



# History of the Armour Conferences



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## INTRODUCTION

Before the EMC Society existed, that is, in the early 1950's, there were yearly conferences in the United States on "Radio Interference Reduction." These conferences were held in Chicago, Illinois and they were called the "Armour Conferences" because they were administered by the Armour Research Foundation of the Illinois Institute of Technology. These conferences were a follow-on of military activities in radio interference in World War II and, as a result, they were divided into classified and non-classified sections. The Armour Conferences were held from 1954 to 1964; a total of ten conferences were successfully completed and proceedings were published containing the technical papers presented at the conferences.

## PURPOSE

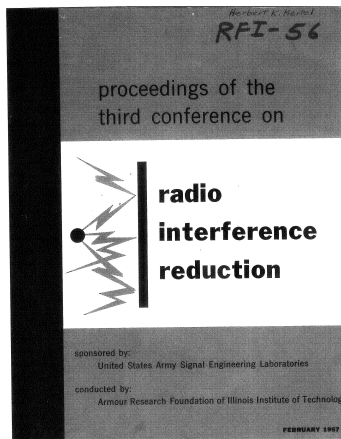
Following World War II, the three US Military Services (Army, Navy, and Air Force) focused many Research and Development programs on addressing radio interference issues that evolved with the expanded use of electronic devices in military operations. These programs ranged from preventing ignition noise from coupling to receivers and transmitters in military vehicles to shielding and bonding issues with high-powered radar signals.

The purpose of the Armour Conferences was to disseminate this R&D information on Radio Frequency Interference (RFI) through formal presentations and to provide an opportunity for engineers interested in RFI to exchange ideas on interference reduction in an informal manner with associates.

The Armour Research Foundation of the Illinois Institute of Technology (IIT) was one of several research organizations that was funded (through the Army Signal Corps Engineering Laboratories) to perform studies in support of the Military's comprehensive program on interference reduction.

## FIRST ARMOUR CONFERENCE

As part of Armour's support effort, the first "Conference on Radio Interference



*Sample cover from an early Armour Conference.*

Reduction" was held at the Armour Research Foundation's campus in Chicago, Illinois, on 7-8 December 1954. The conference was sponsored by the Signal Corps Engineering Laboratories, Wright Air Development Center and Navy Bureau of Aeronautics.

The Introductory Address was given by J. W. Klotz, Office of the Assistant Secretary of Defense (Research and Development). He spoke about the importance of interference reduction activities to military weapons development efforts and gave a historical summary of the formation (in 1949) of a Panel on Interference Reduction reporting to the Committee on Electronics under the Research and Development Board. The objective of the panel was to bring together military project engineers and administrative personnel to plan a coordinated R & D interference reduction program. Four consultants from industry and universities were invited to assist the Panel. The coordinating function of that Panel was continued in the 1953 reorganization of the Department of Defense under the Assistant Secretary of Defense for Research and Development. One policy of the new organization was to endorse sponsorship of symposia in the various fields of electronics. In a closing remark, Mr. Klotz stated, "I trust that one of the by-products of the symposium will be the voluntary interchange of information with other engineers whom you will come to know during these sessions."

The first Conference on Radio Inter-

ference Reduction was attended by about 300 people and contained 25 technical papers covering Practical Suppression Techniques, Measurements, Design Techniques and Components. The Proceedings were over 300 pages in length and the average paper length was 13 pages.

Examples of papers given were:

1. "Research Investigations of Interference Measuring Instruments" by Ralph M. Showers and A. Eckersley
2. "Reduction of Corona Type Interference" by John Robb, M.M. Newman, and J. R. Stahman

## SECOND ARMOUR CONFERENCE

The Second Conference was noteworthy because it was funded solely by the Armour Research Foundation during a time of restricted budgets for the military. It was also important because the first discussions were held among interested technical personnel, as reported in the first newsletter from the Professional Group on Radio Frequency Interference (January 2, 1958), in "forming an organization for people interested in RFI."

The Conference was held at The Sheraton Hotel in Chicago for two days; March 6-7, 1956. Thirty-one technical papers were given over the course of the two days in seven different sessions.

Examples of some of the papers given included:

1. "A Private Rogues' Gallery of Radio Interference Sources" by Richard B. Schulz
2. "The Federal Communications Commission and the Control of Radio Interference" by Herman Garlan and W.C. Boese
3. "Administration of the Bureau of Ships Interference Reduction Program" by Leonard W. Thomas

## THIRD ARMOUR CONFERENCE

By the time the Third Conference on RFI Reduction was held on February 26-27,

1957; a group of six men convinced Fred J. Nichols (father of the current EMC Newsletter editor, Janet Nichols O'Neil) to "plug" a proposed group on "people interested in RFI." In his after-luncheon speech, Mr. Nichols did just that and after a subsequent letter, a first organizing meeting, and a formal petition (signed by 326 RFI engineers) to the Institute of Radio Engineers; the Professional Group on RFI was formed on October 10, 1957. This "group" eventually evolved into the present-day EMC Society of the IEEE.

The papers given in the Third Armour Conference were printed in the "Proceedings of the Third Conference on Radio Interference Reduction."

The 3rd Armour Conference was sponsored by the United States Army Signal Engineering Laboratories, Fort Monmouth, New Jersey. It was administered by the Armour Research Foundation of the Illinois Institute of Technology in Chicago, Illinois and it was held at the Museum of Science and Industry in Chicago.

The Foreword of the Proceedings stated the following:

*The third conference on Radio Interference Reduction again brought together representatives from government agencies and laboratories, and industrial organizations, to bear administrative and technical papers dealing with advancements in the field of interference suppression. Increased awareness of the need for an exchange of information as a means for solving problems in this area was evidenced by the fact that attendance at the conference soared to over 450 persons.*

*This year's conference was under the sponsorship of the Army Signal Engineering Laboratories, Ft. Monmouth, New Jersey. Thirty-four talks were presented during the two-day period, including two non-technical luncheon speeches. The papers of the conference are reproduced in this volume.*

*The conference committee extends its sincerest appreciation and thanks to all of the conference speakers; their informative presentations represent a significant contribution toward a better understanding of suppression problems and their solutions. Our appreciation also goes to the U. S. Army representatives, who were exceedingly helpful in coordinating various aspects of the conference, as well as to the other branches of the armed forces, for their excellent cooperation.*

*S. I. Cohn, R. C. Goedeke, H. M. Sachs  
May 15, 1957, Chicago, Illinois*

Examples of papers in the conference were:

1. "Calculation and Measurement of Radar Interference Signal Levels" by L. Valcik
2. "A New Technique for Evaluating RF



*The plane pictured is an example of the actual airplanes that were used for the paper titled "Radio Interference Studies Conducted on Typical USAF Aircraft and Equipment" published in February 1957 by authors from Lockheed Aircraft Corporation in Burbank, California. The testing was performed at Wright Patterson AFB, Dayton, Ohio.*

- Leakage and Susceptibility of Electronic Equipment" by C. S. Vasaka
3. "The Control of Interference Through Basic Design" by Leonard W. Thomas

## FOURTH ARMOUR CONFERENCE

The Fourth Conference on Radio Interference Reduction and Electronic Compatibility was sponsored by the Armour Research Foundation under agreement with the U. S. Army Signal Research and Development Laboratories, Fort Monmouth, New Jersey. It was held on October 1-2, 1958, at the Museum of Science and Industry in Chicago, Illinois. The newly formed Professional Group on Radio Frequency Interference (PGRFI) cooperated for the first time on the program. The luncheon address was given by Harold R. Schwenk, the first chairman of the PGRFI who was working for the Sperry Gyroscope Company in Great Neck, New York at that time. The title of his talk was "An Outlook into the Future of the RF Interference Field and the Part that the PGRFI will Play in the Future of the Field of RF Interference."

Thirty-six technical papers were published in the "Proceedings of the Fourth Conference on Radio Interference Reduction and Electronic Compatibility."

An added feature of the Fourth conference was the accumulation of information concerning technical reports issued since January 1, 1957, on radio interference. A list of those reports, compiled from contributions of conferees, was reproduced in the Conference Proceedings.

Some of the papers presented included:

1. "Anechoic Chambers for Radio Interference Measurements above 50 Megacycles" by D. J. Shamp

2. "Spectrum Signature" by Leonard W. Thomas
3. "Radio Interference Control of Semiconductor Circuitry" by Fred J. Nichols
4. "Ferrites in Radio Interference Filters" by J. C. Senn

## FIFTH ARMOUR CONFERENCE

The Fifth Armour Conference was held on October 6-8, 1959 in Chicago. There were two days of unclassified papers and one day of classified papers. The keynote address was given by G. P. Sutton, the chief scientist of the Advanced Research Projects Agency in Washington, DC. He urged more general consideration of problems of frequency allocation, radiated power requirements, antenna directivity and other factors to minimize interference. Mr. Sutton indicated "a multi-fold increase in launched space vehicles for weather observation, scientific exploration, biomedical investigations and communication repeater stations is scheduled for the near future. Unless spectrum allocation is determined in advance and undesired emission eliminated, chaos will result. Telemetry data may be rendered useless and valuable scientific programs voided." He further warned that "failure to achieve a satisfactory and relatively interference-free environment may seriously compromise the effectiveness of our defense system. ....Radio interference may mean the loss of lives, expensive equipment or strategic advantage."

Two luncheon addresses were given; one was titled "The Role of CISPR (International Special Committee on Radio Interference) in Radio Interference Reduction and Control" and was given by Leonard W. Thomas.

Over 400 people attended the Conference and a total of 41 technical papers



were given in nine different sessions.

Examples of papers given were:

1. "Design of Electromagnetic Interference Reduction Using Computer Simulation Techniques" by Donald R. J. White and R. Marcus
2. "Low-Noise Devices as System Elements" by James McNaul
3. "Planning Interference – Free Communications – Electronics Systems" by A. H. Sullivan, Jr.
4. "New Techniques for Evaluating the Performance of Shielded Enclosures" by Richard B. Schulz, D. P. Kanelakos, L. C. Peach, and A. P. Massey

## SIXTH ARMOUR CONFERENCE

Mr. S. I. Cohn was the conference chair and the conference was held October 4-6 (1960) at the Museum of Science and Industry in Chicago, Illinois. Over 500 representatives of government and industry attended the conference and it was sponsored jointly by the three military services in cooperation with the Armour Research Foundation and the Professional Group on RFI of the Institute of Radio Engineers.

H. A. Leedy, Executive Vice-President and Director of the Armour Research Foundation, gave the welcome address while H. Randall gave the keynote speech from the Office of the Assistant Secretary of Defense. Herman Garlan of the FCC gave the first day's luncheon address and it was entitled "The FCC's New ISM Certification." The second day's luncheon address was titled "Interference Survey of a Large Missile Manufacturing Plant" and it was given by A. R. Kall of Ark Electronics Co. in Philadelphia, Pennsylvania.

Session titles included: Missile and Space Considerations, Antenna Measurement Seminar, Systems, Shielding, Prediction Methods, Instrumentation, Spurious Emissions, Susceptibility, and Classified Papers.

Forty-four technical papers were published in the "Unclassified Proceedings of the Sixth Conference on Radio Interference and Electronic Compatibility."

Examples of papers given included:

1. "Measurements of Effective Radiated Power" by M. N. Lustgarten
2. "An Instrument for Measurement of High RF Power Density" by W. S. Lambdin and K. W. Knapp
3. "Measurement of Low-Frequency Electromagnetic Interference" by M. Epstein, H. M. Sachs and L. E. Silverman

## SEVENTH ARMOUR CONFERENCE

The cover page of the "Proceedings of the Seventh Conference on Radio Interference Reduction and Electronic Compatibility" stated that it was "Sponsored jointly by U. S. Army, U. S. Navy, and U. S. Air Force" and "Conducted by Armour Research Foundation of Illinois Institute of Technology" and "In Cooperation with the Professional Group on Radio Frequency Interference of the Institute of Radio Engineers." The cover page also included the fact that it was "Held at the Grover M. Hermann Hall, Illinois Institute of Technology, Chicago, Illinois, November 7, 8, and 9 – 1961."

The Foreword of the Proceedings stated:

*The Seventh Conference on Radio Interference Reduction and Electronic Compatibility has seen evidence of the increasing awareness of the need for increased exchange of information in the area of electromagnetic interference analysis and control. More than 550 attendees were evidence to this fact. The widespread interest was attested to by the joint sponsorship of the three services; the U. S. Army, U. S. Navy, and the U. S. Air Force.*

*A total of forty-four technical papers were presented during the three days of the conference, together with an informal luncheon address, and forty-three of these papers are included in this volume.*

*The conference committee would like to extend its thanks to the authors and speakers, to the various session chairman, and also to those who attended the technical sessions for their part in making this conference the most successful yet.*

## Conference Committee

Commander B. D. Inman, U. S. Navy, Bureau of Ships; W. J. Magee, Armour Research Foundation; S. I. Cohn, Armour Research Foundation; B. Lindeman, RADC; H. M. Sachs, Armour Research Foundation; H. G. Tobin, Armour Research Foundation; S. Weitz, USAS-RDL

Examples of papers given included:

1. "A Comparison of Two Methods of Determining System Compatibility" by Eugene D. Knowles
2. "Existing Current Probes and Development of New Probes to 1 KMC" by Joseph F. Fischer, Jr. and Herb Mertel
3. "New Methods of Insertion Loss Measurement of RF Filters Under Rated Load Conditions, Between 14 KC to 1000 MC and Higher" by James C. Klouda

## EIGHTH ARMOUR CONFERENCE

The official title of the papers from the 8th Armour Conference is "Unclassified Proceedings of the Eighth Tri-Service Conference on Electromagnetic Compatibility." The conference was held at the Museum of Science and Industry in Chicago, Illinois from October 30 through November 1, 1962. The U. S. Army, the U. S. Navy, and the U. S. Air Force sponsored it jointly. It was administered by the Armour Research Foundation of the Illinois Institute of Technology (IIT) in cooperation with The Professional Group on Radio Frequency Interference of the Institute of Radio Engineers.

Forty-two technical papers were selected and presented out of an initial population of nearly ninety submitted papers. According to the Foreword in the Proceedings, "attendance set a new record in spite of government travel restrictions due to the Cuban crisis."

J. E. McManus of the Armour Research Foundation gave the welcome address and he noted the significant changes that had occurred in RFI and EMC since the start of the Armour Conferences. He also noted that, "We have moved from the negative aspect of radio interference reduction to the positive approach of electromagnetic compatibility design." James M. Bridges, the Director of the Office of Electronics in the Office of Defense Research and Engineering, gave the keynote address. In his speech, he addressed the future of the EMC program and its probable impact on the defense industry. A luncheon address was given by Oran W. Nicks who was the Director of the Lunar and Planetary Programs in the Office of Space Sciences in NASA. His talk was entitled "Exploration of Space with Scientific Probes" which covered scientific missions to the planets including the Mariner spacecraft which had been launched towards Venus.

Session titles at the 8th Armour Conference included (1) General, (2) Analysis and Prediction I and II, (3) Instrumentation and Techniques I and II, (4) Spectrum Signature Measurements, (5) Antennas and Propagation, (6) Suppression Devices, (7) Classified, (8) Shielding and Bonding, and (9) RFI Control.

Typical papers in the proceedings included (1) Management Responsibility in Obtaining an Electrical/Electronic Compatible Weapon System by Fred J. Nichols; (2) Preliminary Measurements Related to Procedures for Measuring Systems Suscep-

tibility by G. Barker, E. Gray, and Ralph M. Showers; (3) Trends in RFI Measuring Instruments by Richard R. Stoddart; (4) Analysis of Receiver Spurious Response by Graphical Means by Warren A. Kesselman; (5) A New Family of Absorptive-Reactive RFI Filters by Joseph F. Fischer, Jr. and J. C. Senn; and (6) Implementation of Bonding Practices in Existing Structures by James C. Toler and D. R. Lightner.

## NINTH ARMOUR CONFERENCE

The Ninth Tri-Service Conference on Electromagnetic Compatibility was held at the Museum of Science and Industry in Chicago on October 15-17, 1963. The United States Army, Navy, and Air Force services sponsored it jointly. It was administered by the IIT Research Institute in cooperation with the Professional Technical Group on Electromagnetic Compatibility of the Institute of Electrical and Electronic Engineers.

Forty-seven papers were presented and attendance topped 500 people.

J. E. Bridges, the Manager of EMC for the IIT Research Institute, gave the welcome address. Brigadier General Allen T. Stanwix-Hay, the Deputy Chief Signal Officer of the U. S. Army, gave the keynote address. A luncheon address was given by James D. O'Connell, the Chairman of the Joint Technical Advisory Committee and it was entitled "Teamwork in Spectrum Conservation."

Typical papers included (1) RFI/EMI at the Crossroads by Fred J. Nichols; (2) Shielding Theory and Practice by Richard B. Schulz, V. C. Plantz and D. R. Brush; (3) Electromagnetic Compatibility Program for the McDonnell RF-4C, Phantom II Aircraft by Walt D. McKerchar, and (4) MIL-E-6051 Electromagnetic Compatibility Testing Concepts and Techniques by W. A. Taylor.

## TENTH ARMOUR CONFERENCE

The Conferences on Radio Interference Reduction continued until the 10th and final conference was held on November 17-19, 1964 at the Museum of Science and Industry in Chicago. Attendance exceeded 500 and 38 papers were presented covering Electromagnetic Compatibility, Instrumentation, Prediction, Measurement Techniques, Cable Coupling and Shielding, Reduction Techniques, Antennas and, Specifications and Specifications Testing. The

conference name (at that time) was "The Tenth Tri-Service Conference on Electromagnetic Compatibility" and Armour was now the "IIT Research Institute." It was sponsored in cooperation with the IEEE Electromagnetic Compatibility Group.

Admiral Joseph E. Rice gave the keynote address. He noted "Historically, the interference work in the 1940s, one might say, was mainly concerned with defining the problem, that is, getting a better picture of it and "cut and try" corrective measures....The next period, in the early 1950s, I would characterize as "learning the phenomena." A lot of theoretical studies were sponsored; test equipment was developed; and experimental work in grounding, shielding, and filtering was carried out.....Then, we entered into the third phase when we began to realize that we had to do something before we installed our electronic systems if we were going to lick the compatibility problem.....Finally, I think we're in agreement that electromagnetic compatibility has sneaked up on us.....certainly sneaked up on us in the Navy, and I dare say, the other Services and everyone else. It's a problem that is now and will continue to affect to an increasing extent the entire electrical and electronic industry and its users. As the electronic age grows, with the increasing usage of TV, radio, electronic garage doors, microwave ovens, electronically controlled machinery, etc.; the compatibility problem will grow correspondingly. Therefore, I feel that we are definitely at a turning point. After 10 years of getting ready, we should have the tools available to "turn" to producing and getting more things done. And, I think it has to be a national effort, since it is a national problem."

Typical papers included:

1. "A National Policy for Electromagnetic Compatibility" by Fred J. Nichols
2. "Evaluation of System Electrocompatibility" by R. Goldman, J. E. Maynard, Richard B. Schulz, Eugene D. Knowles, and B. E. Rosenberry
3. "Considerations in the Design of a Radio Frequency Compatibility (RFC) Test Set" by Hugh W. Denny
4. "The Electromagnetic Environment of Transport Airplanes" by L. Jorgenson, R. Goldman, and Richard B. Schulz
5. "The Effect of Sites upon the Radiation Characteristics of Antennas" by

W. G. Duff and K. G. Heisler

6. "IEEE Standards to Advance Receiver Interference Prediction" by N. H. Shepherd

## SUMMARY

The entire conference series was hosted by the Armour Research Foundation and jointly sponsored by the U. S. Army, the U. S. Navy, and the U. S. Air Force (except for the 2nd conference which Armour hosted and sponsored). The IRE Professional Group on Radio Frequency Interference (PGRFI) became a cooperating member in the conference in 1958 (the 4th conference). The conference name, in that year, changed to include "and Electronic Compatibility". The PGRFI (which later became the IEEE EMCS) continued to be a cooperating member of the remaining Tri-Service sponsored conferences.

The Armour Conferences were the forerunner of the IEEE International Symposiums on EMC and will be remembered for setting a high-quality example for technical papers and well-run symposiums.

One of the authors, Warren Kesselman, attended many of the Armour Conferences and participated in the administration (as the Army representative) of several of the conferences. His remembrance of the conference series is not of the fine technical papers, but rather the personal relationships with the pioneers who transitioned the 1940's concept of "hands-on black art engineering" into EMC design engineering based on scientific principles. He suspects that the EMC Society may not have been founded if it were not for those pioneers who attended the Third Conference on Radio Interference Reduction. **EMC**

# AND DATE	LOCATION	ATTENDANCE	TECHNICAL PAPERS
1: Dec 7-8, 1954	Armour Campus, Chicago, Illinois	300+	25
2: Mar 6-7, 1956	Sheraton Hotel, Chicago, Illinois	Unknown	31
3: Feb 26-27, 1957	Museum of Science & Industry, Chicago, Illinois	450+	32
4: Oct 1-2, 1958	Museum of Science & Industry, Chicago, Illinois	350+	36
5: Oct 6-8, 1959	Museum of Science & Industry, Chicago, Illinois	400+/-	41
6: Oct 4-6, 1960	Museum of Science & Industry, Chicago, Illinois	500+/-	44
7: Nov 7-9, 1961	Grover M. Hermann Hall, IIT, Chicago, Illinois	550+	44
8: Oct 30-Nov 1, 1962	Museum of Science & Industry, Chicago, Illinois	550+	42
9: Oct 15-17, 1963	Museum of Science & Industry, Chicago, Illinois	500+	47
10: Nov 17-19, 1964	Museum of Science & Industry, Chicago, Illinois	500+	38