Products Lists (QPLs). References can be retrieved by document number, title, Federal Supply Classification (FSC) code, and subject classification (IHS locator code). Each record contains a reference to the cartridge and frame location in IHS's VSMF (Visual Search Microfilm Files), which contains the full text of the document.**Language:** English**Coverage:** U.S.**Time Span:** Standards currently in effect, with earliest data from 1930**Updating:** BRS, BRS/BRKTHRU, and BRS/Colleague, every 2 weeks; TECH DATA, daily.

NIOSHIC

Type: Reference (Bibliographic)

Subject: Occupational Safety & Health

Producer: U.S. Department of Health and Human Services, Public Health Service, National Institute for Occupational Safety and Health, Priorities and Research Analysis Branch (NIOSH)

Online Service: ARAMIS (a cooperative service of the Swedish Center for Working Life, Swedish National Board of Occupational Safety and Health, and The Swedish National Environmental Protection Board); DIALOG Information Services, Inc. (OCCUPATIONAL SAFETY AND HEALTH); Pergamon InfoLine (NIOSH)

Content: Contains over 130,000 citations, with abstracts, to literature on occupational safety and health from more than 400 journals, monographs, and technical reports. Covers toxicology, epidemiology, pathology and histology, occupational medicine, health physics, injury prevention, ergonomics, biochemistry, physiology and metabolism, industrial hygiene, processes and materials in the work place, behavioral sciences, education and training, and control technology.

Language: English

Coverage: International

Time Span: 1900 to date

Updating: About 3000 records a quarter

TECHNICAL REPORTS DATABASE

Type: Reference (Bibliographic)

Subject: Defense & Defense Industry; Science & Technology

Producer: Defense Technical Information Center

Online Service: Defense Technical Information Center (DTIC)

Conditions: Available only to organizations registered with the U.S. Department of Defense; registration is open to U.S. government agencies and their contractors or grantees.

Content: Contains about 1.3 million citations to reports on the results of U.S. Department of Defense-sponsored scientific and technical research, development, test, and evaluation projects. Covers defense-related subjects (e.g., aeronautics, missile technology, space technology, navigation, and nuclear science) and such scientific and technical topics as biology, chemistry, energy, environmental sciences, oceanography, computer sciences, sociology, and human factors engineering. Corresponds to *Technical Reports Awareness Circular*.

Language: English

Coverage: Primarily U.S.

Time Span: 1953 to date

Updating: Every 2 weeks

† NTIS® (National Technical Information Service)

Type: Reference (Bibliographic)

Subject: Science & Technology

Producer: National Technical Information Service (NTIS)

Online Service: BRS; BRS After Dark; BRS/BRKTHRU; BRS/Colleague; Centre de Documentation de l'Armement (CEDOCAR); CISTI; Canadian Online Enquiry Service (CAN/OLE); DATA-STAR; DIALOG Information Services, Inc.; ESA-IRS;

The Japan Information Center of Science and Technology (JICST); Knowledge Index; ORBIT Search Service; STN International; TECH DATA (no longer available through Mead Data Central, Inc.)

Conditions: CISTI accessible only in Canada

Content: Contains about 1.2 million citations, most with abstracts, to unrestricted technical reports from U.S. and non-U.S. government-sponsored research, development, and engineering analyses. The unpublished U.S. reports are prepared by federal, state, and local agencies and their contractors or grantees. Major areas covered include the biological, social, and physical sciences, mathematics, engineering, and business information. Includes announcements of computer-readable software and data files, U.S. government-owned inventions, selected reprints, federally sponsored translations, and some non-English-language reports. Corresponds to the biweekly publication *Government Reports Announcements & Index (GRA & I)* and in part to the weekly *Abstract Newsletters*.

Language: English

Coverage: Primarily U.S., with some international coverage

Time Span: CISTI, DATA-STAR, DIALOG, ESA-IRS, Knowledge Index, ORBIT, and STN, 1964 to date; BRS, BRS After Dark, BRS/BRKTHRU, BRS/Colleague, and TECH DATA, 1970 to date; CEDOCAR, 1974 to date; JICST, 1981 to date.

Updating: BRS, BRS After Dark, BRS/BRKTHRU, BRS/Colleague, CISTI, ESA-IRS, STN, and TECH DATA, about 5500 records a month; all others, about 2600 records twice a month.

STANDARDS & SPECIFICATIONS

Type: Reference (Bibliographic)

Subject: Standards & Specifications

Producer: National Standards Association

Online Service: DIALOG Information Services, Inc.; ESA-IRS

Content: Contains citations to government and industry standards, specifications and related documents. Covers over 110,000 U.S. and international standardization documents, including Department of Defense (DOD) standards, specifications, military sheet form standards, Air Force-Navy Aeronautical Standards (ANs), Qualified Products Lists (QPLs), and handbooks. Also includes 1400 NATO and related standards; 7600 U.S. General Services Administration (GSA) standards, specifications, Commercial Item Descriptions (CIDs) and QPLs; and 27,300 U.S. standards developed by 432 private organizations such as the American Society for Testing and Materials, Society of Automotive Engineers, Aerospace Industries Association, American National Standards Institute, and Underwriters Laboratories. Each record includes a title and identification number identifying the standard or specification, its issuing organization, Federal Supply Classification code (if applicable), and whether the document has been canceled or superseded. A notation is included if designated as an American National Standard and adopted by the DOD. Also includes vendors of products and services conforming to the standard or specification.

Language: English

Coverage: U.S.

Time Span: Latest issue of all standards and specifications, most of which have been issued since 1960 (earliest date from 1920)

Updating: Monthly, with changes and additions

APPENDIX 2

Abstracts: Effects of EMP on Cardiac Pacemakers

Source: Data Base: Biological Effects of Electromagnetic Pulse,
U.S. Army Laboratory Command, Harry Diamond Laboratories,
Woodbridge, Va., 1987.

APPENDIX 2*

EFFECTS OF EMP ON CARDIAC PACEMAKERS

AUTHOR

AUTHOR: Bond, J. Dancz, J., and Nichols, B.
TITLE: Preliminary Record of Environmental Consideration, VEMPS II
DATE: Jan 26, 1987
SOURCE: SAIC, McLean, VA, pp 72-74, 119-125
NOTES: The impact of EMP simulators on cardiac pacemakers is very minor because employees with cardiac pacemakers are not permitted in areas where simulated EMP's are being generated. The USAF recommends a maximum E-field of 300 V/m for repetitive pulse operation (2-100 pps) in areas unrestricted to cardiac pacemaker wearers. USAF tests show that single EMP exposures do not produce catastrophic failures even at 50 kV/m. Pacemaker problems generally occur with rapid pulse rates. The 1978 Ga. Tech study at HDL by Jenkins and Woody found that none of the 40 units tested (with one noted exception) was affected at a field intensity of 1.35 kV/m. At field strength of 5.0 kV/m about 20% of the units were affected by temporary perturbations in the pacemaker's output. No permanent damage to a pacemaker was observed. Newer pacemakers have been manufactured containing an implanted programmable microcomputer. These may be more sensitive to EMP. A program to determine susceptibility levels is planned, and manufacturers are prepared to improve electromagnetic shielding if needed. Automatic drug dispensers and pain eliminators will also be included. Federal Regulations are expected because of the increasing use of implanted, programmable medical devices.

AUTHOR: Borisky, M.
TITLE: Memorandum: Prelimin. Assessment of Modern Pacemakers to EMP
DATE: Dec 16, 1986
SOURCE: EA-Gen-15 File
NOTES: Pacemaker design has become increasingly sophisticated and now uses CMOS circuitry which, according to manufacturers, makes modern pacemakers vulnerable to transient pulses. Zener diodes are used in the front end to protect the CMOS circuitry in the event that a pacemaker wearer must undergo a defibrillation procedure. With respect to EMP, the zener diodes are not fast enough to respond to pulses with fast rise times. Testing has not been done to determine the vulnerability of modern pacemakers with zener diodes and CMOS circuitry to EMP. It is felt that exposure of a CMOS pin pair to a transient pulse of 50-60 V would burn out the CMOS circuitry and the pacemaker would suffer catastrophic failure. Past pacemakers underwent temporary disruption but not catastrophic failure. The CMOS circuitry failure appears to be independent of time and dependent on peak voltage exposure. Bulk CMOS circuitry is more vulnerable than SOS CMOS circuitry, with pacemakers generally using bulk CMOS circuitry. Pacemakers are tested for compliance to voluntary AAMI-PM Standard at Georgia Tech, setting threshold for disturbance when exposed to wide pulse 450 MHz with a prf close to the hour rate which much exceed 200 V/m. There is no experimental data to predict the response of modern pacemakers to EMP.

AUTHOR: Brunhart, G.
TITLE: EMP Effects on Cardiac Pacemakers
DATE: 1974
SOURCE: Kleinstein, B.H., Ed., "Bio. Effects of EM Rad.", 1(2), 55
NOTES: The study will seek to determine the physiological effects of EMP

*Source: Data Base: Biological Effects of Electromagnetic Pulse,
U.S. Army Laboratory Command, Harry Diamond Laboratories, Woodbridge, Va., 1987.

AUTHOR

interference on electronic cardiac pacemaker wearers and the physical effects on the pacemaker circuits and components. A literature search will be conducted. Both a hypothesized model and mathematical analysis will be used to predict effects. Bench testing and in vivo testing will be carried out to verify the model. At each stage of testing, the model will be modified as necessary.

AUTHOR: Brunhart, G. and Martz, J.R.
 TITLE: Potential Hazards of High Amplitude Electromagnetic Pulse
 DATE: undated
 SOURCE: Tom Bock's File: EMP/Pacemaker Effects
 NOTES: There are two types of cardiac pacemakers in use: (1) asynchronous which requires no input signal and has a fixed or adjustable output and (2) synchronous which senses certain pulses of the heart and provides output signal appropriate to the sensed input. The types of pacemaker would determine its EMI sensitivity. There are three types of interference modes: catastrophic failure, extra or arrhythmic output signal, and momentary cutoff of output pulse. Four implantable pacemakers (Medtronic Asynchronous, Medtronic and GE demand, and Cordis atrial triggered) were subjected to up to 10,000 EMP at peak E-fields of up to 500 kV/m using various orientations of the pacemakers and leads to test for catastrophic burnout. Only Cordis failed. After replacement of the Cordis output transistor, the failure could not be repeated. Based on microwave test data, it was concluded that peak EMP fields of 2-3 kV/m would be necessary to cause the last two types of interference. These predictions have been confirmed by tests at AFWL, ALECS Facility. One last hazard needs to be studied: the leads of pacemakers could pick up enough energy to cause extra beats or defibrillation. This is not expected for EMP fields but could be a real hazard in pulsed radar beams. Study is being done on this at AFRI.

AUTHOR: Carestia, R.R.
 TITLE: Letter: EMP/HPM Cardiac Pacemaker Interference Potential
 DATE: Apr 14, 1987
 SOURCE: EA-Gen-11 File
 NOTES: The question of possible high power microwave (HPM) pulse or electromagnetic pulse (EMP) interference with cardiac pacemakers was evaluated by U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD. The particular concern about the effects of fast rise time HPM and EMP on the relatively unprotected CMOS front end of the pacemakers was reviewed with H. Nystrome of Cardiac Pacemakers, Inc. A damage threshold of 833 V/m was derived for present state-of-the-art-pacemakers based on the size of the pacemaker pick up probe (antenna) and the damage threshold voltage rating of the CMOS front end. The minimum range required to protect a pacemaker with 833 V/m radiation damage threshold from a 1.0 MW EMP or HPM pulse is approximately 6.7 m. The assumptions for this determination are listed, and formula used to calculate the range is given. This is a conservative analysis.

AUTHOR: Martz, J.
 TITLE: Preliminary Report--EMP Effects on Implanted Pacemakers
 DATE: 1973
 SOURCE: Tom Bock's File: EMP/Pacemaker Effects
 NOTES: The study of pacemakers has been directed to three categories of physical effects due to interferences: (1) catastrophic failure due to EMP induced destruction of circuit components; (2) temporary output signal rate increase or extra output signals induced by EMP pulse(s); and (3) temporary induced output signal rate decrease or momentary cutoff of pacemaker. These effects will not occur with all pacemakers, nor will they necessarily result in physiological damage. There is a listing of pacemaker types and an analysis of potential vulnerability. The possible physiological damage also depends on the

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specific disorder of the patient, his current condition, and his degree of reliance on the pacemaker. A review of past investigations reveals some studies of interest to the EMP/pacemaker topic. The general interim conclusion is that it is very unlikely that EMP fields up to 50 kV/m in the vicinity of simulators could cause catastrophic failure of cardiac pacemakers in current use. Further investigations are needed for experimental verification. EMP fields encountered by persons in the vicinity but outside the confines of the simulator installation will be lower. Pacemaker manufacturers are aware of EMI and are decreasing vulnerability accordingly.

AUTHOR: Mitchell, J.C.
 TITLE: Electromagnetic Interference of Cardiac Pacemakers
 DATE: Aug, 1975
 SOURCE: Paper, AGARD Lecture Series #78 on Radiation Hazards, pp 10.1-10
 NOTES: Current state-of-the-art technology was presented on the effect of electromagnetic radiation on cardiac pacemakers. Test techniques and results as well as their clinical significance were detailed for various types of EMR. Only EMP testing will be included here. EMP facilities are unique sources of EMR radiation, producing intense pulses (up to 100 kV/m) in about 0.5 micro s with about 90% of the frequency components below 90 MHz. Tests conducted by USAFSAM included the exposure of eight dogs, implanted with different types of pacemakers, to single pulses at 5, 25, and 50 kV/m. On the basis of electrocardiograph recordings made before and after exposure, it was determined that pacemakers were not seriously disrupted. In studies using a repetitively pulsed mode, an EMI level of 500 V/m was established as the threshold for serious effects. These tests were conducted under simulated implant conditions for peak E-field levels from 2 to 100 pps. The extent and significance of electromagnetic interference on cardiac pacemakers is dependent on such factors as frequency, pulse width, pulse repetition, proximity and orientation of pacemaker patient, and state of health and cardiac condition of the user.

AUTHOR: Mitchell, J.C. and Hurt, W.D.
 TITLE: Bio. Signif. of RF Rad. Emission on Cardiac Pacemaker Performance
 DATE: Jan, 1976
 SOURCE: USAF School of Aerospace Medicine, Interim Report SAM-TR-76-4
 NOTES: The effect of radiofrequency radiation emission on cardiac pacemaker function is a unique bioeffect phenomenon. It is dependent on pacemaker type and design and on frequency, peak E-field intensity, pulse width, and effective pulse repetition. The effects range vary among complete shut-off, reversion to a fixed interference rejection mode of operation, intermittent disruption, and total lack of effect. Experimental evidence is presented from a wide variety of tests conducted under controlled laboratory conditions in the vicinity of numerous types of RF emitters prevalent in U.S. population centers. These results are discussed with respect to their clinical significance, technical feasibility of pacemaker design to avoid EMI, and overall design to achieve RF environmental compatibility.

AUTHOR: Mitchell, J.C., Hurt, W.D., and Steiner, T.O.
 TITLE: EMC Design Effectiveness in Electrical Medical Prosthetic Devices
 DATE: Feb, 1976
 SOURCE: Fund. and App. Aspects of Nonionizing Rad., Plenum, NY, pp351-363
 NOTES: There is increasing use of electronic prostheses as the amount and intensity of RF radiation sources are also increasing. Thus, manufacturers and physicians need to attend to potential problems. The cardiac pacemaker has been tested extensively for EMI effects. Test data are reported and indicate the need for continuing awareness of potential RF interference situations. The data also provide evidence that by such awareness many of the potential EMI problems

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 can be effectively circumvented. The pacemakers currently marketed are considerably more resistant to EMI than those of two years ago. Thus, manufacturers can incorporate good EMI rejection technics in all new devices.

AUTHOR: Mitchell, J.C., Hurt, W.D., Walters, W.H., and Miller, J.K.
 TITLE: Empirical Studies of Cardiac Pacemakers
 DATE: Feb, 1974
 SOURCE: Aerospace Medicine, Vol 45, No 2, pp 189-195
 NOTES: Tests were conducted at several radar sites in the US to evaluate the relative susceptibility of cardiac pacemakers to electromagnetic radiation interference. Twenty-one pacemakers of different types and manufacture were evaluated in free field configuration as well as in a saline solution phantom (implant simulation). Test results are presented for five frequency bands between 200 and 6000 MHz. Many pacemakers skipped one or two beats when the main beam of the radars scanned past the point of closest approach. This effect, which was observed regularly for some pacemakers at distances out to a mile or more from the radar, might result in a pacemaker losing a normal heartbeat every 10-12 seconds (about 5-6 beats/minute). This interference is not considered a threat, but it can become more serious for a patient closer to the radar. Factors affecting the seriousness are the particular pacemaker in use, the state of the patient's health, and the activity the patient is performing.

AUTHOR: Mitchell, J.C., Rustan, P.L., Frazer, J.W., and Hurt, W.D.
 TITLE: Electromagnetic Compatability of Cardiac Pacemakers
 DATE: undated
 SOURCE: Reprint: Tom Bock's File: EMP/Pacemaker Effects
 NOTES: Recent tests demonstrate a wide range of electromagnetic radiation susceptibility among different types and models of cardiac pacemakers. The pacemakers tested were made by seven different manufacturers and represented the vast majority of implantable devices currently being marketed. Many of the tests were performed on pacemakers implanted in large canines having surgically induced atrioventricular heart blocks. Eleven discrete frequencies between 10 MHz and 3050 MHz, pulse repetitions from 0.5 to 360 Hz, pulse durations from 0.5 to 5 ms, and E-Field strengths up to 800 V/m were used in this series of tests. Field intensities as low as a few volts per meter caused complete inhibition (cutoff of pacemaker activity) of some pacemakers, whereas others in the same tests were essentially unaffected in fields 100 times higher. These tests and data from similar studies indicate a need for further improvements of cardiac pacemakers to be compatible with the ever increasing electromagnetic background found in many major metropolitan areas of today. (For date estimation, the latest reference cited was dated 1971.)

AUTHOR: Oliva, S.A. and Stromberg, L.R.
 TITLE: Medical Electronic Equipment: Can It Survive the Nuclear EM Envi
 DATE: Jan, 1979
 SOURCE: Military Medicine, Vol 144, No 1, pp 28-30
 NOTES: The article discusses the survivability of medical electronic equipment in the nuclear electromagnetic environment. EMP would likely render useless medical electronic equipment such as computers, communications systems, and modern solid state automated diagnostic and life support systems. Some of the effects of EMP are:

- (1) failure of components due to manufacturing defects
- (2) equipment upset
- (3) breakdown of insulation
- (4) failure of semiconductor junctions
- (5) burnout of metal interconnections

Medical equipment is at least as vulnerable to EMP as communications and weapons systems, and it must be designed to reduce its risk of failure due to EMP.

AUTHOR

AUTHOR: Smyth, N.P., Parsonnet, V. Escher, D.J.W., and Furman, S.
 TITLE: The Pacemaker Patient and the Electromagnetic Environment
 DATE: 1974
 SOURCE: J Am Med Assn, Vol 227, #12, pp 1412, Kleinstein, Bioeff, 1(1)63
 NOTES: Manufacturers of cardiac pacemakers have made improvements in the shielding, filtration, and discrimination of the circuitry to cope with the ability of the inhibitory-demand pacemaker to sense electromagnetic interference (EMI). However, with the increased protection against EMI, the strength and variety of EMI sources also increased. Despite this, there are very few documented cases of EMI affecting implanted pacemakers. The action of environmental EMI on the patient with an implanted demand pacemaker does not at this time constitute an important clinical problem. The pacemaker must not lose clinically important sensitivity and versatility while becoming more resistant to EMI. Government agencies can control EMI emissions where feasible (e.g. microwave ovens) and impose geographic limitations where the first option is not feasible (e.g. powerful sources of radar).

AUTHOR: Tenforde, T.S.
 TITLE: Phys Prop of High Voltage ELF EM Fields & Interact with Liv Sys.
 DATE: 1986
 SOURCE: Paper, Electric Energy Sys. Wkshp, Nat'l Resch Coun., Pb87-137238
 NOTES: The principles underlying the interactions of high voltage ELF fields with living organisms to are discussed. High electric fields exist around high voltage transmission lines, small motors, and electric blankets. High magnetic fields exist close to rotary devices such as hair dryers, electric shavers, mixers, circular saws, etc. Interactions of ELF fields and power-frequency magnetic fields with living systems are highlighted. Electromagnetic interferences with pacemakers are categorized. the risk to the general population is analyzed, and the manufacturer's response to EMI is reviewed.

AUTHOR: Vault, W.L.
 TITLE: Letter to Intermedics about EMP Effects on Cardiac Pacemakers
 DATE: May 11, 1987
 SOURCE: EA-Gen-10 File
 NOTES: In 1970's testing of cardiac pacemakers, it was found that manufacturers of then state-of-the-art pacemakers had essentially solved the potential electromagnetic interference problems and that no significant EMP interference of such devices should be expected under normal operational considerations. Since that time, new semiconductor technologies have been developed and utilized in cardiac pacemakers. Harry Diamond Laboratories is planning a test series to determine if new pacemaker technologies are more or less susceptible to EMP exposures and accepts the offer of Intermedics to provide pacemakers for this project. A general description of the testing procedure follows, and there is an offer to allow a company representative to observe the tests.

APPENDIX 3

Bibliography

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Testing in the field of electrical medical instruments

Cinka, V.

Elektrotechnik (Czechoslovakia) vol. 41, no.9 265-7 Sept. 1986

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: Czech

Discusses test methods, standards and practices adopted at the Electrotechnical Testing Institute for testing electrical and electronic equipment used in medical diagnostics and treatment. Amongst test parameters which have to be considered are: effects of electric current and electric fields; dangerous finger-type contact, protection against fire and burns, safety in the event of instrument failure or incompetent handling; and overall quality and functionality of the instruments including ease of cleaning, stability in humid environment and protection against radio interference. The importance of compulsory testing of biomedical equipment is emphasized.

Descriptors: biomedical electronics; biomedical equipment; electronic equipment testing; fires; health hazards; inspection; interference suppression; maintenance engineering; protection; quality control; safety; standards

Identifiers: biomedical equipment; health hazards; electrical medical instruments; standards; Electrotechnical Testing Institute; testing; medical diagnostics; treatment; electric current; electric fields; finger-type contact; protection; fire; safety; quality; stability; humid environment; radio interference

Safety in electromedicine

Cabrera, J.L.

Rev. Electr. Electron. (Argentina) vol.74, no. 872 400-3 April 1986

Treatment: APPLIC; EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: Spanish

Reviews literature about the safety of electrical and electronic equipment in medical establishments, and deals in particular with overheating, short-circuits, electric shocks, induction, radiation, and rules for inspections and for the training of personnel. For nonionizing radiation acting on the human body, most Western countries accept a minimum of 10 milliW/cm/sup 2/ but in the USSR only 10 microW/cm/sup 2/ is permitted.

Descriptors: bioelectric phenomena; biomedical equipment; safety
Identifiers: electromedicine; safety; medical establishments; overheating ; short-circuits; electric shocks; induction; radiation; nonionizing radiation; human body

ELECTRICAL SAFETY TESTING-HOW MUCH IS ENOUGH?

CRAIG, D.L.

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AUSTRALAS. PHYS. AND ENG. SCI. MED. (AUSTRALIA) VOL.7, NO.1 24-6
JAN.-MARCH 1984

Treatment: PRACTICAL;
Document Type: JOURNAL PAPER
Languages: ENGLISH

THE STANDARDS ASSOCIATION OF AUSTRALIA (SAA) HAS RECENTLY ISSUED A DRAFT STANDARD FOR PUBLIC REVIEW FOR ACCEPTANCE AND IN SERVICE TESTING OF ELECTROMEDICAL EQUIPMENT. THIS DRAFT STANDARD COVERS PROCEDURES FOR: (I) PROCUREMENT, (II) ACCEPTANCE TESTING, AND (III) IN-SERVICE TESTING OF ELECTROMEDICAL EQUIPMENT IN A HOSPITAL SITUATION. THIS PAPER DOES NOT EXAMINE THE CONTENTS OF THE DRAFT STANDARD IN DETAIL. RATHER IT CONCENTRATES ON THE SECTIONS SPECIFYING THE ELECTRICAL SAFETY TESTS TO BE APPLIED DURING ACCEPTANCE AND IN-SERVICE TESTING. THE PRACTICALITY OF THIS SET OF TESTS IS OF PARTICULAR CONCERN. THE SET OF PHYSICAL INSPECTIONS AND MECHANICAL TESTS SPECIFIED SEEM QUITE REASONABLE AND PRACTICABLE.

Descriptors: SAFETY; BIOMEDICAL EQUIPMENT; STANDARDS
Identifiers: STANDARDS ASSOCIATION OF AUSTRALIA; DRAFT STANDARD; PROCUREMENT; ACCEPTANCE TESTING; IN-SERVICE TESTING; ELECTROMEDICAL EQUIPMENT; HOSPITAL SITUATION; ELECTRICAL SAFETY TESTS; PHYSICAL INSPECTIONS; MECHANICAL TESTS

THE DRIVE TO REGULATE ELECTROMAGNETIC FIELDS

LERNER, E.J.

IEEE SPECTRUM, NEW YORK, NY, USA

IEEE SPECTRUM (USA) VOL. 21, NO. 3 63-70 MARCH 1984

U.S. Copyright Clearance Center Code: 0018-9235/84/0300-0063 \$01.00

Treatment: GENERAL, REVIEW;
Document Type: JOURNAL PAPER
Languages: ENGLISH

PRESENTS A DISCUSSION OF THE QUESTIONS: (1) WHY IS THERE SO MUCH ACTIVITY AIMED AT EM-FIELD REGULATIONS? (2) WHAT ARE THE MAJOR WEAKNESSES OF PRESENT REGULATIONS AND STANDARDS? (3) WHAT IS THE OUTLOOK FOR RESOLVING THE MANY CONFLICTS BETWEEN LOCAL AND FEDERAL STANDARDS IN THE UNITED STATES, AND BETWEEN THOSE USED IN THE UNITED STATES AND ABROAD?

Descriptors: ELECTROMAGNETIC FIELDS; STANDARDS; BIOLOGICAL EFFECTS OF RADIATION

Identifiers: ELECTROMAGNETIC FIELDS; EM-FIELD REGULATIONS; REGULATIONS; STANDARDS; UNITED STATES

POTENTIALLY HAZARDOUS SOURCES OF RADIOFREQUENCY RADIATION

REPACHOLI, M.H.

NON-IONIZING RADIATION SECTION, HEALTH AND WELFARE, OTTAWA, CANADA
AUSTRALAS. PHYS. AND ENG. SCI. MED. (AUSTRALIA) VOL.5, NO.4 161-5
OCT.-DEC. 1982

Treatment: GENERAL, REVIEW;
Document Type: JOURNAL PAPER
Languages: ENGLISH

A BRIEF REVIEW IS GIVEN CONSIDERING THE FOLLOWING SOURCES: THE EARTH; THE HUMAN BODY; COMMUNICATIONS AND BROADCASTING; MOBILE COMMUNICATIONS DEVICES; RADARS; MICROWAVE OVENS; DIELECTRIC HEATERS; MEDICAL DEVICES; VISUAL DISPLAY UNITS.

Descriptors: HEALTH HAZARDS; REVIEWS; BIOLOGICAL EFFECTS OF RADIATION

Identifiers: POTENTIALLY HAZARDOUS RF RADIATION SOURCES; EARTH; HUMAN BODY; COMMUNICATIONS AND BROADCASTING; MOBILE COMMUNICATIONS DEVICES; RADARS; MICROWAVE OVENS; DIELECTRIC HEATERS; MEDICAL DEVICES; VISUAL DISPLAY UNITS

ELECTRICAL SAFETY OF MEDICAL ELECTRONIC INSTRUMENTS IN HEALTH CARE FACILITIES. I

GALVAN, J.; PALLAS, R.

MUNDO ELECTRON. (SPAIN) NO.93 43-55 FEB. 1980

Treatment: GENERAL, REVIEW;

Document Type: JOURNAL PAPER

Languages: SPANISH

DISCUSSES THE ESSENTIAL POINTS, WHICH ARE THE TARGET OF TECHNICAL CONSIDERATIONS, TO BE KEPT IN MIND BY MANUFACTURERS, USERS AND SERVICEMEN OF BOTH INSTRUMENTS AND INSTALLATIONS OF A HOSPITAL. ACCORDINGLY, THE AUTHORS DRAW A SERIES OF CONSIDERATIONS OR RECOMMENDATIONS WHICH SHOULD ALLOW SAFER AND MORE RELIABLE SYSTEMS TO BE ACHIEVED IN SPANISH HOSPITALS.

Descriptors: SAFETY; BIOMEDICAL EQUIPMENT

Identifiers: MEDICAL ELECTRONIC INSTRUMENTS; HEALTH CARE FACILITIES; TECHNICAL CONSIDERATIONS; ELECTRICAL SAFETY

CARDIAC PACEMAKER RESPONSES TO POWER FREQUENCY SIGNALS

JENKINS, B.M.; WOODY, J.A.

ENGG. EXPERIMENT STATION, GEORGIA INST. OF TECHNOL., ATLANTA, GA, USA Sponsor: IEEE

PROCEEDINGS OF THE IEEE 1978 INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY 273-7 1978

20-22 JUNE 1978 ATLANTA, GA, USA

Publ: IEEE, NEW YORK, USA

II+427 pp.

Treatment: EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

SIX EVALUATION PROGRAMS HAVE BEEN CONDUCTED TO DETERMINE THE SUSCEPTIBILITY OF CARDIAC PACEMAKERS TO DIRECTLY INJECTED SIGNALS AT 50, 60, AND 400 HZ AND MAGNETICALLY INDUCED FIELDS AT 60 HZ. THIS PAPER DESCRIBES THE SPECIFIC TEST CONFIGURATIONS AND SUMMARIZES THE RESULTS. FOR DIRECTLY INJECTED SIGNALS, ALL PACEMAKERS WERE SUSCEPTIBLE AT LEVELS RANGING FROM 0.1 TO 11.5 MV. APPROXIMATELY 80PERCENT OF THE PACEMAKERS EVALUATED WERE SUSCEPTIBLE TO MAGNETIC FIELDS AT THRESHOLDS RANGING FROM 1 TO 4 GAUSS.

Descriptors: PACEMAKERS; ELECTROMAGNETIC COMPATIBILITY

Identifiers: CARDIAC PACEMAKERS; DIRECTLY INJECTED SIGNALS; 400 HZ;
MAGNETICALLY INDUCED FIELDS; 60 HZ; TEST CONFIGURATIONS; 50 HZ

SIMULATION OF INTERFERENCE IN HEART PACEMAKERS

GEBHARDT, U.; URNICH, W.

RWTH, AACHEN, GERMANY

BIOMED. TECH. (GERMANY) VOL.23, SUPPL. 210/1-2 MAY-JUNE 1978

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

TWO SIMULATOR MODELS ARE DESCRIBED: THE FIRST USES A ROD AERIAL AND RESPONDS TO THE ELECTRICAL FIELD OF THE INTERFERING SOURCE; THE SECOND USES A SEMICIRCULAR ELECTRODE IN A DIFFUSE CONDUCTOR AND RESPONDS TO THE ELECTRICAL AND MAGNETIC FIELD COMPONENTS. EXPERIMENTS WERE CONDUCTED ON 20 PACEMAKERS IN THE 27, 433 AND 2450 MHZ BANDS. THE RESULTS INDICATE THAT MICROWAVE RADIATION IS NOT CRITICAL, BUT THAT UHF RADIATION SUCH AS DIATHERMY ON 433 MHZ PRESENTS THE WORST CASE. THE PICKUP AT LOWER FREQUENCIES IS VERY INEFFICIENT, AND ONLY LARGE POWERS OF INTERFERING SOURCE PRESENT REAL DANGERS.

Descriptors: PACEMAKERS; INTERFERENCE (SIGNAL); ELECTROMAGNETIC COMPATIBILITY; SIMULATION

Identifiers: INTERFERENCE; HEART PACEMAKERS; SIMULATOR MODELS; ROD AERIAL; SEMICIRCULAR ELECTRODE; MICROWAVE RADIATION; UHF RADIATION; DIATHERMY

ELECTROMAGNETIC COMPATIBILITY OF IMPLANTED CARDIAC PACEMAKERS

SCHLENTZ, R.J.

MEDTRONIC INC., MINNEAPOLIS, MN, USA

DVORAK, T. (Editors)

Sponsor: PURDUE UNIV.; ET AL

ELECTROMAGNETIC COMPATIBILITY 1975 428-32 1975

20-22 MAY 1975 MONTREUX, SWITZERLAND

Publ: IEEE, NEW YORK, USA

XII+549 pp.

Treatment: APPLIC;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

THE ELECTROMAGNETIC ENVIRONMENT TO WHICH THE PACEMAKER PATIENT IS EXPOSED IS DISCUSSED WITH RESPECT TO FREQUENCIES, MODULATION, AND FIELD STRENGTH. DATA ON THE ELECTROMAGNETIC SUSCEPTIBILITY OF DIFFERENT PACEMAKERS IS PRESENTED. METHODS OF ACHIEVING ELECTROMAGNETIC COMPATIBILITY, SUCH AS SHIELDING AND FILTERING, ARE DISCUSSED WITH RESPECT TO THEIR SUCCESSFUL APPLICATION TO PACEMAKERS.

Descriptors: PACEMAKERS; ELECTROMAGNETIC COMPATIBILITY; SHIELDING

Identifiers: IMPLANTED CARDIAC PACEMAKERS; FREQUENCIES; MODULATION; FIELD STRENGTH; ELECTROMAGNETIC SUSCEPTIBILITY; ELECTROMAGNETIC COMPATIBILITY; SHIELDING; FILTERING

Electromagnetic interference (EMI), electrostatic discharge (ESD)-
the diseases, their preventions and/or cures

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R&B Enterprises, W. Conshohocken, PA, USA

Lin, J.C.; Feinberg, B.N. (Editors)

Sponsor: IEEE

Proceedings of the Seventh Annual Conference of the IEEE/Engineering
in Medicine and Biology Society. Frontiers of Engineering and
Computing in Health Care - 1985 (Cat. No. 85CH2198-0) 203-5 vol.1
1985 27-30 Sept. 1985 Chicago, IL, USA

Publ: IEEE, New York, USA

2 vol. 1295 pp.

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Treatment: PRACTICAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

The wide acceptance of ICs in bioinstrumentation, microprocessors,
and medical electronics, in general, has led to an escalating number of
EMI-caused malfunctions. The author addresses general EMI design
precautions which will increase the immunity of such electronics to EMI
and ESD. EMI filtering, shielding, grounding, transient suppression,
and other methods are described. Methods of evaluating these
preventions and cures are covered and specific applications are
included.

Descriptors: biomedical electronics; discharges (electric);
electromagnetic interference

Identifiers: electromagnetic interference; electrostatic discharge;
ICs; bioinstrumentation; microprocessors; medical electronics;
filtering; shielding; grounding; transient suppression

EMC, fertility and the pacemaker

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Elektron (S. Africa) vol.2, no. 11-12 36-9 Nov.-Dec. 1985

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

The pacemaker is a typical combination of an electronic source and
receptor. As a 'source' it stimulates the heart to beat in a regular
and controlled rhythm. As a 'receptor' its protective circuits must
make it insensitive to outside interference so as to be compatible with
the EMR of a microwave oven, television set, a smelter carrying
hundreds of thousands of amperes or just a nearby lightning stroke. In
the wide field of EMC, a need was identified for a National Co-
ordinating Committee for EMC to be established. The Committee should
monitor the implementation of existing EMC regulations and recommend
amendments or additions, as appropriate.

Descriptors: electromagnetic compatibility; pacemakers

Identifiers: pacemaker; heart; protective circuits; EMC; regulations

Electromagnetic compatibility planning for new hospital buildings

Kohling, A.

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Elektrotech. Z. ETZ (Germany) vol. 106, no. 9 428-30 May 1985

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: German

Electromagnetic compatibility planning for hospitals has to take into consideration the frequency range extending from DC to 1 GHz. Routine physiological investigations (ECG, EEG and EMG) operate with 5 to 100 μ V levels in the 0.1 to 20000 Hz range; these have to be protected from conducted and radiated interference generated by external and internal (i.e. electro-medical equipment in the hospital) sources. Recommendations for low-radiation cabling, screening and references to standards on medical devices for reduction of electrical interference on bioelectric potentials are given.

Descriptors: biomedical engineering; building; electromagnetic compatibility; electromagnetic interference; interference suppression

Identifiers: EMC; electromagnetic compatibility; EMG; EMI; medical equipment; interference suppression; hospital buildings; planning; ECG; EEG; low-radiation cabling; screening; standards; medical devices; electrical interference; bioelectric potentials

Electromagnetic interference and pacemakers-a view from the DHSS

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Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers (Digest No.7) 11/1-3 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: GENERAL,REVIEW; PRACTICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

Although pacemakers are in principle subject to electromagnetic interference, in practice the construction and specification of modern units has minimised the consequent hazard. The author describes the construction and characteristics of a modern pacemaker and the possible mechanisms of interference (modulation, the electrode and magnetic fields).

Descriptors: electromagnetic interference; health hazards; pacemakers

Identifiers: DHSS; pacemakers; pacemakers; electromagnetic interference; construction; specification; modern units; hazard; modulation; electrode; magnetic fields

Nuclear magnetic resonance (NMR) imaging systems and the possible influences of the magnetic environmental field conditions on pacemaker performance

Timms, W.E.

Oxford Res. Syst. Ltd., Abingdon, England

Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
(Digest No. 7) 9/1-2 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: PRACTICAL; THEORETICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

The technique of nuclear magnetic resonance (NMR) imaging requires the use of a uniform high magnetic field (up to 2 Tesla), various additional pulsed gradients of the field and a radiofrequency transmitter/receiver. The basic theory of NMR is outlined and the above three aspects discussed. The possible hazards to pacemaker wearers are thus the static field which can extend over a significant volume of space, the currents induced by pulsed magnetic field gradients and the total effects of the RF field components.

Descriptors: biomedical NMR; electromagnetic interference; health hazards ; pacemakers; radiofrequency interference

Identifiers: NMR imaging systems; magnetic environmental field conditions ; pacemaker performance; uniform high magnetic field; pulsed gradients; radiofrequency transmitter/receiver; hazards; static field; currents; pulsed magnetic field gradients; RF field components

The function of implanted pacemakers in the MAGLEV system

Camm, A.J.; Butrous, G.S.; Kaye, G.C.; Meldrum, S.J.; Shennan, A.
Cardiac Dept., St. Bartholomew's Hospital, London, England

Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
(Digest No. 7) 8/1-8 1985

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Publ: IEE, London, England

54 pp.

Treatment: PRACTICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

MAGLEV is the name given to a rail suspension system which uses electromagnets in place of the springs, dampers and wheels of a conventional vehicle. Because of the use of an electromagnetic system for the operation of this new method of transportation, concerns about its safety for patients with implanted cardiac pacemakers have been raised. Therefore at the request of the project managers of the system, a team from St. Bartholomew's Hospital conducted special tests to monitor the function of implanted cardiac pacemakers exposed to the MAGLEV system. The general protocol of this study was to expose patients with different types of pacemakers, from different manufacturers, to the MAGLEV system and to monitor the function of their pacemakers. It was obviously impossible to test all commercially

available devices or to test all possible programme settings for any individual pacemaker. It was established that there was no obvious interference with the function of the cardiac pacemakers tested in this study during various phases of the MAGLEV operation. The investigators feel that the MAGLEV system is safe for patients with those cardiac pacemakers which are currently being implanted in the United Kingdom.

Descriptors: electromagnetic interference; electromagnets; health hazards ; magnetic levitation; pacemakers

Identifiers: implanted pacemakers; MAGLEV system; rail suspension system; electromagnets; electromagnetic system; safety; patients; cardiac pacemakers

Principles of interference detection and rejection in cardiac pacemakers

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Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers (Digest No. 7) 7/1-4 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: PRACTICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

Outlines the different existing methods of interference detection with their advantages and disadvantages. A proposal is made as to how a better interference suppression could be established.

Descriptors: electromagnetic interference; health hazards; interference suppression; pacemakers

Identifiers: EMI; interference rejection; interference detection; cardiac pacemakers; interference suppression

Electromagnetic field conditions in the vicinity of power transmission lines and possible influences upon pacemaker performance

Male, J.C.

Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers (Digest No. 7) 5/1-3 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: PRACTICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

There are very few known instances of implanted pacemakers suffering interference from the electromagnetic fields in the vicinity of power-transmission plants. Experiments to check the susceptibility of various pacemaker models to such interference have been carried out in

which fifty patients were exposed to electric-field strengths up to 20 kV m/sup -1/ and their pacemaker's performance was monitored by radio-telemetry. Most of the pacemaker models tested were disturbed by exposure to the electric field. The field strengths required varied from unit to unit and from model to model. The interference threshold also depended on the magnitude and distribution of the induced body current and thus varied with patient height, build and posture. In most cases, the interference caused the pacemaker to revert to its fixed-rate mode and this occurred at body currents as low as 26 mu A, corresponding to an electric field strength of 2 kV m/sup -1/ at head height for the patient standing normally upright. Some models showed slow or irregular pacing at fields of 5 kV m/sup -1/ or more, followed by reversion to fixed rate at higher fields. Others proved to be immune to all interference up to 20 kV m/sup -1/, the highest field used. In all cases, the pacemakers resumed normal function as soon as the field was removed. Despite the abnormal behaviour seen with some pacemaker models, it should be stressed that members of the public will rarely encounter electric fields greater than 5 kV m/sup -1/ near power transmission lines and that only two units out of some 85 units so far tested have proved susceptible to fields less than this.

Descriptors: electromagnetic interference; health hazards; pacemakers; power overhead lines

Identifiers: EM field conditions; patient build; patient posture; slow pacing; overhead transmission lines; power transmission lines; pacemaker performance; implanted pacemakers; power-transmission plants; electric-field strengths; radio-telemetry; interference threshold; induced body current; patient height; fixed-rate mode; irregular pacing; normal function

Variation in the interference response of VVI cardiac pacemakers

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Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
(Digest No. 7) 4/1-4 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: PRACTICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

This study is concerned with the wide variation in the way ventricular demand pacemakers respond to sensed external electromagnetic interference. This variation is found in both reversion rates and sensing frequency responses when these parameters are measured in vitro, and is reflected in the behaviour of some pacemakers in the presence of actual interference fields. Pacemakers using the 'noise recognition window' type of reversion mechanism combined with poor attenuation of high frequency signals are more likely to be continuously inhibited by interference signals than are

other types, and should not be implanted in patients who work in 'noisy' electromagnetic environments.

Descriptors: electromagnetic interference; health hazards; pacemakers; radiofrequency interference

Identifiers: interference response variation; VVI cardiac pacemakers; ventricular demand pacemakers; external electromagnetic interference; reversion rates; sensing frequency responses; noise recognition window

Pacemaker dependent patients and the electromagnetic fields they are likely to encounter

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Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers (Digest No. 7) 3/1-3 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

The author has undertaken a study of pacemaker dependence with selected patients who at a routine visit to the pacemaker clinic were in predominantly paced rhythm at between 65 and 80 beats per minute. Their responses to inhibition of pacing either abruptly or after gradual slowing were recorded on three occasions at one month intervals. A small group, less than 10% consistently failed to develop adequate escape rhythm on either test and could therefore be considered completely pacemaker dependent. A similar number developed severe symptoms only on abrupt pacemaker inhibition and of these about a half were inconsistent in their response. The great majority, over 80% consistently tolerated both tests with only mild transient symptoms or none at all. It is concluded that pacemaker dependence is a real measurable entity and although the result of gradual rate reduction is more consistent, abrupt withdrawal of pacing may reveal an important degree of suppression of the spontaneous rhythm by the faster paced rhythm. There are three situations where the degree of pacemaker dependence is important; firstly, pulse generator change operations; secondly, where it is known that a batch of pulse generators or leads have an increased chance of unpredictable failure generally due to a manufacturing defect; thirdly, where the pacemaker is unintentionally temporarily inhibited by noise.

Descriptors: electromagnetic interference; health hazards; pacemakers; radiofrequency interference

Identifiers: pacemaker dependent patients; pacing inhibition response; spontaneous rhythm suppression; electromagnetic fields; escape rhythm; severe symptoms; abrupt pacemaker inhibition; mild transient symptoms; faster paced rhythm; pulse generator change operations; pulse generators; leads; manufacturing defect; noise

Clinical evidence for impairment of pacemaker performance by
electromagnetic interference

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Tyne, England

Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
(Digest No. 7) 2/1-4 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: GENERAL, REVIEW; PRACTICAL; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

Periodically review articles in medical and scientific publications describe the ever growing theoretical list of situations which could give rise to pacemaker interference. Although authors are usually careful to point out that the risk to the patient is minimal, the news media are all too prone to stress the possible dangers, thus creating unnecessary anxiety in pacemaker users. For this reason the British Pacing Group decided to canvass their members inviting reporting of examples where pacemaker interference had given rise to a clinically detectable symptom or incident. Over a two-year period only 16 examples were reported and in only 6 of these patients was a cause and effect relationship between electromagnetic interference and pacemaker malfunction demonstrated conclusively. In 2 further patients electromagnetic interference causing symptoms seemed probable but could not be proved. In 3 patients the theoretical possibility existed for pacemaker interference to have been the cause of the incident but neither proof nor strong circumstantial evidence was forthcoming. In the remaining 5 patients the role of electromagnetic interference as a cause of the problem was disproved.

Descriptors: electromagnetic interference; health hazards;
pacemakers; radiofrequency interference

Identifiers: pacemaker performance impairment; clinical evidence;
clinically detectable incident; electromagnetic interference; British
Pacing Group; clinically detectable symptom; pacemaker malfunction
Class

Factors that influence the susceptibility of implanted pacemakers to
interference by electromagnetic fields

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Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
(Digest No. 7) 1/1-8 1985

22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Treatment: GENERAL, REVIEW; PRACTICAL; EXPERIMENTAL;
 Document Type: CONFERENCE PAPER
 Languages: ENGLISH

In considering or attempting to assess the susceptibility of implanted pacemakers to exogenic electromagnetic fields it is necessary to appreciate the complexity of problem in terms of the media in which the pacemaker is situated, the propensity for fields to enter the body, the depth of penetration into the body and the electrode-lead configuration and type of pacemaker. In this way an insight may be gained into the possible influence that electromagnetic fields may have upon the sensory and stimulus delivery functions of the pacemaker.

Descriptors: electromagnetic interference; health hazards; pacemakers; radiofrequency interference

Identifiers: EM field interference; pacemaker type; sensory functions; implanted pacemakers; exogenic electromagnetic fields; depth of penetration; electrode-lead configuration; stimulus delivery functions

Evaluation of the effects of electric fields on implanted cardiac pacemakers

Issued by: Electr. Power Res. Inst., Palo Alto, CA, USA; 28 Feb. 1985
 92 pp.

Availability: Res. Rep. Center, Box 50490, Palo Alto, CA 94303, USA

Report No.: EPRI-EA-3917

Treatment: EXPERIMENTAL;

Document Type: REPORT

Languages: ENGLISH

The electromagnetic fields around extra high voltage transmission lines can interfere with the performance of some cardiac pacemakers, although they leave other models undisturbed. These findings can help manufacturers improve pacemaker design to resist such external electrical interference.

Descriptors: electric field effects; electromagnetic fields; electromagnetic interference; high-voltage engineering; pacemakers; power overhead lines

Identifiers: electromagnetic fields; extra high voltage transmission lines; cardiac pacemakers; manufacturers; pacemaker design; external electrical interference

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
 (Digest No. 7)

Sponsor: IEE

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
 (Digest No. 7) 1985

IEE Colloquium on Electromagnetic Interference and Cardiac Pacemakers
 (Digest No. 7) 22 Jan. 1985 London, England

Publ: IEE, London, England

54 pp.

Document Type: CONFERENCE PROCEEDINGS

Languages: ENGLISH

The following topics were dealt with: pacemaker susceptibility to EMI; pacemaker dependent patients; EM field reduction methods; effect of NMR imaging systems and diagnostic X-rays on pacemaker performance. Abstracts of individual papers can be found under the relevant classification codes in this or other issues.

Descriptors: electromagnetic interference; health hazards; pacemakers; radiofrequency interference

Identifiers: EM interference; cardiac pacemakers; EMI; EMI; pacemaker dependent patients; EM field reduction methods; NMR imaging systems; diagnostic X-rays; pacemaker performance

RF SUSCEPTIBILITY OF AN EEG MACHINE AND CONSIDERATIONS FOR ATTENUATION OF RFI IN HOSPITALS

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VETERANS ADMINISTRATION, WASHINGTON, DC, USA

Sponsor: IEEE

CONFERENCE RECORD. INDUSTRIAL AND COMMERCIAL POWER SYSTEMS TECHNICAL CONFERENCE 1983 44-54 AUG. 1983

9-12 MAY 1983 MILWAUKEE, WI, USA

Publ: IEEE, NEW YORK, USA

209 pp.

Treatment: GENERAL, REVIEW; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

A DISCUSSION IS PRESENTED OF THE TESTING CONDUCTED TO DETERMINE THE RF SUSCEPTIBILITY OF A TYPICAL ELECTROENCEPHALOGRAPH (EEG) MACHINE AND TO DETERMINE THE EFFECTIVENESS OF LEAD X-RAY SHIELDING AS AN RF SHIELD. NEW DATA IS PRESENTED ON THRESHOLD FIELD STRENGTHS AND FREQUENCIES WHICH JUST BEGIN TO CAUSE INTERFERENCE ON A TYPICAL EEG BRAIN SCAN. RESULTS ARE COMBINED WITH DATA FROM OTHER STUDIES TO SHOW THAT A TYPICAL EEG MACHINE WOULD BE IMMUNE TO THE RF ENVIRONMENT TO BE EXPECTED IN THE VICINITY OF MOST HOSPITALS. THEREFORE, EXPENSIVE RF SHIELDING IN A HOSPITAL EEG SUITE IS USUALLY NOT REQUIRED. FINALLY, AN INEXPENSIVE SHIELDING SYSTEM UTILIZING X-RAY SHIELDING DEVELOPED BY THE US VETERANS ADMINISTRATION IS PRESENTED.

Descriptors: RADIOFREQUENCY INTERFERENCE; SHIELDING; RADIATION PROTECTION; BIOMEDICAL EQUIPMENT; ELECTROENCEPHALOGRAPHY

Identifiers: PB SHIELDING; EEG MACHINE; RFI; RF SUSCEPTIBILITY; ELECTROENCEPHALOGRAPH; LEAD X-RAY SHIELDING; THRESHOLD FIELD STRENGTHS; INTERFERENCE; HOSPITALS

THE EFFECTS OF NUCLEAR MAGNETIC RESONANCE ON PATIENTS WITH CARDIAC PACEMAKERS

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DEPT. OF RADIOLOGY AND CARDIOLOGY, CLEVELAND CLINIC FOUND., CLEVELAND, OH, USA

RADIOLOGY (USA) VOL. 147, NO. 1 149-53 APRIL 1983

Treatment: EXPERIMENTAL;
 Document Type: JOURNAL PAPER
 Languages: ENGLISH

THE EFFECT OF NUCLEAR MAGNETIC RESONANCE (NMR) IMAGING ON SIX REPRESENTATIVE CARDIAC PACEMAKERS WAS STUDIED. THE RESULTS INDICATE THAT THE THRESHOLD FOR INITIATING THE ASYNCHRONOUS MODE OF A PACEMAKER IS 17 GAUSS. RADIOFREQUENCY LEVELS ARE PRESENT IN AN NMR UNIT AND MAY CONFUSE OR POSSIBLY INHIBIT DEMAND PACEMAKERS, ALTHOUGH SENSING CIRCUITRY IS NORMALLY PROVIDED WITH ELECTROMAGNETIC INTERFERENCE DISCRIMINATION. TIME-VARYING MAGNETIC FIELDS CAN GENERATE PULSE AMPLITUDES AND FREQUENCIES TO MIMIC CARDIAC ACTIVITY. A SERIOUS LIMITATION IN THE POSSIBILITY OF IMAGING A PATIENT WITH A PACEMAKER WOULD BE THE ALTERATION OF NORMAL PULSING PARAMETERS DUE TO TIME-VARYING MAGNETIC FIELDS.

Descriptors: BIOMEDICAL NMR; PACEMAKERS

Identifiers: NMR IMAGING; RADIOFREQUENCY LEVELS; CARDIAC PACEMAKERS; ASYNCHRONOUS MODE; TIME-VARYING MAGNETIC FIELDS

PACEMAKERS AND RISKS OF ELECTRICAL DANGER

FRANK, R.; PETITOT, J.C.; FONTAINE, G.

REV. GEN. ELECTR. (FRANCE) NO. 10 728-9 OCT. 1981

RELMED 81. SYMPOSIUM ON RISK OF ELECTRICAL DANGER IN MEDICINE 20 MARCH 1981 PARIS, FRANCE

Treatment: GENERAL, REVIEW; PRACTICAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

THE ROLE OF IMPLANTED PACEMAKERS IS TO AVERT ANY INCREASE IN THE DURATION OF HEART CYCLE. THE AUTHORS EXAMINE THE EFFECT OF AN ELECTROMAGNETIC FIELD ON THE OPERATION OF THESE PACEMAKERS AND THE POSSIBLE RISKS OF VENTRICULAR ARRHYTHMIA IN EVERYDAY LIFE AS WELL AS IN INDUSTRIAL AND MEDICAL ENVIRONMENTS.

Descriptors: PACEMAKERS; SAFETY; ELECTROMAGNETIC FIELDS

Identifiers: PATIENT TREATMENT; SAFETY; RISKS OF ELECTRICAL DANGER; ELECTROMAGNETIC FIELD; PACEMAKERS; VENTRICULAR ARRHYTHMIA

RELMED 81. SYMPOSIUM ON RISK OF ELECTRICAL DANGER IN MEDICINE REV. GEN. ELECTR. (FRANCE) NO. 10 OCT. 1981

RELMED 81. SYMPOSIUM ON RISK OF ELECTRICAL DANGER IN MEDICINE 20 MARCH 1981 PARIS, FRANCE

Treatment: GENERAL, REVIEW;

Document Type: CONFERENCE PROCEEDINGS

Languages: ENGLISH

THE FOLLOWING TOPICS WERE DEALT WITH: ELECTRIC SHOCKS, ACCIDENTS, SAFETY, HEALTH HAZARDS, PACEMAKERS, SURGICAL EQUIPMENT, BIOMEDICAL EQUIPMENT; BIOMEDICAL MEASUREMENT, EARTHING, EMERGENCY POWER SUPPLIES AND ELECTROMAGNETIC FIELDS. 7 PAPERS WERE PRESENTED, OF WHICH ALL ARE PUBLISHED IN FULL IN THE PRESENT PROCEEDINGS.

Descriptors: BIOMEDICAL MEASUREMENT; BIOMEDICAL EQUIPMENT; ELECTRIC SHOCKS; SAFETY; ACCIDENTS

Identifiers: ACCIDENTS; SAFETY; HEALTH HAZARDS; PACEMAKERS; SURGICAL EQUIPMENT; BIOMEDICAL EQUIPMENT; BIOMEDICAL MEASUREMENT; EARTHING; EMERGENCY POWER SUPPLIES; ELECTROMAGNETIC FIELDS

ANALYSIS OF THE COUPLING OF ELECTROMAGNETIC INTERFERENCE TO UNIPOLAR CARDIAC PACEMAKERS

SMITH, G.S.; TOLER, J.C.

SCHOOL OF ELECTRICAL ENGG., GEORGIA INST. OF TECHNOL., ATLANTA, GA, USA MED. AND BIOL. ENG. AND COMPUT. (GB) VOL. 19, NO. 1 97-109 JAN. 1981

Treatment: THEORETICAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

A THEORETICAL ANALYSIS IS DEVELOPED TO DETERMINE THE BEHAVIOUR OF THE UNIPOLAR PACEMAKER CATHETER AS A RECEIVING AERIAL. THE THEORY IS USED TO PREDICT THE EFFECT OF PARAMETERS SUCH AS THE FREQUENCY AND THE LENGTH OF THE CATHETER ON THE COUPLING OF ELECTROMAGNETIC INTERFERENCE TO THE PACEMAKER. THE RESULTS ARE PRESENTED IN TERMS OF AN EQUIVALENT CIRCUIT WHICH IS USEFUL FOR DEVELOPING SIMPLE EXPERIMENTAL TESTS TO EVALUATE THE SUSCEPTIBILITY OF PACEMAKERS TO ELECTROMAGNETIC INTERFERENCE. THE THEORETICAL RESULTS ARE SHOWN TO BE IN GOOD AGREEMENT WITH MEASUREMENTS MADE ON AN ACTUAL CATHETER.

Descriptors: PACEMAKERS; ELECTROMAGNETIC INTERFERENCE

Identifiers: UNIPOLAR CARDIAC PACEMAKERS; RECEIVING AERIAL; EQUIVALENT CIRCUIT; EM INTERFERENCE COUPLING

THE INFLUENCE OF RADIATION THERAPY ON CARDIAC PACEMAKERS

COLES, J.R.; CIDDOR, G.S.

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AUSTRALAS. PHYS. AND ENG. SCI. MED. (AUSTRALIA) VOL. 3, NO. 3 142-7 MAY-JUNE 1980

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

PACEMAKERS OF THE TYPE TESTED APPEAR TO BE LARGELY UNAFFECTED BY THE ENVIRONMENT OF CLINICAL RADIOTHERAPY MACHINES. IONIZING RADIATION HAS NO DETRIMENTAL EFFECT ON THE PACEMAKERS, AND ELECTROMAGNETIC INTERFERENCE CAUSES ONLY TEMPORARY SINGLE-BEAT INHIBITION AT MOST. IN NO CASE WAS PROLONGED MALFUNCTION OBSERVED.

Descriptors: PACEMAKERS; RADIATION THERAPY

Identifiers: RADIATION THERAPY; CARDIAC PACEMAKER FUNCTION; IONISING RADIATION; EM INTERFERENCE; SINGLE BEAT INHIBITION

INFLUENCE OF HIGH-VOLTAGE IGNITION SYSTEMS ON THE FUNCTION OF IMPLANTED PACEMAKERS. I

NEU, H.; THULL, R.; KARR, D.E.

ROBERT-BOSCH GMBH, STUTTGART, GERMANY;

BIOMED. TECH. (GERMANY) VOL. 25, NO. 5 116-22 MAY 1980

Treatment: EXPERIMENTAL;
 Document Type: JOURNAL PAPER
 Languages: GERMAN

CONTROLLED CARDIAC PACEMAKERS WHICH INHIBIT THE PULSE OUTPUT IN THE EVENT OF HEART MUSCLE ACTIVITY MAY ENDANGER THE PATIENT IF ELECTROMAGNETIC OR ELECTRIC DISTURBANCE SIGNALS ARE COUPLED INTO THE CIRCUIT VIA THE ELECTRODE IN THE HEART AND ARE INTERPRETED BY THE PACEMAKER AS ACTION POTENTIALS. IT IS NOT USUALLY POSSIBLE TO PREDICT THE EXTENT TO WHICH A SOURCE OF DISTURBANCE MAY INFLUENCE FUNCTIONING AS THE SIGNAL AMPLITUDE FOLLOWING THE INPUT FILTER OF THE PACEMAKER CIRCUIT DEPENDS ON A NUMBER OF PARAMETERS. POSITIVE STATEMENTS THUS CALL FOR EXPERIMENTS AND REALISTIC SIMULATION SET-UP OF THE SOURCE OF DISTURBANCE AND STIMULATION SYSTEM. THE RESULTS COMMUNICATED IN THIS RESPECT REFER TO INFLUENCING OF PACEMAKER FUNCTIONING BY IGNITION SYSTEMS IN PASSENGER CARS AS POTENTIAL SOURCES OF DISTURBANCES ON ACCOUNT OF THE HIGH VOLTAGE REQUIRED TO IGNITE THE AIR/FUEL MIXTURE. FUNCTIONAL TESTING WAS CARRIED OUT ON IGNITION SYSTEMS WITH AND WITHOUT INTERFERENCE SUPPRESSION UNDER ACTUAL AND WORST-CASE CONDITIONS. IT IS ESTABLISHED THAT THE FUNCTIONING OF IMPLANTED PACEMAKERS IS NOT AFFECTED BY IGNITION SYSTEMS WITHOUT INTERFERENCE SUPPRESSION. THE TESTS CONDUCTED UNDER UNREALISTICALLY SEVERE CONDITIONS INDICATE THAT PACEMAKERS WITH DOUBLE HERMETIC ENCAPSULATION OF THE ELECTRONIC CIRCUITRY WITH LEAD-THROUGH FILTER ARE LESS SUSCEPTIBLE TO DISTURBANCE THAN THE EPOXY RESIN TYPES AND VERSIONS ENCLOSED IN A SIMPLE METAL HOUSING.

Descriptors: PACEMAKERS; ELECTRIC IGNITION; ELECTROMAGNETIC INTERFERENCE Identifiers: HV AUTOMOBILE IGNITION SYSTEMS; PACEMAKER FUNCTION; IMPLANTED CARDIAC PACEMAKERS; EM INTERFERENCE

THE EFFECT OF ELECTRIC AND MAGNETIC FIELDS NEAR HVDC CONVERTER TERMINAL ON IMPLANTED CARDIAC PACEMAKERS

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1979 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY
 385-91 1979

9-11 OCT. 1979 SAN DIEGO, CA, USA

Publ: IEEE, NEW YORK, USA

451 pp.

Treatment: PRACTICAL;
 Document Type: CONFERENCE PAPER
 Languages: ENGLISH

THE EXPERIMENTAL PROCEDURES EMPLOYED TAKE INTO ACCOUNT THE COMBINED EFFECTS OF THE ELECTRIC AND MAGNETIC FIELDS. THE EFFECT OF THE RESULTING BODY CURRENT ON THE RESPONSE OF SIX PACEMAKERS IS ASSESSED IN THE LABORATORY, USING A PREVIOUSLY DEVELOPED MODEL TO RELATE BODY CURRENT TO PACEMAKER PICKUP VOLTAGE. THE RESULTS SHOW THAT R-WAVE PACEMAKER REVERSION CAN BE EXPECTED AT SOME LOCATIONS WITHIN THE CONVERTER FACILITY, BUT THAT A LARGE SAFETY MARGIN FOR UNPERTURBED PACEMAKER OPERATION EXISTS BENEATH THE TRANSMISSION LINES.

Descriptors: ELECTROMAGNETIC INTERFERENCE; POWER CONVERTORS;
ELECTRIC FIELD MEASUREMENT; PACEMAKERS

Identifiers: IMPLANTED CARDIAC PACEMAKERS; HVDC CONVERTOR TERMINAL;
TRANSMISSION LINE EFFECTS; EMC

INCREASING INTERFERENCE IMMUNITY OF ASYNCHRONOUS CARDIOSTIMULATORS
ZUSMAN, G.V.

MOSCOW INST. OF PHYS. ENGN. , MOSCOW, USSR

MED. TEKH. (USSR) VOL. 12, NO. 4 42-4 JULY-AUG. 1978

Trans in: BIOMED. ENG. (USA) VOL. 12, NO. 4 206-8 JULY-AUG. 1978

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

LABORATORY TESTS WERE CONDUCTED TO DETERMINE THE INTERFERENCE
IMMUNITY OF THE TYPES EKS-2, EKS-4, AND EKS-8 CARDIOSTIMULATORS.

Descriptors: PACEMAKERS; INTERFERENCE SUPPRESSION

Identifiers: INTERFERENCE IMMUNITY; ASYNCHRONOUS CARDIOSTIMULATORS;
PACEMAKER

MICROWAVE INTERFERENCE WITH THE FUNCTION OF AN IMPLANTED CARDIAC
PACEMAKER

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SCHOOL OF APPL. SCI., UNIV. SCI. MALAYSIA, MINDEN, PENANG, MALAYSIA
IEEE TRANS. ELECTROMAGN. COMPAT. (USA) VOL. EMC-21, NO. 3 274-6
AUG. 1979

Treatment: THEORETICAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

THE EFFECT OF EXTERNAL MICROWAVE RADIATION ON AN IMPLANTED CARDIAC
PACEMAKER IS STUDIED. BASED ON A CLINICAL CASE HISTORY INDICATING AN
EFFECTIVE BLOCKING IN A PATIENT OF THE IMPLANTED PACING ACTIVITY DUE TO
MICROWAVE RADIATION, THE PROCESS BY WHICH MICROWAVE ENERGY MAY CAUSE
THIS OBSERVED EFFECT IS ANALYZED. THE PROBLEM IS FORMULATED IN TERMS
OF THERMOELASTIC THEORY IN WHICH THE ABSORBED MICROWAVE ENERGY OF THE
BIOMEDIUM CONTAINING THE IMPLANTED PACEMAKER REPRESENTS A VOLUME OF
HEAT SOURCE AND A RESULTING THERMOELASTIC MOTION SETS UP ACOUSTIC
WAVES; THESE IN TURN, CAUSE MICROPHONIC OSCILLATIONS IN THE PACEMAKER
WHICH CORRESPOND TO THE NOISY HIGH-FREQUENCY ARTIFACT RECORDED ON THE
ECG TRACINGS.

Descriptors: RADIOFREQUENCY INTERFERENCE; PACEMAKERS

Identifiers: IMPLANTED CARDIAC PACEMAKER; EXTERNAL MICROWAVE
RADIATION; CLINICAL CASE HISTORY; THERMOELASTIC THEORY; ACOUSTIC WAVES;
MICROPHONIC OSCILLATIONS; MICROWAVE INTERFERENCE

ELECTROMAGNETIC INTERFERENCE-A PROBLEM OF GROWING CONCERN

MCGEHAN, F.P.

ELECTRON. AUST. (AUSTRALIA) VOL. 40, NO. 8 16-19 NOV. 1978

Treatment: GENERAL, REVIEW;

Document Type: JOURNAL PAPER

Languages: ENGLISH

DISCUSSES PROBLEMS CONNECTED WITH ELECTROMAGNETIC POLLUTION INCLUDING ITS EFFECTS ON ALL TYPES OF ELECTRONIC EQUIPMENT RANGING FROM HEART PACEMAKERS AND TV SETS TO GIANT COMPUTERS AS WELL AS ITS BIOLOGICAL EFFECTS.

Descriptors: ELECTROMAGNETIC INTERFERENCE

Identifiers: BIOLOGICAL EFFECTS; ELECTROMAGNETIC INTERFERENCE; ELECTROMAGNETIC POLLUTION; PROTECTION

THE EFFECTS ON CARDIAC PACEMAKERS OF IONIZING RADIATION AND ELECTROMAGNETIC INTERFERENCE FROM RADIOTHERAPY MACHINES

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INT. J. RADIAT. ONCOLOGY BIOL. PHYS. (GB) VOL. 4, NO. 11-12 1055-8 NOV.-DEC. 1978

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

FOUR DEMAND-TYPE PACEMAKERS WERE EXPOSED TO THERAPEUTIC LEVELS OF /SUP 60/CO RADIATION AS WELL AS TO THE ELECTRO-MAGNETIC FIELDS ASSOCIATED WITH TWO BETATRONS AND THREE LINEAR ACCELERATORS. RESULTS INDICATE THAT PATIENTS WHO HAVE PACEMAKERS IMPLANTED SHOULD NOT BE TREATED WITH BETATRONS; LINEAR ACCELERATORS SHOULD BE USED WITH EXTREME CAUTION IN TREATMENT OF THESE PATIENTS. THERAPEUTIC LEVELS OF /SUP 60/CO RADIATION (LESS THAN 7000 RAD) PRODUCED NO APPARENT MALFUNCTION ON THE UNITS TESTED.

Descriptors: RADIATION EFFECTS; ELECTROMAGNETIC INTERFERENCE; PACEMAKERS; RADIATION THERAPY

Identifiers: RADIOTHERAPY MACHINES; PACEMAKERS; THERAPEUTIC LEVELS; BETATRONS; LINEAR ACCELERATORS; /SUP 60/CO RADIATION; CO

PACEMAKER INDUCED T WAVE INVERSION PHENOMENON

HARSANYI, A.; BUKOSZA, I.; PREDA, I.; ANTALOCZY, Z.

2ND MEDICAL CLINIC OF POSTGRADUATE MEDICAL SCHOOL, BUDAPEST, HUNGARY ANTALOCZY, Z. (Editors)

MODERN ELECTROCARDIOLOGY. PROCEEDINGS OF THE IVTH INTERNATIONAL CONGRESS ON ELECTROCARDIOLOGY 413-16 1978

20-23 SEPT. 1977 BALATONFURED, HUNGARY

Publ: EXCERPTA MEDICA, AMSTERDAM, NETHERLANDS

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Treatment: APPLIC; EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

THIS PAPER IS BASED ON THE DATA OF 25 PATIENTS ON PACEMAKER IN 1975-6 WHERE THE PHENOMENON WAS CLEARLY DEMONSTRABLE, BECAUSE EITHER THE ELECTRICAL STIMULATION HAD BEEN ONLY TEMPORARY, OR THE PACEMAKER WAS OF STANDBY FUNCTION, OR PACEMAKER INTERFERENCE HAD OCCURRED. IN 23

INSTANCES CHRONIC PATHOLOGIC ALTERATIONS WERE IN THE BACKGROUND, SUCH AS CORONARY SCLEROSIS OR FIBROSIS OF THE CONDUCTIVE SYSTEM. TWO PATIENTS HAD MYOCARDIAL INFARCTION, ONE DIGITALIS INTOXICATION. THE CHARACTER OF THE ARRHYTHMIAS RESPONSIBLE FOR THE PACEMAKER STIMULATION, IS TABULATED. THE NORMAL OR WIDE QRS CONFIGURATIONS ARE INDICATED. THE CHARACTERISTIC ECG CHANGE WAS T INVERSION IN THE UNPACED ELECTROCARDIOGRAM, SUBSEQUENT TO VENTRICULAR PACING.

Descriptors: PACEMAKERS; ELECTROCARDIOGRAPHY

Identifiers: T WAVE INVERSION; PACEMAKER; CHRONIC PATHOLOGIC ALTERATIONS; ARRHYTHMIAS; QRS; ECG; VENTRICULAR PACING

INSIDE K2VGV THE AMATEUR AND HIS PACEMAKER

SCHWARTZ, J.

CQ RADIO AMAT. J. (USA) VOL. 34, NO. 10 20-1, 98 OCT. 1978

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

DESCRIBES THE ELECTRICAL OPERATION OF HEART PACEMAKERS. THE QUESTION OF INTERFERENCE ARISING FROM ELECTRICAL DEVICES IN THE HOME, CARS AND DUE TO AMATEUR RADIO SYSTEM OPERATIONS IS DISCUSSED.

Descriptors: PACEMAKERS; ELECTROMAGNETIC INTERFERENCE

Identifiers: HEART PACEMAKERS; INTERFERENCE; ELECTRICAL DEVICES; HOME; CARS; AMATEUR RADIO SYSTEM; DOMESTIC APPLIANCES

THE EFFECT OF 60 HERTZ ELECTRIC FIELDS AND CURRENTS ON IMPLANTED CARDIAC PACEMAKERS

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Sponsor: IEEE

PROCEEDINGS OF THE IEEE 1978 INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY 258-65 1978

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Languages: ENGLISH

INPUT DATA TO THE PREDICTION MODEL INCLUDED IN VITRO SUSCEPTIBILITY BENCH TESTS ON PACEMAKERS, IN VIVO EXPOSURE MEASUREMENTS ON BABOONS WITH IMPLANTED PACEMAKERS, AND NONHAZARDOUS NONINVASIVE TESTS ON HUMANS. THE RESULTS SHOW THAT WIDESPREAD INTERFERENCE FROM 60 HZ ELECTRIC FIELDS OR CURRENTS DOES NOT CONSTITUTE A PROBLEM FOR THE VAST MAJORITY OF PACEMAKER PATIENTS. THIS PAPER PROVIDES BASIC INFORMATION ON 60 HZ ENVIRONMENTS, PACEMAKER OPERATION, IN VITRO BENCH MEASUREMENTS AND IN VIVO STUDIES.

Descriptors: PACEMAKERS; LEAKAGE CURRENTS; ELECTROMAGNETIC INTERFERENCE; SAFETY

Identifiers: IMPLANTED CARDIAC PACEMAKERS; PREDICTION MODEL;

EXPOSURE MEASUREMENTS; 60 HZ ELECTRIC FIELDS; PACEMAKER OPERATION;
LEAKAGE CURRENTS

SLOW AND RAPID RESPONSES TO CW AND PULSED MICROWAVE RADIATION BY
INDIVIDUAL APLYSIA PACEMAKERS

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USA J. MICROWAVE POWER (CANADA) VOL. 13, NO. 1 77-86 MARCH 1978

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

SPECIFIC ABSORPTION RATES (SARS) OF MICROWAVE ENERGY THAT ALTERED
FIRING RATES WERE DETERMINED FOR INDIVIDUAL PACEMAKER NEURONS IN THE
ABDOMINAL GANGLION OF APLYSIA CALIFORNICA. TWO TYPES OF RESPONSES WERE
OBSERVED. THE RESPONSE THAT WAS SEEN IN ALL NEURONS DEVELOPED SLOWLY,
REACHING A STEADY STATE IN ONE TO THREE MINUTES. THE OTHER RESPONSE
WAS SEEN IN A FEW NEURONS AND OCCURRED WITHIN FIVE SECONDS FROM THE
ONSET OF IRRADIATION. SIMILAR RESPONSES WERE OBTAINED FOR TWO
MICROWAVE FREQUENCIES, 1.5 AND 2.45 GHZ. PULSED RADIATION INDUCED
RAPID CHANGES OF FIRING RATE MORE READILY THAN DID CW RADIATION. THE
EFFECTS OF TEMPERATURE CHANGES ON THE PACEMAKERS' FIRING RATES WERE
STUDIED. SINCE SOME RESPONSES WERE NOT READILY EXPLAINED BY GENERAL
HEATING OF THE PREPARATION ALTERNATE MECHANISMS ARE SUGGESTED FOR THE
OBSERVED EFFECTS.

Descriptors: BIOLOGICAL EFFECTS OF MICROWAVES; NEUROPHYSIOLOGY

Identifiers: PULSED MICROWAVE RADIATION; MICROWAVE ENERGY; PACEMAKER
NEURONS; APLYSIA CALIFORNICA; IRRADIATION; CW RADIATION

NEW INTERFERENCE SENSING DEMAND PACEMAKER FUNCTIONS

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IEEE TRANS. BIOMED. ENG. (USA) VOL. BME-25, NO. 3 264-9 MAY 1978

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

DEMAND CARDIAC PACEMAKER FUNCTIONS ARE UNDER STUDY THAT PROVIDE NEW
METHODS TO DISTINGUISH BETWEEN CARDIAC ACTIVITY AND PULSATILE
ELECTROMAGNETIC INTERFERENCE (PEMI). ALL KNOWN FORMS OF CURRENTLY
MARKETED VENTRICULAR INHIBITED DEMAND PACEMAKER (VVI) FUNCTIONS CAN BE
INHIBITED BY HIGH LEVEL PULSATILE ELECTROMAGNETIC INTERFERENCE. THE
RECENT INTRODUCTION OF SHIELDED CIRCUITRY TO PROTECT AGAINST DISRUPTIVE
(INHIBITING) EMI HAS REDUCED PACEMAKER SENSITIVITY TO INTERFERENCE.
HOWEVER, EMI RECEIVED VIA THE CARDIAC LEAD/ELECTRODE CAN STILL MIMIC
CARDIAC ACTIVITY. THE NEW FUNCTIONS UNDER DEVELOPMENT EMPLOY A
SEPARATE EMI DETECTION RECEIVER FOR CONTROLLING THE PACEMAKER MODE TO
MINIMIZE INHIBITION BY PEMI.

Descriptors: PACEMAKERS; INTERFERENCE SUPPRESSION

Identifiers: INTERFERENCE SENSING DEMAND PACEMAKER FUNCTIONS; CARDIAC PACEMAKER; PULSATILE ELECTROMAGNETIC INTERFERENCE; VENTRICULAR INHIBITED DEMAND PACEMAKER; SHIELDED CIRCUITRY

BEHAVIOR OF CARDIAC PACEMAKERS IN PULSED EM FIELDS

DENNY, H.W.; JENKINS, B.M.; TOLER, J.C.

ENGG. EXPERIMENT STATION, GEORGIA INST. OF TECHNOL., ATLANTA, GA,

USA Sponsor: IEEE

1977 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY
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2-4 AUG. 1977 SEATTLE, WA., USA

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XI+487 pp.

Treatment: EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

A PRESENTATION AND INTERPRETATION ARE GIVEN OF THE FINDINGS OF A SERIES OF SEVENTEEN INVESTIGATIVE PROGRAMS INTO THE RF SUSCEPTIBILITY PROPERTIES OF CARDIAC PACEMAKERS. HISTORICAL TRENDS SHOWING THE RELATIVE EFFECTS OF THE MANUFACTURERS' DESIGN AND CONSTRUCTION IMPROVEMENTS ARE PRESENTED. A POPULATION PROFILE OF THE PACEMAKERS TESTED RELATES PERCENTAGE OF FAILURES TO FIELD INTENSITY. BAR GRAPHS ILLUSTRATE THE EFFECTS OF PRF ON PACEMAKER PERFORMANCE. EFFECTS OF DIFFERENT IMMERSION MEDIA ARE EXAMINED.

Descriptors: PACEMAKERS; RADIOFREQUENCY INTERFERENCE; ELECTRONIC EQUIPMENT TESTING; FAILURE ANALYSIS

Identifiers: PULSED EM FIELDS; RF SUSCEPTIBILITY; CARDIAC PACEMAKERS; TRENDS; DESIGN; CONSTRUCTION; POPULATION PROFILE; FAILURES; FIELD INTENSITY ; PRF; IMMERSION MEDIA

INFLUENCE ON IMPLANTED CARDIAC PACEMAKERS BY ELECTRONIC SENSOR SWITCHES AND ELECTROSTATIC DISCHARGES

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(Editors)

Sponsor: IEEE; ET AL.

2ND SYMPOSIUM AND TECHNICAL EXHIBITION ON ELECTROMAGNETIC
COMPATIBILITY 491-4 1977

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Document Type: CONFERENCE PAPER

Languages: ENGLISH

A PACEMAKER SYSTEM CONSISTS OF A SIMULATOR AND A LEAD AND MAY BE INFLUENCED BY INDUCTIVELY, ELECTRICALLY AND GALVANIC COUPLED INTERFERENCE SIGNALS. THIS REPORT DEALS MAINLY WITH TWO TYPES OF GALVANIC COUPLED INTERFERENCE.

Descriptors: PACEMAKERS; ELECTROMAGNETIC INTERFERENCE; DISCHARGES (ELECTRIC)

Identifiers: IMPLANTED CARDIAC PACEMAKERS; ELECTRONIC SENSOR SWITCHES; ELECTROSTATIC DISCHARGES; GALVANIC COUPLED INTERFERENCE

NEW RECHARGEABLE HG-ZN PACEMAKER IS FREE FROM ELECTROMAGNETIC INTERFERENCE

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JEE (JAPAN) NO. 119 54-6 NOV. 1976

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

DESCRIBES A SMALL, THIN, HERMETICALLY SEALED, RECHARGEABLE PACEMAKER THAT WILL RUN FOR 4 TO 6 YEARS BETWEEN RECHARGINGS. ACTUAL TIME CONTINUOUS FUNCTION TO DATE IS IN ITS SEVENTH YEAR AND ACCELERATED TESTS INDICATE A 50 YEAR PLUS FUNCTIONAL LIFE. A CLINICAL TEST SERIES HAS BEEN INITIATED.

Descriptors: PACEMAKERS; SECONDARY CELLS; PROSTHETIC POWER SUPPLIES

Identifiers: HG-ZN RECHARGEABLE PACEMAKER; SMALL PACEMAKER; 4 YEAR RUNNING TIME BETWEEN RECHARGINGS; CHARACTERISTICS; EM INTERFERENCE FREE

EVALUATION OF IN VIVO VERSUS IN VITRO TEST METHODS FOR THE DETERMINATION OF ELECTROMAGNETIC COMPATIBILITY OF IMPLANTABLE CARDIAC PACEMAKERS AT 450 MHZ

SCHLENTZ, R.J.; LARSON, K.L.; EXWORTHY, K.W.

MEDTRONIC INC., MINNEAPOLIS, MN, USA

Sponsor: IEEE

INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY 231-6 1976 13-15 JULY 1976 WASHINGTON, D.C., USA

Publ: IEEE, NEW YORK, USA

XII+437 pp.

Treatment: PRACTICAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

EVALUATES TWO SYSTEMS FOR MEASURING THE SUSCEPTIBILITY TO EMI OF IMPLANTABLE CARDIAC PACEMAKERS. EACH SYSTEM CONSISTS OF FOUR PARTS: THE PACEMAKER; A 450 MHZ ELECTROMAGNETIC FIELD; THE INSTRUMENTATION FOR MONITORING PACEMAKER FUNCTION; AND THE MEDIUM IN WHICH THE PACEMAKER IS PLACED FOR TEST. THE TWO SYSTEMS DIFFER IN THE MEDIUM USED; ONE IS AN EMPIRICALLY DERIVED SOLUTION AND THE SECOND IS A CANINE. THE TWO SYSTEMS ARE VALIDATED IN PRELIMINARY TESTING DONE IN VIVO AND IN VITRO. THE MEAN DATA RATIO BETWEEN THE FACILITIES IS 0.94 IN VIVO AND 0.92 IN VITRO INDICATING GOOD ABSOLUTE AGREEMENT OF THE TEST SETUP, CALIBRATION AND PROCEDURE.

Descriptors: PACEMAKERS; ELECTROMAGNETIC COMPATIBILITY; ELECTRONIC EQUIPMENT TESTING; CARDIOLOGY

Identifiers: IN VITRO TEST; IMPLANTABLE CARDIAC PACEMAKERS;
SUSCEPTIBILITY; MEAN DATA RATIO; EM COMPATIBILITY; IN VIVO TEST; EM
FIELD

THE EFFECT OF RADAR ON CARDIAC PACEMAKERS

ROHL, D.; LAUN, H.M.; HAUBER, M.E.T.; STAUCH, M.; VOIGT, H.
DEPT. OF CARDIOLOGY, UNIV. OF ULM, ULM, GERMANY;
ISA TRANS. (USA) VOL. 14, NO. 2 115-17 1975

Treatment: EXPERIMENTAL;
Document Type: JOURNAL PAPER
Languages: ENGLISH

THE SUSCEPTIBILITY OF 16 NONCOMPETITIVE CARDIAC PACEMAKERS TO RADIATION FROM A POWERFUL RADAR SYSTEM WAS INVESTIGATED IN THE LABORATORY AND IN THE VICINITY OF ITS PROTOTYPE. FROM COMPARATIVE IN VITRO TESTS IN AIR, FAT, WATER, AND SALINE IT WAS CONCLUDED THAT ONLY TESTS IN FAT OR AIR REPRESENT THE WORST CASE CONDITION AFTER IMPLANTATION. IN AIR ALL PACEMAKERS SHOWED SIGNS OF INTERFERENCE AT PULSE POWER DENSITIES BETWEEN 0.025 MW/CM/SUP 2/ AND 62.5 MW/CM/SUP 2/. THREE OF SIX IMPLANTED PACEMAKERS WERE TRIGGERED OR INHIBITED DEPENDING ON THEIR MODE OF OPERATION WHEN TESTED AT A LOCATION 1.2 KM AWAY FROM THE RADAR STATION BY THE RADAR BEAM OCCURRING EVERY 5.5 SEC. BECAUSE INTERFERING RADIATION CAN ENTER THE PACEMAKER CIRCUITRY DIRECTLY ALONG THE ELECTRODE, ACTING AS AN ANTENNA, METAL ENCAPSULATION OF THE PULSE GENERATOR DOES NOT PROVIDE SUFFICIENT SHIELDING AGAINST MICROWAVE RADIATION. PACEMAKERS MODIFIED BY METAL ENCAPSULATION AND A LOW-PASS FILTER AT THE ELECTRODE REMAINED UNDISTURBED AT PULSE POWER DENSITIES OF >10 W/CM/SUP 2/ WHEN TESTED UNDER WORST CONDITIONS IN AIR.

Descriptors: PACEMAKERS; CARDIOLOGY; RADAR SYSTEMS; RADIATION EFFECTS; TESTING; ELECTROMAGNETIC INTERFERENCE

Identifiers: NONCOMPETITIVE CARDIAC PACEMAKERS; POWERFUL RADAR SYSTEM; AIR; FAT; WATER; SALINE; IMPLANTATION; METAL ENCAPSULATION; MICROWAVE RADIATION; RADIATION EFFECTS; ELECTROMAGNETIC INTERFERENCE; LOW PASS FILTER; TESTING

DEVELOPMENT OF A PACEMAKER MONITOR WITH CARDIAC SIMULATOR
STEINER, T.O.

Issued by: SCHOOL OF AEROSPACE MEDICINE, BROOKS AFB, TEX., USA;
FEB. 1975

12 pp.

Availability: NTIS, SPRINGFIELD, VA. 22161, USA

Report No.: SAM-TR-75-7

Treatment: PRACTICAL;

Document Type: REPORT

Languages: ENGLISH

A CARDIAC PACEMAKER MONITORING SYSTEM WAS DEVELOPED FOR USE IN TESTING CARDIAC PACEMAKERS IN RF FIELDS. THE SYSTEM PROVIDED FOR BOTH CONTINUOUS MONITORING OF THE PACEMAKER OUTPUT AND SIMULATING NORMAL CARDIAC ACTIVITY AT THE PACEMAKER LEADS. FIBER OPTICS TECHNIQUES WERE USED TO PROVIDE THE NECESSARY ELECTRICAL ISOLATION OF THE PACEMAKER.

TESTS HAVE SHOWN THAT THE MONITORING SYSTEM DOES NOT SIGNIFICANTLY AFFECT PACEMAKER RESPONSE TO RF FIELDS.

Descriptors: PACEMAKERS; ELECTRONIC EQUIPMENT TESTING; BIOMEDICAL ELECTRONICS; RADIOFREQUENCY INTERFERENCE; MONITORING; FIBRE OPTICS

Identifiers: CARDIAC SIMULATOR; CARDIAC PACEMAKER MONITORING SYSTEM; RF FIELDS; ELECTRICAL ISOLATION; PACEMAKER RESPONSE

ENERGY DENSITY: A PROPOSED PARAMETER FOR ASSESSING ELECTROMAGNETIC PERFORMANCE OF DEMAND PACEMAKERS

TOLER, J.C.

ENGG. EXPERIMENT STATION, GEORGIA INST. OF TECHNOL., ATLANTA, GA, USA DVORAK, T. (Editors)

Sponsor: PURDUE UNIV.; ET AL

ELECTROMAGNETIC COMPATIBILITY 1975 507-10 1975

20-22 MAY 1975 MONTREUX, SWITZERLAND

Publ: IEEE, NEW YORK, USA

XII+549 pp.

Treatment: PRACTICAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

BECAUSE OF ITS LIFE SUPPORT NATURE, THE IMPLANTABLE CARDIAC PACEMAKER HAS BECOME AN ELECTRONIC DEVICE FOR WHICH INTERFERENCE IS OF PARTICULAR CONCERN. EFFORTS TO DEFINE INTERFERENCE EFFECTS ON PACEMAKERS HAVE BEEN HAMPERED BY THE LACK OF AN ELECTROMAGNETIC PARAMETER AGAINST WHICH PERFORMANCE CAN BE JUDGED. RESEARCH PROGRAMS USING DEMAND PACEMAKERS EXPOSED TO PULSED ELECTROMAGNETIC ENVIRONMENTS INDICATE THE POSSIBILITY THAT ENERGY DENSITY MAY BE A SUITABLE PERFORMANCE PARAMETER. THIS PARAMETER AND ITS DERIVATION ARE DESCRIBED IN THIS PAPER.

Descriptors: PACEMAKERS; ELECTRONIC EQUIPMENT TESTING; POWER MEASUREMENT; ELECTROMAGNETIC INTERFERENCE

Identifiers: IMPLANTABLE CARDIAC PACEMAKER; INTERFERENCE EFFECTS; ELECTROMAGNETIC PARAMETER; DEMAND PACEMAKERS; ENERGY DENSITY; PERFORMANCE

INTERFERENCE WITH CARDIAC PACEMAKERS SOURCES OF INTERFERENCE, PACEMAKER BEHAVIOUR COUNTERACTIONS

IRNICH, W.; DE BAKKER, J.M.T.; BISPING, H.-J.

RWTH AACHEN, GERMANY

BIOMED. TECH. (GERMANY) VOL. 19, NO. 5 193-204 OCT. 1974

Treatment: GENERAL, REVIEW;

Document Type: JOURNAL PAPER

Languages: GERMAN

THIS ARTICLE PROVIDES THE RECENT REPORTS ON THE SOURCES OF INTERFERENCES WITH CARDIAC PACEMAKERS, SUCH AS ELECTROCAUTERY, TV TRANSMITTERS AND MICROWAVES. IN ADDITION, INTRACORPORAL DISTURBANCES OF THE DEMAND MODE HAVE BEEN REPORTED CAUSED BY MUSCLE SWITCHING SIGNALS AND BY TEMPORARILY TOUCHING OF TWO ELECTRODES. THE BEHAVIOUR OF SYNCHRONIZED PACEMAKERS REGARDING INTERFERENCE IN THE LOW FREQUENCY

RANGE IS DISCUSSED TOGETHER WITH THE PROBLEM OF A CONTINUOUS INTERFERENCE.

Descriptors: PACEMAKERS; ELECTROMAGNETIC INTERFERENCE; FILTERS
 Identifiers: INTERFERENCES; CARDIAC PACEMAKERS; ELECTROCAUTERY; TV TRANSMITTER; MICROWAVES; INTRACORPOREAL DISTURBANCES; MUSCLE SWITCHING SIGNALS; CONTINUOUS INTERFERENCE; ELECTRO THERAPY; HEART RATE; SIGNAL DETECTING DEVICES; FILTERING DEVICES

THE EFFECT OF RADAR ON CARDIAC PACEMAKERS. III. REDUCTION OF INTERFERENCE SUSCEPTIBILITY THROUGH METAL-SHIELDING AND ELECTRODE FILTERING

ROHL, D.; HAUBER, M.E.T.; LAUN, H.M.; VOIGT, H.; STAUCH, M. UNIV. ULM, GERMANY

BIOMED. TECH. (GERMANY) VOL. 19, NO. 1 27-30 FEB. 1974

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: GERMAN

OPTIMAL SHIELDING OF CARDIAC PACEMAKERS AGAINST MICROWAVE RADIATION MUST PREVENT DIRECT CIRCUITAL INTERFERENCE AS WELL AS REDUCE THE RADIATION ENTERING THROUGH THE ELECTRODE ACTING AS AN ANTENNA. THE FORMER CAN BE ACHIEVED BY METAL-ENCAPSULATION, THE LATTER BY A LOW-PASS FILTER AT THE ELECTRODE. PACEMAKERS MODIFIED ACCORDING TO THESE PRINCIPLES REMAINED UNDISTURBED AT RADIATION LEVELS WHICH MIGHT OCCUR IN THE PUBLICLY ACCESSIBLE VICINITY OF MICROWAVE SOURCES.

Descriptors: PACEMAKERS; RADIATION PROTECTION; RADIOFREQUENCY INTERFERENCE; MICROWAVE FILTERS; RADAR

Identifiers: RADAR; CARDIAC PACEMAKERS; INTERFERENCE SUSCEPTIBILITY; ELECTRODE FILTERING; DIRECT CIRCUITAL INTERFERENCE; VICINITY OF MICROWAVE SOURCES; METAL ENCAPSULATION

MEASUREMENT TECHNIQUES FOR ASSESSING THE INFLUENCE OF ELECTROMAGNETIC FIELDS ON IMPLANTED PACEMAKERS

VAN-WIJK VAN-BRIEVINGH, R.P.; HOEKSTRA, A.; DEBAKKER, J.M.T.; HEMELAAR, A.

DELFT UNIV. TECHNOL., NETHERLANDS

MED. AND BIOL. ENG. (GB) VOL. 12, NO. 1 42-9 JAN. 1974

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: ENGLISH

A METHOD IS DESCRIBED FOR ASSESSING QUANTITATIVELY THE INFLUENCE OF ELECTROMAGNETIC FIELDS ON THE FUNCTION OF IMPLANTED CARDIAC PACEMAKERS. THIS INFLUENCE MAY OCCUR EITHER INDIRECTLY BY THE ACTION AS AN ANTENNA OF THE CATHETER OR DIRECTLY BY INDUCTION INTO THE PACEMAKER'S ELECTRONIC CIRCUIT. THE TECHNIQUE COMPRISES: MEASUREMENT OF THE INFLUENCE OF ELECTRIC VOLTAGES OF VARIOUS FREQUENCIES APPLIED DIRECTLY ACROSS THE GENERATOR'S OUTPUT CONNECTIONS; DETERMINATION OF THE AERIAL FACTOR OF THE CATHETER CONFIGURATION; COMBINATION OF THE DATA ACQUIRED TO A DIAGRAM OF OVERALL SENSITIVITY OF THE COMBINATION, AND MEASUREMENT OF THE DIRECT INFLUENCE OF FIELDS ON THE PACEMAKER ITSELF. IT IS

CONCLUDED, THAT DISTURBANCE OF PACEMAKER ACTION MAY OCCUR IN THE VICINITY OF APPARATUS DESIGNED TO PRODUCE ELECTROMAGNETIC FIELDS, SUCH AS BROADCAST TRANSMITTERS, DIATHERMY APPLICATORS, AND RADAR SETS. NORMAL HOUSEHOLD APPLIANCES APPEAR TO BE SAFE IN THE RESPECT INVESTIGATED.

Descriptors: PACEMAKERS; ELECTROMAGNETIC INTERFERENCE; NOISE MEASUREMENT

Identifiers: ANTENNA; CATHETER; CARDIAC PACEMAKERS; EM INTERFERENCE; EM FIELDS; SENSITIVITY DIAGRAM

THE EFFECT OF RADAR ON CARDIAC PACEMAKERS. I. RADAR FACILITY AND EXPERIMENTAL METHODS

ROHL, D.; LAUN, H.M.; HAUBER, M.E.T.; STAUCH, M.; VOIGT, H. UNIV. ULM, GERMANY

BIOMED. TECH. (GERMANY) VOL. 18, NO. 6 209-16 DEC. 1973

Treatment: EXPERIMENTAL;

Document Type: JOURNAL PAPER

Languages: GERMAN

COMPARATIVE SUSCEPTIBILITY MEASUREMENTS OF 10 SYNCHRONOUS CARDIAC PACEMAKERS TO RADIATION FROM THE SRE-LL-1 RADAR SYSTEM OPERATING AT A FREQUENCY OF 1.3 GHZ WERE PERFORMED IN AIR, FAT AND NACL-SOLUTION. IT COULD BE SHOWN THAT ONLY THROUGH TESTS IN FAT OR AIR WITH PACEMAKER AND ELECTRODE IN THEIR MOST SENSITIVE ORIENTATION AND AN ELECTRODE LENGTH CONSTITUTING AN OPTIMAL RECEIVING ANTENNA IT IS POSSIBLE TO REPRODUCE THE WORST CASE CONDITION AFTER IMPLANTATION. THE DATA ARE IN AGREEMENT WITH THE KNOWN DIELECTRIC PROPERTIES OF THE DIFFERENT MEDIA AT HIGH FREQUENCIES.

Descriptors: PACEMAKERS; RADAR

Identifiers: CARDIAC PACEMAKERS; COMPARATIVE SUSCEPTIBILITY MEASUREMENTS; OPTIMAL RECEIVING ANTENNA; DIELECTRIC PROPERTIES; SRE LLI RADAR SYSTEM; FAT

PACEMAKER PERFORMANCE IN THE VICINITY OF FM AND TV TRANSMITTERS

VREELAND, R.W.; SHEPHERD, M.D.

UNIV. CALIFORNIA SAN FRANCISCO MEDICAL CENTER, USA

Sponsor: ALLIANCE FOR ENGG. IN MEDICINE AND BIOLOGY

PROCEEDINGS OF THE 26TH ANNUAL CONFERENCE ON ENGINEERING IN MEDICINE AND BIOLOGY 211 1973

30 SEPT. - 4 OCT. 1973 MINNEAPOLIS, MINN., USA

Publ: ALLIANCE FOR ENGG. IN MEDICINE AND BIOLOGY, ARLINGTON, VA., USA XIX+422PP.

Treatment: EXPERIMENTAL;

Document Type: CONFERENCE PAPER

Languages: ENGLISH

NINE PACEMAKERS WERE TESTED AT A MOUNTAIN TOP TRANSMITTER SITE. THEY INCLUDED SIX EXTERNAL DEMAND PACEMAKERS, ONE OF THE BIPOLAR IMPLANTABLE DEMAND TYPE, ONE MONOPOLAR IMPLANTABLE DEMAND PACEMAKER AND ONE MONOPOLAR IMPLANTABLE FIXED RATE UNIT. VARIOUS PACEMAKER TERMINATIONS INCLUDING SEVERAL STANDARD CATHETERS AS WELL AS TRANSMISSION LINES AND DIPOLE ANTENNAS WERE STUDIED. PACEMAKER PERFORMANCE WAS CLEARLY A

FUNCTION OF THE TYPE OF TERMINATION. EIGHT OF THE NINE PACEMAKERS WERE AFFECTED. SIX OF THEM STOPPED PACING. THE STRONGEST SIGNALS AT THE MOUNTAIN TOP WERE 0.71 AND 1.3 VOLTS PER METER FROM TWO TV STATIONS AND 0.47, 0.56, 0.84 AND 2.8 VOLTS PER METER FROM FM TRANSMITTERS.

Descriptors: PACEMAKERS; ELECTROMAGNETIC INTERFERENCE; RADIO TRANSMITTERS ; TELEVISION TRANSMITTERS; ELECTRONIC EQUIPMENT TESTING
Identifiers: PACEMAKER PERFORMANCE; FM TRANSMITTER EFFECTS; TV TRANSMITTER EFFECTS

DEMAND CARDIAC PACER WITH INTERFERENCE PROTECTION

COLE, A.D.; SMITH, R.S.

Patent No.: USA 3678937 Assignees: ADCOLE CORP.

Filed: 1 JUNE 1970

Original Patent Appl. No.: USA 41880

25 JULY 1972

Treatment: APPLIC; PRACTICAL;

Document Type: PATENT

Languages: ENGLISH

RELATES TO A DEMAND CARDIAC PACER COMPRISING A RELAXATION OSCILLATOR FOR APPLYING HEART-STIMULATING PULSES TO A PAIR OF ELECTRODES AT A RATE SOMEWHAT LESS THAN THE LOWEST RATE OF NATURAL HEARTBEATS, AND A TIMING CIRCUIT FOR MEASURING THE INTERVAL BETWEEN VOLTAGE PULSES ON THE ELECTRODES PRODUCED EITHER BY THE OSCILLATOR, BY NATURAL HEART SIGNALS, OR BY NOISE SIGNALS, FOR DISABLING THE OSCILLATOR WHEN NATURAL HEART PULSES ARE RECEIVED AT A RATE IN THE NORMAL RANGE, AND FOR ENABLING THE OSCILLATOR IN THE PRESENCE OF NOISE SIGNALS ABOVE A CERTAIN FREQUENCY RANGE.

Descriptors: PACEMAKERS; OSCILLATORS; TIMING CIRCUITS; CARDIOLOGY

Identifiers: DEMAND CARDIAC PACER; INTERFERENCE PROTECTION; RELAXATION OSCILLATOR; ELECTRODES; TIMING CIRCUIT; NOISE SIGNALS; HEART STIMULATING PULSES

INTERFERENCE LIMITS OF IMPLANTED CARDIAC PACEMAKERS

BLASER, R.; DITTRICH, H.; KIRSCH, U.; SCHALDACH, M.

BIOMED. TECH. (GERMANY) VOL. 17, NO. 3 109-16 JUNE 1972

Treatment: PRACTICAL;

Document Type: JOURNAL PAPER

Languages: GERMAN

A NUMBER OF ELECTRICAL APPARATUSES CAN BE POTENTIALLY HAZARDOUS TO PATIENTS WITH IMPLANTED CARDIAC PACEMAKERS (MAINS CONNECTED HOUSEHOLD ARTICLES, TOOLING MACHINES, RADAR UNITS MICROWAVE OVENS AND ELECTRICALLY DRIVEN PUBLIC TRANSPORT VEHICLES). A STUDY WAS MADE OF THESE FACTORS AND THE EFFECT OF APPARATUS OF DIFFERENT MANUFACTURES. ONLY PACEMAKERS WHICH HAVE A METALLIC SCREENING DEVICE FULFIL THE NECESSARY SAFETY REGULATIONS. BECAUSE OF THE MAXIMALLY PERMITTED INTERFERENCE DENSITY IS OFTEN EXCEEDED, THE PACEMAKER MUST INCORPORATE A DEVICE WHICH AUTOMATICALLY SWITCHES TO A SAFE RHYTHM WHEN THE INTERFERENCE LIMITS ARE REACHED. ALL PACEMAKERS WITH A STEEL CAPSULE ARE ESPECIALLY SAFE.

Descriptors: PACEMAKERS; SAFETY; INTERFERENCE
 Identifiers: INTERFERENCE LIMITS; IMPLANTED CARDIAC PACEMAKERS;
 METALLIC SCREENING DEVICE; SAFETY REGULATIONS

Effect of magnetic resonance imaging on DDD pacemakers.

Erlebacher JA; Cahill PT; Pannizzo F; Knowles RJ
 Am J Cardiol Feb 15 1986, 57 (6) p437-40,

Languages: ENGLISH

Journal Announcement: 8605

A previous study suggested the safety of exposing patients with certain pacemakers models to magnetic resonance imaging (MRI). However, the function of a variety of more advanced DDD pacemakers and the effect of higher magnetic and radio-frequency (rf) field strengths has not been reported. In the present study 4 different DDD pacemakers (Cordis 233F, Intermedic 283-01, Medtronic 7000A, and Pacemaker 283) were tested in a saline phantom under several conditions and with various imaging sequences. Pacemaker output was monitored using electrocardiographic telemetry. All units paced normally in the static magnetic field. However, during imaging, all units malfunctioned, with total inhibition of atrial and ventricular output in 3 of the pacemakers. In the fourth pacemaker, ventricular backup pacing was activated at high rf pulse repetition rates. However, the MRI scanner could trigger atrial output in this pacemaker at rates of up to 800/minute. All malfunctions were a result of rf interference, whereas gradient and static magnetic fields had no effect. Thus, despite magnetic fields had no effect. Thus, despite magnetic field strengths adequate to close pacemaker reed switches, rf interference during MRI may cause total inhibition of atrial and ventricular output in DDD pacemakers, and can also cause dangerous atrial pacing at high rates. MRI should be avoided in patients with these DDD pacemakers.

Descriptors: *Nuclear Magnetic Resonance--Adverse Effects--AE;
 *Pacemaker, Artificial; Electrocardiography; Equipment Failure;
 Evaluation Studies; Telemetry

The effects of ionizing radiation on eight cardiac pacemakers and the influence of electromagnetic interference from two linear accelerators.

Venselaar JL

Radiother Oncol Jan 1985, 3 (1) p81-7,

Languages: ENGLISH

Journal Announcement: 8506

Eight cardiac pacemakers were irradiated in a cobalt-60 beam. Two out of six demand-type pacemakers showed an alarming decrease in pulse repetition frequency when irradiated to dose levels that are used in radiotherapy (less than 100 Gy). Two modern programmable pacemakers showed a failure at a dose of 97 and 147 Gy, respectively. The dose levels at which these failures occurred were low enough to recommend that cardiac pacemakers should always be kept outside the radiation beam. The signals induced by electromagnetic interference (EMI) from two linear accelerators were measured using a simulation model of a

pacemaker. In the laboratory, 22 modern-type pacemakers were tested with these signals to determine the sensitivity for the electromagnetic fields in the treatment rooms. It was observed that an inhibition of one pacemaker pulse was to be expected on one of the two linear accelerators when switching the machine on and off. No permanent effects were found. These findings resulted in the recommendation in our department not to use this treatment machine for radiation therapy of pacemaker-bearing patients.

Descriptors: *Pacemaker, Artificial; *Particle Accelerators; *Radiotherapy--Adverse Effects--AE; Electromagnetics; Radiation, Ionizing

Resetting of DDD pacemakers due to EMI.

Belott PH; Sands S; Warren J
PACE Mar 1984, 7 (2) p169-72,
Languages: ENGLISH

Journal Announcement: 8407

Multiprogrammable pacemakers have long been subject to inappropriate reprogramming and electromagnetic interference (EMI). A limited clinical experience with DDD pacing systems precludes the significance of such phenomena in these units. Since August 1981, in a series of 140 DDD systems, certain units demonstrated consistent and reproducible resetting to the back-up modes caused by electrocautery. One unit was permanently reset to the VOO mode. These observations suggest the need for renewed caution at the time of surgery; they also underscore the importance of a thorough understanding of any DDD system and careful follow-up so that such phenomena will not be misinterpreted as pacemaker failure, resulting in erroneous pacemaker removal.

Descriptors: *Electrocoagulation; *Electromagnetics; *Pacemaker, Artificial; Arrhythmia--Etiology--ET; Postoperative Complications--Etiology --ET

[Reactions of modern cardiac pacemakers to interference sources]
Reaktionen moderner Herzschrittmacher auf Storquellen.

Gebhardt-Seehausen U; Recker S
Lebensversicherungsmedizin Jan 1 1984, 36 (1) p2-6,
Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 8405

Descriptors: *Electromagnetic Fields--Adverse Effects--AE; *Electromagnetics--Adverse Effects--AE; *Pacemaker, Artificial; Diathermy --Adverse Effects--AE; Electrosurgery--Adverse Effects--AE; Radiotherapy, High Energy --Adverse Effects--AE

Effects of high-intensity power-frequency electric fields on implanted modern multiprogrammable cardiac pacemakers.

Butrous GS; Meldrum SJ; Barton DG; Male JC; Bonnell JA; Camm AJ
J R Soc Med May 1982, 75 (5) p327-31,

Languages: ENGLISH

Journal Announcement: 8209

Descriptors: *Electromagnetic Fields--Adverse Effects--AE;
*Electromagnetics--Adverse Effects--AE; *Pacemaker, Artificial; Aged;
Electrocardiography; Equipment Failure; Microcomputers; Middle Age

[External interference of cardiac pacemakers (author's transl)]

Externe Störbeeinflussung von Herzschrittmachern.

Gams E; Feder E; Heimisch W; Meisner H

Herz Dec 1978, 63 (36) p367-73,

Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 8106

The pacemaker patient is faced with potential origins of interference to the pacemaker function in his daily life, at his working place and during medical-therapeutic interventions. Technical faults in the electronic circuit induced by external sources can be neglected. Malfunctions of synchronized cardiac pacemakers may occur in the presence of electrical signals similar to the intracardiac ECG (e.g. nerve stimulators) or by the influence of high energy electrical field (e.g. pulsed electromagnetic fields). Technical improvements like metalshielding of the unit, electronic filtering components and automatic conversion to fixed rate stimulation increase the reliability to a high degree.

Descriptors: *Arrhythmia--Etiology--ET; *Pacemaker, Artificial--Adverse Effects--AE; Activities of Daily Living; Arrhythmia--Prevention and Control --PC; Pacemaker, Artificial--Standards--ST; Quality Control; Risk

Linac microwave hazards to cardiac pacemaker wearers [letter]

Annett CH

J Microwave Power Sep 1979, 14 (3) p297,

Languages: ENGLISH

Journal Announcement: 8009

Descriptors: *Microwaves--Adverse Effects--AE; *Pacemaker, Artificial; *Particle Accelerators; *Radiotherapy; Risk

Potential interference with medical electronic devices.

Reis R

Bull NY Acad Med Dec 1979, 55 (11) p1216-21,

Languages: ENGLISH

Journal Announcement: 8008

Descriptors: *Electromagnetic Fields; *Electromagnetics;
*Electronics, Medical--Instrumentation--IS; Diathermy--Instrumentation--IS; Electrosurgery--Instrumentation--IS; Pacemaker, Artificial; Radio Waves

Low power radio-frequency and microwave effects on human electroencephalogram and behavior.

Bise W

Physiol Chem Phys 1978, 10 (5) p387-98,

Languages: ENGLISH

Journal Announcement: 7909

In a pilot study of ten human subjects, temporary changes in brain waves and behavior were seen on exposure to power densities lower than 10(-12) W/cm², which is substantially below typical urban levels. Frequencies included .1 to 960 MHz continuous and 8.5 to 9.6 GHz pulse-modulated waves. Since the relaxation frequency of protein-bound water is considered to fall between 100 and 1,000 MHz, absorptions and quantum effects may be the mechanistic basis for the electroencephalogram changes observed in most of the subjects produced by 10(-15) W/cm² cw radio-frequency energy of between 130 and 960 MHz. Constructive and destructive interference patterns from standing waves within the skull possibly interact with the bioelectric generators in the brain, since electroencephalogram wave amplitudes and frequencies increased or decreased respectively at different radio wavelengths.

Descriptors: *Brain--Radiation Effects--RE; *Microwaves--Adverse Effects --AE; *Radio Waves--Adverse Effects--AE; Adolescence; Adult; Behavior --Radiation Effects--RE; Electroencephalography; Middle Age

Medical electronic equipment: can it survive in the nuclear electromagnetic environment?

Oliva SA; Stromberg LR

Milit Med Jan 1979, 144 (1) p28-30,

Languages: ENGLISH

Journal Announcement: 7906

Descriptors: *Electromagnetic Fields; *Electromagnetics; *Electronics, Medical; Equipment and Supplies, Hospital; Nuclear Energy; Radiation Protection; War

Electromagnetic interference in implantable pacemakers.

Irnich W; de Bakker JM; Bisping HJ

PACE Jan 1978, 1 (1) p52-61,

Languages: ENGLISH

Journal Announcement: 7905

The inhibited pacemaker (VVI or AAI) has become the most popular in recent years because of its ability to combine a physiological advantage with economical current consumption in cases with spontaneous activity. One of its disadvantages is its sensitivity to external electromagnetic interference. Though today's pacemakers possess effective protection against most interference signals there may be instances in which patients are subjected to uncomfortable or even life-threatening situations. This is the case of "amplitude modulated" or "pulsed" fields with modulation frequencies in the physiological range. Fields of that sort have been found in the vicinity of a welder, an electric steel plant, and in medical practice where

therapeutic currents were applied. Even touch-actuated switches may influence a demand pacemaker. However, these situations may be overcome by a device within the pacemaker for simple time analysis which can be carried out with few components. If electromagnetic fields of diathermy equipment are applied, today's pacemakers may react with intolerably high or low rates. They should, therefore, be avoided.

Descriptors: *Electromagnetics--Adverse Effects--AE; *Electronics, Medical--Instrumentation--IS; *Pacemaker, Artificial--Standards--ST

[Radiation therapy in patients with electronic cardiac pacemakers: interferences with the pacemaker's function by ionizing radiation and other sources of disturbances (author's transl)]

Strahlentherapie bei Patienten mit elektrischen Herzschrittmachern. Beeinflussung der Schrittmacherfunktion durch ionisierende Strahlung und andere Störquellen.

Bisping HJ; Stockberg H; Meyer J; Friik W

Strahlentherapie Jul 1977, 153 (7) p456-61,

Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 7712

In the course of radiation therapy and connected diagnostical measures ionizing radiation and other sources of disturbance may interfere with the function of permanent pacemakers. The conditions of such hazards are investigated in theory and practice making allowance for the different susceptibility to trouble of various models of permanent pacemakers. It appears that no extension of long-term follow-up of the cardiac pacemaker's function is needed with regard to possible late effects of ionizing radiation, but that the follow-up of pacemaker-patients during their first period of treatment should not be neglected, since other sources of electronic interference may be present. Routine checks as radiotherapy installations should also include possible sources of disturbance to electronic pacemakers.

Descriptors: *Pacemaker, Artificial; *Radiotherapy--Adverse Effects--AE; Aged

Interference to cardiac pacemakers.

Webber BA

Physiotherapy Sep 10 1975, 61 (9) p276,

Languages: ENGLISH

Journal Announcement: 7712

Descriptors: *Microwaves--Adverse Effects--AE; *Pacemaker, Artificial

[Electromagnetic fields and ventricular demand pacemakers] Champs electro-magnetiques et pacemakers sentinelles ventriculaires.

Birmann L; Friederici R; Sacrez A

Bull Soc Sci Med Grand Duché Luxemb May 1977, 114 (1) p5-10,

Languages: FRENCH
 Journal Announcement: 7712
 Descriptors: *Electromagnetic Fields; *Electromagnetics; *Pacemaker, Artificial; Pacemaker, Artificial--Adverse Effects--AE

Interference with cardiac pacemaker function.

Ohm OJ
 Acta Med Scand [Suppl] 1976, (596) p87-95,
 Languages: ENGLISH
 Journal Announcement: 7704

A survey is given of the factors affecting cardiac pacemaker function. Whereas it was earlier considered that external interference was a frequent cause of a pacemaker failure, more recent studies indicate that this is of minor importance. It would appear that failure of pacemaker function due to changes in the QRS-complex, i.e. voltage change, intraventricular conduction defects and frequency changes, intraventricular conduction defects and frequency changes, are more important. A lesser known cause of failure in demand function is the inhibition which arises from skeletal muscle potentials. This appears to be a major problem in some types of pacemaker. Manufacturing defects are unavoidable, and it can still be assumed that electronic component defects may develop in 1 of 1000 pulse generators. Cases with the problem of early run-away pacemaker are still being reported and two such cases are discussed. In one of the patients the run-away phenomenon was intermittent, and was accompanied by a variation in run-away frequency. This possibility should thus always be taken into consideration in a pacemaker patient presenting with syncope. In a patient with a QRS-inhibited pacemaker a double stimulation phenomenon has been observed.

Descriptors: *Electromagnetics; *Pacemaker, Artificial; Electrodes, Implanted; Heart Conduction System--Physiopathology--PP; Pacemaker, Artificial--Instrumentation--IS

Pacemakers and external interference.

Elmqvist H
 Acta Med Scand [Suppl] 1976, (596) p83-6,
 Languages: ENGLISH
 Journal Announcement: 7704
 Descriptors: *Electromagnetics; *Pacemaker, Artificial; Pacemaker, Artificial--Instrumentation--IS

Electromagnetic field interference and cardiac pacemakers.

Jones SL
 Phys Ther Sep 1976, 56 (9) p1013-8,
 Languages: ENGLISH
 Journal Announcement: 7612
 The physical and physiological effects of electromagnetic field interference on 440 patients with cardiac pacemakers were determined by

reviewing the literature from 1949 to 1973. The sources, mechanisms, and findings of physiological dysfunction and ventricular fibrillation in patients with pacemakers are presented. Shortwave and microwave diathermy and electrical stimulators have been found to have a definite adverse influence on some cardiac pacemakers. The effect of interference may be an increase or decrease in pacemaker rate or rhythm, ventricular fibrillation, a total loss of pacing, or cessation of impulses. Because all pacemaker units are not resistant to interference, no ungrounded electrical equipment and no equipment such as microwave diathermy, short wave diathermy, and electrical stimulators should be placed on, or near, a patient with a cardiac pacemaker.

Descriptors: *Electromagnetic Fields; *Electromagnetics; *Pacemaker, Artificial; Diathermy; Electric Stimulation; Physical Therapy; Ventricular Fibrillation--Etiology--ET

[Proceedings: Round table discussion: The patient with a pacemaker]

Rundtischgesprach: Der Schrittmacherpatient

Med Klin Jun 6 1975, 70 (23) p995-6,

Languages: GERMAN

Document Type: Historical Article

Journal Announcement: 7605

Descriptors: *Pacemaker, Artificial; Arrhythmia--Therapy--TH; Electrodes --Standards--ST; Electromagnetic Fields; Heart Block--Therapy--TH; History of Medicine, 20th Cent.; Pacemaker, Artificial--History--HI; Pacemaker, Artificial--Standards--ST; Pulse

Safety from microwave hazards in using microwave power equipment--an IMPI policy statement.

J Microwave Power Dec 1975, 10 (4) p333-41,

Languages: ENGLISH

Journal Announcement: 7606

Descriptors: *Microwaves--Adverse Effects--AE; Maximum Permissible Exposure Level; Pacemaker, Artificial; Safety

[Pacemaker failure due to electromagnetic interference (author's transl)] Herzschrittmacherversagen durch elektromagnetische Storfelder

Lampadius MS; Wirtzfeld A; Himmler FC

Med Klin Aug 29 1975, 70 (35) p1380-5,

Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 7602

Pacemakers may be influenced by a variety of external methods such as a magnet to test the stimulation threshold or a special programmer to change the pacers output or rate. This designed influence must not be confused with electromagnetic interference on pacemakers. The paper differentiates between functional and faulty behavior of pacemakers. A case report shows the influence of EMI by electrical devices. It is

recommended to undertake field tests if EMI is likely to occur under special occupational conditions.

Descriptors: *Electromagnetic Fields; *Electromagnetics; *Pacemaker, Artificial; Disability Evaluation; Electrocardiography; Environmental Exposure; Occupations; Spectrophotometry

[Problems of interference in artificial pacemaker's stimulation (author's transl)]

Interferenzprobleme bei der Schrittmacherbehandlung

Richter-von Arnould HP; Thiem AE; Westermann KW

Med Klin Sep 13 1974, 69 (37) p1500-5,

Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 7504

Descriptors: *Arrhythmia--Physiopathology--PP; *Pacemaker, Artificial --Adverse Effects--AE; Arrhythmia--Therapy--TH; Bradycardia--Physiopathology--PP; Electrocardiography; Extrasystole--Physiopathology--PP; Heart Block --Physiopathology--PP; Pacemaker, Artificial--Standards--ST; Time Factors; Ventricular Fibrillation--Etiology--ET

[Influence of radar radiation on cardiac pacemakers. II. Studies of synchronisable implantable pacemakers]

Der Einfluss von Radarstrahlung auf Herzschrittmacher. II.

Untersuchungen synchronisierbarer implantierbarer Schrittmacher

Rohl D ROHL D; Laun HM; Hauber ME; Voigt H; Stauch M

Z Kardiol May 1974, 63 (3) p444-60,

Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 7502

Descriptors: *Pacemaker, Artificial; *Radar; Dogs; Electrocardiography; Electromagnetics; Heart Block--Therapy--TH; Radiation Effects

[The influence of radar and high frequency sources on cardiac pacemakers (author's transl)]

Die Beeinflussung von Herzschrittmachern durch Radaranlagen und Hochfrequenzherde

Forsmark L; Taschner J; Weisshaar M; Rutsch F; Vause D; Wernitsch W; Kessler E

Thoraxchirurgie (Germany, West) Apr 1974, 22 (2) p106-12,

Languages: GERMAN Summary Languages: ENGLISH

Document Type: English Abstract

Journal Announcement: 7412

Descriptors: *Pacemaker, Artificial; *Radar; Metals; Microwaves--Adverse Effects--AE; Plastics; Radar--Adverse Effects--AE; Radiation Effects

[The effect of radar on cardiac pacemakers. IV. Interference susceptibility of external pacemakers (author's transl)]
 Der Einfluss von Radarstrahlung auf Herzschrittmacher. IV. Storanfalligkeit externer Schrittmacher
 Rohl D ROHL D; Laun HM; Hauber ME; Voigt H; Stauch M
 Dtsch Med Wochenschr (Germany, West) May 31 1974, 99 (22) p1167-71,
 Languages: GERMAN Summary Languages: ENGLISH
 Document Type: English Abstract
 Journal Announcement: 7410
 Descriptors: *Pacemaker, Artificial; *Radar; Electricity; Health Physics; Hospitals; Microwaves; Radiation Effects; Radiation Protection; Ventricular Fibrillation--Etiology--ET

The employee wearing a cardiac pacemaker.
 Koerner DR
 J Occup Med (United States) Jun 1974, 16 (6) p392-4,
 Languages: ENGLISH
 Journal Announcement: 7410
 Descriptors: *Accident Prevention; *Pacemaker, Artificial; Bioelectric Energy Sources; Electric Stimulation; Electrocardiography--Adverse Effects --AE; Electrodes, Implanted; Electromagnetics--Adverse Effects--AE; Environment; Microwaves--Adverse Effects--AE; Occupational Health Services; Occupational Medicine; Pacemaker, Artificial--Adverse Effects--AE; Ventricular Fibrillation--Etiology--ET

Experimental response curves: a means of predicting pacemaker response to electrical interference.
 Bonney CH; Rustan PL
 Am Heart J (United States) Jun 1974, 87 (6) p757-60,
 Languages: ENGLISH
 Journal Announcement: 7409
 Descriptors: *Electricity; *Pacemaker, Artificial; Dogs; Environmental Exposure

[Influence of radar rays on heart pacemakers]
 Die Beeinflussbarkeit von Herzschrittmachern durch Radarstrahlung.
 Rohl D; Laun HM; Hauber ME; Voigt H; Stauch M
 Verh Dtsch Ges Inn Med (Germany, West) 1973, 79 p1077-9,
 Languages: GERMAN
 Journal Announcement: 7409
 Descriptors: *Pacemaker, Artificial; *Radar

Interference effect of myopotentials on function of unipolar demand pacemakers.
 Ohm OJ; Bruland H; Pedersen OM; Waerness E
 Br Heart J (England) Jan 1974, 36 (1) p77-84,

Languages: ENGLISH

Journal Announcement: 7407

Descriptors: *Heart--Physiopathology--PP; *Muscles--Physiology--PH;
*Pacemaker, Artificial--Adverse Effects--AE; Aged; Arrhythmia--
Etiology--ET ; Electrocardiography; Electromyography;
Electrophysiology; Exertion; Middle Age; Muscle Contraction

[Health hazards through microwaves. Dangers for heart pacemakers]
Gesundheitsstorungen durch Mikrowellen. Gefahr fur Herzschrittmacher.
Z Allgemeinmed (Germany, West) Sep 30 1973, 49 (27) p1299,

Languages: GERMAN

Journal Announcement: 7403

Descriptors: *Microwaves--Adverse Effects--AE; *Pacemaker, Artificial
--Adverse Effects--AE

Evaluation of effects of the microwave oven (915 and 2450 MHz) and
radar (2810 and 3050 MHz) electromagnetic radiation on noncompetitive
cardiac pacemakers.

Bonney CH; Rustan PL Jr; Ford GE

IEEE Trans Biomed Eng (United States) Sep 1973, 20 (5) p357-64,

Languages: ENGLISH

Journal Announcement: 7312

Descriptors: *Microwaves--Adverse Effects--AE; *Pacemaker,
Artificial; *Radar--Adverse Effects--AE; Abdomen--Surgery--SU; Dogs;
Electricity; Heart Block--Therapy--TH; Pulse

Cardiac pulse generators and electromagnetic interference.

Walter WH; Mitchell JC; Rustan PL; Frazer JW; Hurt WD

JAMA (United States) Jun 18 1973, 224 (12) p1628-31,

Languages: ENGLISH

Journal Announcement: 7309

Descriptors: *Electromagnetics--Adverse Effects--AE; *Pacemaker,
Artificial; Dogs; Microwaves--Adverse Effects--AE; Radio Waves--
Adverse Effects--AE

[Value and danger of electric, magnetic or electromagnetic fields in
sentinel pacemaker control]

Interet et danger des champs electriques magnetiques ou
electromagnetiques pour le controle des pacemakers sentinelles.

Welte JJ; Kevorkias M; Pioger G; Fontaine G

Ann Cardiol Angeiol (Paris) (France) Mar-Apr 1973, 22 (2) p101-7,

Languages: FRENCH

Journal Announcement: 7308

Descriptors: *Electromagnetics; *Magnetics; *Pacemaker, Artificial;
Arrhythmia--Therapy--TH; Electrocardiography; English Abstract;
Pacemaker, Artificial--Adverse Effects--AE

CURRENT FACTS ON PACEMAKER ELECTROMAGNETIC INTERFERENCE AND THEIR APPLICATION TO CLINICAL CARE

SAGER D P

4001 BARNSLEY LANE, OLNEY, MD 20832.

HEART LUNG 16 (2). 1987. 211-221.

Language: ENGLISH

Descriptors/Keywords: HUMAN MYOPOTENTIAL INTERFERENCE

Concept Codes:

Biophysics-General Biophysical Studies

Biophysics-Bioengineering

Cardiovascular System-General; Methods

Cardiovascular System-Heart Pathology

Biophysics-General Biophysical Techniques

Biosystematic Codes:

Hominidae

Super Taxa:

Animals; Vertebrates; Mammals; Primates; Human

EFFECTS OF ELECTRO MAGNETIC INTERFERENCE FROM VARIOUS RADIO THERAPY MACHINES ON CONTEMPORARY MULTI PROGRAMMABLE CARDIAC PACEMAKERS

MARBACH J R; HARDAGE M

PHYS. DEP., M. D. ANDERSON HOSP., HOUSTON, TX 77030.

24TH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE, NEW ORLEANS, LA., USA, AUG. 1-5, 1982. MED PHYS 9 (4). 1982. 629.

Language: ENGLISH

Document Type: CONFERENCE PAPER

Descriptors/Keywords: ABSTRACT STRAY ELECTRO MAGNETIC FIELD

Concept Codes:

Radiation-Radiation and Isotope Techniques

Biophysics-General Biophysical Studies

Biophysics-Bioengineering

External Effects-Physical and Mechanical Effects (1970-)

Cardiovascular System-General; Methods

General Biology-Symposia, Transactions and Proceedings of Conferences, Congresses, Review Annuals

Biosystematic Codes:

Vertebrata-Unspecified

Super Taxa:

Animals; Vertebrates; Nonhuman Vertebrates

PACEMAKER INTERFERENCE

EXWORTHY K W

PHYSIOL. RES. LAB., DIV. MEDTRONIC INC., MINNEAPOLIS, MINN., USA. VARRIALE, P. AND E. A. NACLERIO. CARDIAC PACING: A CONCISE GUIDE TO CLINICAL PRACTICE. XVII+382P. LEA AND FEBIGER: PHILADELPHIA, PA., USA. ILLUS. ISBN 0-8121-0668-7. 0 (0). 1979. P325-336.

Language: ENGLISH

Descriptors/Keywords: REVIEW HUMAN ELECTRO MAGNETIC INTERFERENCE
ELECTRO CARDIOGRAM

Concept Codes:

Biophysics-Bioengineering
Cardiovascular System-General; Methods
Cardiovascular System-Heart Pathology
Biophysics-General Biophysical Studies
Biophysics-General Biophysical Techniques
External Effects-Electric, Magnetic and Gravitational Phenomena
Pathology, General and Miscellaneous-Diagnostic
Pathology, General and Miscellaneous-Therapy (1971-)

Biosystematic Codes:

Hominidae

Super Taxa:

Animals; Vertebrates; Mammals; Primates; Human

CARDIAC PACEMAKERS AND ELECTRO MAGNETIC INTERFERENCE FROM THERAPEUTIC
RADIATION GENERATING MACHINES

BAKER R J; SMITH V

PHYS MED BIOL 22 (1). 1977 136

Document Type: CONFERENCE PAPER

Descriptors/Keywords: ABSTRACT HUMAN ELECTRO MAGNETIC INTERFERENCE
MICROWAVE

Concept Codes:

Radiation-Radiation Effects and Protective Measures
Biophysics-Bioengineering
Cardiovascular System-General; Methods
General Biology-Information, Documentation, Retrieval and Computer
Applications
Mathematical Biology and Statistical Methods
Radiation-Radiation and Isotope Techniques
External Effects-Electric, Magnetic and Gravitational Phenomena
Pathology, General and Miscellaneous-Therapy (1971-)

Biosystematic Codes:

Hominidae

Super Taxa:

Animals; Vertebrates; Mammals; Primates; Human

ELECTRO MAGNETIC INTERFERENCE OF CARDIAC PACEMAKERS

MITCHELL J C

AGARD (ADVISED GROUP AEROSP RES DEV) LECT SER 78. 1975 10-1-10-10

Descriptors/Keywords: HUMAN PROSTHETIC DEVICE FREQUENCY RADIO
FREQUENCY RADIATION

Concept Codes:

Radiation-Radiation Effects and Protective Measures
Biophysics-Bioengineering
External Effects-Electric, Magnetic and Gravitational Phenomena
Cardiovascular System-General; Methods
Mathematical Biology and Statistical Methods

Biophysics-General Biophysical Studies
 Biophysics-General Biophysical Techniques
 Cardiovascular System-Heart Pathology
 Public Health: Environmental Health-Radiation Health
 Biosystematic Codes:
 Hominidae
 Super Taxa:
 Animals; Vertebrates; Mammals; Primates; Human

DEGRADATION OF PACEMAKER FUNCTION BY ELECTRO MAGNETIC INTERFERENCE
 FLEMING W H; TOLER J C
 CIRC SUPPL 50 (4-3). 1974 III226
 Document Type: CONFERENCE PAPER
 Descriptors/Keywords: ABSTRACT HUMAN ARRHYTHMIA
 Concept Codes:
 Biophysics-Bioengineering
 External Effects-Electric, Magnetic and Gravitational Phenomena
 Cardiovascular System-General; Methods
 Cardiovascular System-Heart Pathology
 Biophysics-General Biophysical Techniques
 Biosystematic Codes:
 Hominidae
 Super Taxa:
 Animals; Vertebrates; Mammals; Primates; Human

THE EFFECT OF RADAR ON CARDIAC PACEMAKERS PART 1 RADAR FACILITY AND
 EXPERIMENTAL METHODS
 ROEHL D; LAUN H M; HAUBER M E T; VOIGT V; STAUCH M
 BIOMED TECH 18 (6). 1973 (RECD 1974) 209-216.
 Concept Codes:
 Radiation-Radiation Effects and Protective Measures
 Biophysics-Bioengineering
 External Effects-Sonics; Ultrasonics
 Cardiovascular System-General; Methods
 Biochemistry-Gases (1970-)
 Biochemical Studies-General
 Biochemical Studies-Lipids
 Biochemical Studies-Minerals
 Anatomy and Histology, General and Comparative-Surgery
 Pathology, General and Miscellaneous-Therapy (1971-)
 Cardiovascular System-Heart Pathology

PACEMAKER ELECTRO MAGNETIC INTERFERENCE CRITERIA STANDARDS A PROGRESS
 REPORT
 FLINK R C
 MED INSTRUM (BALT) 7 (1). 1973 53
 Document Type: CONFERENCE PAPER
 Descriptors/Keywords: ABSTRACT ELECTRO MAGNETIC INTERFERENCE

Concept Codes:

Biophysics-Bioengineering
 Cardiovascular System-General; Methods

The Effect of Radar on Cardiac Pacemakers. IV. Interference
 Susceptibility of External Pacemakers

Roehl, D., H. M. Laun, and M. E. T. Hauber

Deutsche Medizinische Wochenschrift, Vol. 99, No. 22, pages
 1167-1171, 9 references 1974

Interference susceptibility of three external demand pacemakers to radar emissions was tested in a laboratory and at a hospital 1.2 kilometers from a SR-LL-1 radar transmitter. The transmitting frequency was 1.3 gigahertz equal to 23 centimeters in wavelength with a pulse width of 5 microseconds and a pulse interval of 2.5 milliseconds. The Medtronic 5840, Siemens Elema EMI45, and Biotronic EDP pacemakers were tested. Pacemakers were adjusted for an impulse frequency of approximately 70 minutes and an impulse of 5 volts. The most sensitive pacemaker could be inhibited at pulse power densities of 0.1 millivolts per square centimeter (mV/cm²). At the hospital, pulse power densities of 3.5mV/cm² were recorded and the radar signal triggered pacemaker impulses which occurred within the vulnerable period of the cardiac cycle. The authors conclude that better protection from electrical interference fields is necessary for external and implanted pacemakers. They recommend the use of a metal capsule for pacemakers and a method of filtering the electrode entrance to reduce pacemaker susceptibility to radiation interference. (German).

DESCRIPTORS: TRANS; DMWOAX; Equipment design; Biophysics;
 Cardiovascular system disorders; Medical equipment; Cardiac function

Empirical Studies of Cardiac Pacemaker Interference

Mitchell, J. C., W. D. Hurt, W. H. Walters, III, and J. K. Miller

Aerospace Medicine, Vol. 45, No. 2, pages 189-195, 8 references
 February 1974

Tests are conducted at several representative radar sites to evaluate the relative susceptibility of cardiac pacemakers to electromagnetic radiation interference, the evaluation being done in a "free-field" configuration and also in a saline solution phantom. Data are given for cardiac pacemaker test samples, and empirical results of pacemaker interference tests. Test results are presented for five frequency bands between 200 and 6,000 Mega-Hertz. The slight interference observed regularly, though not considered a threat to life, can cause serious effects for a patient closer to the radar, depending on the particular pacemaker in use, the state of the patients' health, and the patients' activities.

DESCRIPTORS: Electrophysiological equipment; Cardiovascular system disorders; Radiation hazards; High frequencies; Electromagnetism; Prosthetic devices

Shields Needed for Pacemakers

Milroy, W. C., and Yatteav, R. F.

New England Journal of Medicine, Vol. 284, No. 9, page 501, 2 references March 4, 1971

In a letter to the editor, Milroy comments on an article by Yatteau ("Radar-Induced Failure of a Demand Pacemaker", New England Journal of Medicine, Vol. 283, page 1447, 1970). Milroy believes that the basic problem does not lie with radar or other interference sources, but in the fact that pacemakers are not designed to adequately shield out external interference. Yatteau responds that interference rejection by pacemakers must be effected by more efficient shielding of the pulse generator. Yatteau replies that demand pulse generators are now available which will revert to fixed-rate pacing when their sensing circuits become saturated with microwave interference.

DESCRIPTORS: Hearts; Controls; Biomechanics

Environmental Influences on Implanted Cardiac Pacemakers

Michaelson, S. M., and A. J. Moss

Journal of the American Medical Association, Vol. 216, No. 12, pages 2006-2007, 4 references June 21, 1971

Description of various kinds of cardiac pacemakers and the effect exerted by the environment on some of them. Fixed rate (asynchronous) pacemakers are fairly insensitive to electrical interferences except when electrocautery is used within a few inches of the unit or radiofrequency diathermy is applied directly to the pacemaker site. Fixed rate pacemakers are not affected by x-radiation, auto ignition systems, incandescent, fluorescent, or neon lights, televisions, electrical shavers, household appliances, or power tools. A review of pacemaker interference phenomena indicates that the basic problem does not necessarily lie with the interference sources, but that the pacemakers are not designed to shield out external interference adequately.

DESCRIPTORS: Cardiovascular disorders; Non ionizing radiation; Heart prosthesis; Electronic pacemakers

ASSESSING LOW FREQUENCY ELECTROMAGNETIC ENVIRONMENTAL EFFECTS ON IMPLANTED CARDIAC PACEMAKERS.

Frazier, Marvin J.

Ill Inst of Technol, Chicago

Proceedings of the National Electronics Conference v 33, Chicago, Ill, Oct 29-31 1979. Publ by Natl Eng Consortium, Inc, Oak Brook, Ill, 1979 p 441-446

Language: ENGLISH

Over the past several years concern has been expressed over the performance of sensitive implanted electromedical devices, such as cardiac pacemakers, when subjected to ordinary everyday electromagnetic environments. The procedures summarized in this paper can be used to assess how implanted cardiac pacemakers will perform in low-frequency electromagnetic environments, such as may be produced by

industrial equipment and processes. The model which has been developed allows one to relate the electric or magnetic field to the voltage that will be induced at the terminals of an implanted pacemaker. For complex waveforms, such as may be encountered in industrial situations, it is suggested that representative pacemakers be tested to determine how they respond. The measurement and testing procedures that have been outlined provide the basis for such evaluations of pacemakers. 9 refs.

Descriptors: *PROSTHETICS--*Pacemakers; ELECTROMAGNETIC WAVES; MATHEMATICAL MODELS

Identifiers: LOW FREQUENCY ELECTROMAGNETIC FIELDS; INDUSTRIAL ENVIRONMENT ; SUSCEPTIBILITY TESTING

EFFECTS OF FM AND TV BROADCAST STATIONS UPON CARDIAC PACEMAKERS.

Vreeland, Robert W.; Shepherd, Marvin D.; Hutchinson, John C.
Univ of Calif, San Francisco

IEEE Electromagn Compat Symp Rec, San Francisco, Calif, Jul 16-18 1974 p 99-106. Publ by IEEE (74CH0803-7 EMC), New York, NY, 1974

Language: ENGLISH

In order to predict the possible effects of the New Sutro Tower upon pacemaker performance at the University of California San Francisco, in vitro pacemaker tests were conducted near the FM and TV transmitter sites on San Bruno mountain. It was found that one type of external pacemaker stopped in an area where the maximum average field intensity was 0.63 volt per meter. The other pacemakers functioned normally in an area where the highest measured average field intensity was one volt per meter. Most of them functioned erratically or even stopped under certain conditions in an area where the highest measured average field intensity was 2.8 volts per meter. Some of the test conditions (such as the substitution of a dipole antenna for the catheter) were more severe than would be encountered during normal operation. 21 refs.

Descriptors: *PROSTHETICS; RADIO INTERFERENCE

ELECTROMAGNETIC POLLUTION OF PATIENT CARE EQUIPMENT: THE DIMENSION OF THE PROBLEM.

Aller, J.

Adv in Instrum v 28, Annu ISA Conf, 28th, Proc, Houston, Tex, Oct 15-18 1973 Part 3, Pap 725, 9 p. Publ by ISA, Pittsburgh, Pa, 1973

Language: ENGLISH

Electromagnetic noise sources that may affect normal operation of electronic patient care equipment are considered. As an example, the cardiac pacemaker and a number of electronic pollutants that can affect its operation are described. Test methods to determine implantable pacemaker interference and methods of controlling this interference are discussed. 34 refs.

Descriptors: *BIOMEDICAL ENGINEERING--*Cardiology; BIOMEDICAL EQUIPMENT

Identifiers: PACEMAKERS

CARDIAC PACEMAKER EMC IN PERSPECTIVE.

Miller, D. A.

IIT Res Inst, Chicago, Ill

IEEE Int Electromagn Compat Symp Rec, New York, NY, Jun 20-22 1973 p 173-174. Publ by IEEE (73 CHO 751-8 EMC), New York, 1973

Language: ENGLISH

This discussion summary examines the susceptibility of cardiac pacemakers to electromagnetic interference and considers questions in the following seven areas: the clinical significance of cardiac pacemaker interference susceptibility; the response of different types of pacemakers to various interference situations; various coupling mechanisms into the pacemaker; test methods; the role of animal tests; the role of clinical studies; and the requirements for standards development. 10 refs.

Descriptors: *BIOMEDICAL ENGINEERING--*Electronics; ELECTROMAGNETIC COMPATIBILITY

Identifiers: PACEMAKERS

MICROWAVE INTERFERENCE WITH PACEMAKERS.

Merrow, Richard J.

Raytheon Co, Waltham, Mass

J Am Soc Safety Eng v 18 n 1 Jan 1972 p 35-37

Language: ENGLISH

The author examines the problems of interference between demand pacemakers and microwave ovens, and the possible hazards that can arise if microwave equipment such as ovens are not properly serviced and maintained. Eight different demand type pacemaker models were exposed to microwave radiation at the two frequencies available for microwave oven use: 915 and 2450 MHz. Pacemakers with catheter leads attached were positioned 6 to 10 in. in front of radiating waveguides, and the power density was measured with a Narda 8100 probe. 6 refs.

Descriptors: *MICROWAVE DEVICES; ACCIDENT PREVENTION

Electromagnetic interference control in medical electronics/ by Michael F. Gard

Gard, Michael F.

Series: Multi-volume EMC encyclopedia series; v. 10

1st ed. Gainesville, Va. : Don White Consultants, c1979. 174 p. in various pagings: ill.; 24 cm.

Publication Date(s): 1979

Place of Publication: Virginia

LC Call No.: TK6553.M75 vol. 10; R857.E54 Dewey Call No.: 621.38/0413 s; 610/.28

Languages: English

Document Type: Monograph

Includes bibliographical references and index.

Descriptors: Electromagnetic compatibility; Medical electronics

Govt. Document No.: HE 20.1513-71-5
 Electromagnetic radiation interference with cardiac pacemakers [by]
 Paul S. Ruggera and Robert L. Elder, Division of Electronic Products
 Ruggera, Paul S.
 Elder, Robert L., joint author.
 Corporate Source: United States.; Bureau of Radiological Health.;
 Division of Electronic Products.
 Rockville, Md., U.S. Bureau of Radiological Health; for sale by the
 Supt. of Docs., U.S. Govt. Print. Off., 1971. ix, 25 p. 27 cm.
 Publication Date(s): 1971
 Price: \$0.45
 Place of Publication: Maryland
 LC Call No.: RC684.P3R8 Dewey Call No.: 616.1/28/0645
 Languages: English
 Document Type: Monograph
 "BRH/DEP 71-5." Includes bibliographical references.
 Descriptors: Pacemaker, Artificial (Heart); Electromagnetic waves

RECS. FOR STANDARDIZATION OF LEADS AND OF SPECS. FOR INSTRUMENTS IN
 ELECTROCARDIOGRAPHY AND VECTORCARDIOGRAPHY
 AMHA (AMERICAN HEART ASS'N)
 1975
 ENGLISH

A-A-51597 NSA CARD NO: 51H
 Electrode, Electrocardiograph
 GSA (GENERAL SERVICES ADMINISTRATION)
 6515 (MEDICAL & SURGICAL INST, EQUIP & SUPPLIES)
 1986 AUG 22
 ENGLISH

A-A-51494A NSA CARD NO: 51F
 Electrode, Electrocardiograph
 GSA (GENERAL SERVICES ADMINISTRATION)
 6515 (MEDICAL & SURGICAL INST, EQUIP & SUPPLIES)
 1987 MAR 31
 ENGLISH

A-A-51320 NSA CARD NO: 51C
 Electrode, Electrocardiograph
 GSA (GENERAL SERVICES ADMINISTRATION)
 6515 (MEDICAL & SURGICAL INST, EQUIP & SUPPLIES)
 1985 DEC 27
 ENGLISH

MIL-E-36359 NSA CARD NO: 10

Electroencephalograph, 8 Channel, 110 Volt, 60 Cycle, AC
DOD (DEPARTMENT OF DEFENSE)
6515 (MEDICAL & SURGICAL INST, EQUIP & SUPPLIES)
1965 JAN 14
ENGLISH

PM-1
STD. LABELING REQUIREMENTS, PERFORMANCE REQUIREMENTS, AND TERMINOLOGY
FOR IMPLANTABLE ARTIFICIAL CARDIAC PACEMAKERS
AAMI (ASS'N FOR THE ADVANCEMENT OF MEDICAL INSTRUMENTATION)
1975
ENGLISH

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