



RELIABILITY GROUP NEWSLETTER

October 1972 Vol. XVII · Issue 4

Editor: Paul Gottfried

Contents

EDITOR'S NOTES.....	1
CHAPTER CHAIRMEN.....	2
CHAPTER NEWS.....	3
CALL FOR RELIABILITY PHYSICS PAPERS.....	4
REPORT OF 1972 RELIABILITY PHYSICS SYMPOSIUM.....	5-11
CONFERENCES.....	12
EMPLOYMENT ADVERTISING.....	13
POSITION WANTED.....	13
SHORT COURSE.....	13
PUBLICATIONS.....	14
HELP FOR COLLEGE LIBRARY.....	14
ROSTER.....	15-19
MEMBERSHIP APPLICATION.....	20

Editor's Notes

The October issue always reflects the preceding summer doldrums. The customary change in Chapter command and June-August inactivity leave most chapters unprepared to submit their programs by the late-August deadline. A chance for advance publicity for Chapter activities thus is missed.

This might be construed as a basis for changing the Newsletter publication schedule. Your editor feels that the present January-April-July-October schedule is sound for two reasons: it meshes well with a number of other Group activities, and a delay to November would also interfere with timely program publication.

Instead, we encourage incoming Chapter Chairmen -- many of whom are identified in this issue's listing by virtue of IEEE Headquarters communications -- to get their successors off to a running start next June. Most chapters find their planning more effective and their relations with sections smoother if meeting dates and topic areas are set one season in advance. Set your schedule and send it in along with election results; speaker identification can always be added later.

"Material for the January issue must be in the Editor's hands by November 22."

Chapter Chairmen

Baltimore	Mr. Richard A. Kowalski Westinghouse Electric Corp. P. O. Box 1897 Baltimore, Md. 21203	New Jersey Coast	Mr. Weldon V. Lane 57 Throckmorton Avenue W. Long Beach, N.J. 07764
Binghamton	Mr. Joseph J. Rexford 20 Merrill Street Binghamton, N.Y. 13905	New York - Long Island	Dr. Martin L. Shooman 12 Broadfield Place Glen Cove, N.Y. 11542
Boston	Mr. Paul E. Curtis 12 Autumn Lane Waltham, Mass. 02154	North Jersey	Mr. Stanley M. Cherkasky 61A Salisbury Road Wayne, N.J. 07470
Canaveral/Daytona	Mr. Jack R. Lykins 285 Carissa Drive Satellite Beach, Fla. 32935	Philadelphia	Mr. Irving Hyams 134 East Cheltenham Ave. Philadelphia, Penna. 19120
Chicago	Mr. Charles W. N. Thompson 240 Randolph Street Chicago, Ill. 60022	San Diego	Mr. Thomas W. Wright Evaluation Research Systems and Management Systems 2001 Kettner Blvd., Suite 3 San Diego, Calif. 92101
Connecticut	Mr. J. R. Breton 320 Ocean Avenue New London, Conn. 06320	San Francisco	Mr. Gilmore Bowers 766 Berkley Avenue Menlo Park, Calif. 94025
Florida West Coast	Mr. Robert P. Dalton 2170 College Drive Clearwater, Fla. 33516	Twin Cities	Mr. Stephen J. Pech 109 East Golden Lake Lane Circle Pines, Minn. 55014
Los Angeles	Mr. Robert B. Babin 26822 Hawhurst Drive Palos Verdes, Calif. 90274	Washington	Mr. William E. Wallace, Jr. 304 Wayne Avenue Silver Spring, Maryland 20910
Mohawk Valley	Mr. George Kasouf 1513 Bette Road Utica, N.Y. 13502		
Montreal	Mr. Duco W. Weytze 17 Howard Roxboro 970 Quebec, Canada		

Group President

Mr. V. R. Monshaw, MS 115
RCA Astro Electronics Division
Box 800
Princeton, N.J. 08540

Editor

Paul Gottfried
9251 Three Oaks Drive
Silver Spring, Md. 20901

The Reliability Group Newsletter is published quarterly by the Reliability Group of the Institute of Electrical and Electronics Engineers, Inc. Headquarters address: 345 East 47th Street, New York, N. Y. 10017. Sent automatically and without additional cost to each member of the Reliability Group.

Second class postage is paid at New York, N. Y.

Send Form 3579 to IEEE Inc. 345 East 47th Street, N.Y., N.Y.

Chapter NEWS

North Jersey

The 1971-72 season featured talks on Beam-Leaded IC's by D. S. Peck, Non-Constant Failure Rates by J. Frogola, RADC Failure Analysis by E. Doyle and Specifying Hi-Rel Devices for Military Applications by S. Grubman. The Chapter wound up its activities with a Section meeting highlighted by a tour of Buyer's Laboratory.

The following officers were elected to serve during the 1972-73 term:

Chairman	Stanley Cherkasky
Vice Chairman	Everett Labagh
Secretary	Sidmon Markowitz
Members at Large	Richard Jacobs Donald Jensen Victor Kalata Dr. Raj Misra

Ken Grace, Jr., Past Chairman, is a member of the Chapter Executive Committee along with the seven newly elected officers.

Chapter meetings for the 1972-73 season have been scheduled for October 11, November 30, January 30, and May 24 at the Singer-Kearfott Division, Little Falls, New Jersey (all meetings at 8:00 p. m.). Edward Emery will speak on the Reliability Physics Approach to Components Evaluation at the October meeting; subsequent meetings will address Software Reliability, Human Reliability, and Product Liability vs. Reliability, with speakers to be determined. A tour will be scheduled for March 21, at which time officers will be nominated for the May 24 election. The January and May meetings have been proposed as joint meetings with the Section. For further information, contact Victor Kalata, (201) 256-4000, Ext. 2062.

Philadelphia

Firm plans have been developed for the following 1972-73 season events:

September 26	Joint meeting with Engineering Management and Systems, Man & Cybernetics Chapters on "Club of Rome Project/Limits to Growth. The Model -- its Implications and Limitations". Panel discussion at David Rittenhouse Lab., University of Pennsylvania, 33rd & Walnut Streets, 8:00 p. m.
October 25	"Decision Risk Analysis" presentation by John Todaro, U. S. Army Logistic Management Center, Ft. Lee, Virginia. At the Presidential Apartments, Schuylkill Expressway & City Line Avenue, 8:00 p. m.
May 17	6th Annual Failure Analysis Seminar; Harvey A. Barton, Jr., Seminar Chairman. Towne School, University of Pennsylvania, 9:00 a. m.

Additional meetings are planned for November 30, February 20, March 21, and April 26. For further information on all meetings, contact Helen Yonan at (215) 594-8106.

Washington

The first event of the new season will be a joint meeting with the ASQC Washington Section on October 31. The subject will be "System Engineering -- Past and Present" and will be presented by Elmer L. Peterson, Professor of System Engineering at Virginia Polytechnic Institute and State University and author of AFSCP 800-6.

Continued...

The meeting includes a social hour at 6:30, dinner at 7:00, and presentation at 8:00. It will be held at the Arlington Hall Officers Club, Arlington Blvd. at Glebe Road, Arlington, Virginia. Dinner reservations must be made no later than Friday, October 27; meeting reservations by October 30 (attendance list must be furnished to the guard). For further information, contact William E. Wallace (G-R) at home (585-1932) or Del Burchfield (ASQC) at work (697-3974, 697-4175).

Call for Papers

RELIABILITY PHYSICS SYMPOSIUM

Papers describing original, unpublished work on failure analysis techniques, failure modes, failure mechanisms, and reliability improvements are solicited for the 1973 Reliability Physics Symposium to be held at the Dunes Hotel, Las Vegas, April 3-5. Papers should be in the following or related areas: MSI/LSI, Design and Process Control for Reliability, Hybrid Circuits, Passive Components, Surfaces and Interfaces, Microwave and Optoelectronic Devices, and Metallization and Bonding.

Prospective authors should notify the Program Chairman immediately of their intention to submit an abstract, including whatever information concerning subject matter is available. The deadline for submission of abstracts is November 20.

The 50-word abstract, suitable for publication in an advance program, should be typed on a separate sheet and include the title of the talk, author(s) and affiliation, complete return address, and telephone number.

A 300-500 word summary appropriate to a 20-minute paper clearly stating the purpose of the work, how it advances the knowledge of reliability physics, and the results of the investigation, also is required. Summaries must be submitted in single-sided, double-spaced typewritten form suitable for immediate reproduction and review purposes. The title, author's name, affiliation, complete return address and telephone number should appear on the first page, and the author's name and paper title on each subsequent page.

The abstract and summary should be forwarded to:

H. E. Nigh, Technical Program Chairman
1973 Reliability Physics Symposium
Bell Telephone Laboratories, Inc.
555 Union Boulevard
Allentown, Penna. 18103
(215) 439-7769

Authors of accepted papers will be required to submit their completed papers, at the time of presentation, for publication in the conference proceedings.

A limited number of late-news papers (suitable for 10-minute papers) reflecting important new developments will be considered if 100-word abstracts and 300-500 word summaries are received by February 16.

Report of 1972 Reliability Physics Symposium

The 1972 Reliability Physics Symposium held in Las Vegas, Nevada, April 5-7, attracted an attendance of 430 scientists and engineers. The meeting was keynoted by Dr. George Heilmeyer, DDR&E Assistant Director for Electronics and Computer Sciences. The audience was told that strict concern must be given to total life-time costs in system development in lieu of the present emphasis on pushing the forefront of performance. He also suggested that we must develop a more thorough understanding of LSI process control parameters so that cost effective, in process screen control techniques can be instituted.

A very educational and worthwhile program consisting of 34 technical papers plus a failure analysis Workshop was assembled by Chairwoman Jayne Partridge, MIT Draper Laboratories, and her committee. This committee comprised of J. Black (Motorola), J. Cunningham (TI), I. A. Lesk (Motorola), H. Nigh (BTL), J. Seacord (Plessey, Inc.), followed the trend established at the previous symposium by stressing the practical aspects of failure mechanisms and their effect on device reliability. A brief summary of the technical sessions is given below. Complete proceedings may be obtained through IEEE Headquarters.

New and Improved Failure Analysis Techniques

The technical program started off with several papers on new methods for isolating and identifying underlying failure causes. The first speaker, S. K. Behera, Microsystems International, described potential contrast studies, under DC and AC conditions, of MOS devices. By suitable calibration, threshold voltages, and signal changes can be monitored. In strobe mode, switching speeds to 100 KHz can be monitored making this an excellent tool for observing anomalies. No radiation damage is evident if the 2KV limit is maintained.

A non-destructive screening technique for indicating power transistor sensitivity to hot spot formation was discussed by F. F. Oettinger, NBS. In this technique, base current is measured as a function of collector voltage with collector current held constant. Two types of hot spots have been observed. In the first, a slow I_B rise is noted at relative low E_c with a maximum hot spot temperature of 265-295°C. The 2nd occurs at a higher collector voltage and is characterized by a more abrupt base current change. The hot spot may be from 1-10% of chip area with temperatures reaching 315°C. Many times the hot spots occur within maximum ratings, below 2nd breakdown point. Transistors of the same type number, made by different manufacturers, may exhibit completely different current crowding characteristics.

R. E. McCullough described a novel approach for determining the presence of foreign particles within device packages. High speed movie techniques were used in conjunction with glass encased components for studying the dynamics of foreign particle excitation. From this work a monitored shock screening test was developed. The test has approximately 40% effectivity for 2 mil gold particle and nearly 100% effectivity for particles of 4 mils or larger. Shock pulse energy is limited to 15 g to minimize noise. Small particles tend to adhere after 5-7 pulses.

A technique applicable for inprocess monitoring of bipolar IC devices was described by R. E. McMahon, MIT Lincoln Labs. A scanned laser beam generates photo currents whose level is determined on material type and structure. By monitoring the photo currents on a synchronized scope, operating characteristics, and various metalization and diffusion defects can be observed. A 2nd laser beam can be used to switch bistable circuits to observe switching characteristics. The technique is not too useful for MOS structures because the gate area metalization shields the underlying gate region from the laser energy.

Another method for detecting conductive particles inside component enclosures was suggested by J. E. Mann of NAR, Autonetics Div. In this method test devices are periodically subjected to a 175-200 g shock pulse simultaneously with a 5 g-2Hz vibration. The circuit is electrically monitored for particle shorting between adjacent

circuit elements. The method has been applied on a production basis for many thousand transistors and ICs with good results. Typically, original process DTL devices showed 3.9% dropout which dropped to 0.6% after process clean-up. With a glass over protection the defect level reduced to less than 0.01% on 100,000 parts.

In the final paper of the session, R. P. Beaulieu, Communications Research Centre, Ottawa, Canada, described the use of an SEM electron beam for measuring voltage potential at selected regions of an IC device. Secondary electrons are removed by a normal field and fed to a calibrated linear detector. With this technique surface potential measurements are possible without physical contact to the wafer.

Design and Process Control for Reliability

This session considered design and process control concepts for producing reliable semiconductor devices. These measures are finding greater interest among manufacturers in contrast to screening and testing out defects as practiced earlier.

The first paper, by H. W. Van Beek, Texas Instruments, described techniques employed by the circuit designer for enhancing the reliability of production MOS/LSI devices. The main consideration was geometries that improve heat dissipation and producibility. Typically, source-drain dimensions are 0.4 mils x 0.4 mils. Contact openings are maintained at 0.4 x 0.4 or 0.3 x 0.5 mils with a 0.1 mil P+ margin. Redundant contacts are used for ground lines and each chip contains test transistors. A feedback system has been instituted whereby production device characteristics and reliability evaluation results represent engineering inputs for design or process changes.

Two case studies illustrating how reliability improvement was achieved through understanding and controlling key process parameters were described by W. H. Schroen, Texas Instruments. It was determined that processes contributing to parameter instability have greatest effect on reliability. For bipolar devices, h_{FE} was investigated using tetraode and field plate structures. A family of I_B vs transverse bias voltage curves based on percent of surface control revealed that h_{FE} was a linear function of the base resistance under the emitter. A single measurement of this parameter is effective in detecting h_{FE} instability.

In MOS structures, V_{TX} and V_{TFX} are significant to device reliability. Stress testing indicated instability mechanisms to be ion drift, hole injection and trapping at the oxide-silicon interface, polarization, and differential electronic conductivities.

G. G. Harman of NBS reported on findings of a comprehensive study of ultrasonic bonding. The NBS studies indicate that ultrasonic energy, not heat is responsible for deformation and embrittlement of the bond. Lift off patterns illustrated with SEM photomicrographs show that completed bonds often have an unwelded area at the center region. Welding takes place at between 10-15 milliseconds after application of ultrasonic energy. Another significant finding reported is that the bonding tool does not lock onto the wire during any portion of the bond cycle. Therefore, the wire does not slide over the metalization but rather the tool moves back and forth across the wire. It was stressed that bonds should not be made over active substrate areas as the ultrasonic energy and pressure may damage the silicon.

In a late news paper, Erwin Herr, General Electric, reported on the design features employed in a new small signal solid encapsulated transistor. The device utilizes a 1000 Å silicon nitride barrier over silicon dioxide. Metalization consists of platinum-moly-gold with thermocompression bonded gold interconnect wires. An 18 K Å glassivation covers the entire surface prior to encapsulation in transfer molded epoxy. This structure was subjected to extended temperature (250°C), moisture (7500 hours, 85°C/85% RH) and temperature cycling (400 cycles) with good results.

Microwave Devices

Two papers on microwave device reliability were included in the session on design for reliability. The first, authored by W. J. Moroney and Y. Anand, Microwave Associates, compared reliability behavior of newer Schottky barrier diodes with the traditional point contact structure. Expected power handling improvement of the former has not materialized - in fact, RF burnout resistance of the silicon point contact is superior. Indications are that proper selection of metals and improved processes should eventually make the Schottky device more burnout resistant.

Y. Fukukawa, et al, Fujitsu Laboratories, Ltd., reported that the use of diamond heat sinks for IMPATT diodes results in stable operation up to 500°C. In comparison to a copper heat sink at 330°C thermal resistance of the diamond heat sink structure is lower initially (approximately 50%) and remains stable throughout 1000 hours exposure. Thermal resistance of copper heat sinked devices increase dramatically with age. The latter is due to copper diffusion into the gold plating. IR studies of diamonds revealed a relationship between the absorption intensity and its thermal resistance. This phenomena enables diamond selection and classification for heat sink applications.

Reliability of Plastic Encapsulated Devices

This evening session consisted of 7 short technical papers and an open-ended rump discussion that drew wide and pointed audience participation.

R. Beard of National Semiconductor initiated the session by describing a new phenolic-cured epoxy encapsulant that was found, after an exhaustive evaluation of materials, to give superior results. The material is chemically inert and devices encapsulated in this material purportedly show excellent resistance to thermal intermittent failures and hostile environments.

Consumer reliability demands are approaching those of military customers according to E. R. Hnatek, National Semiconductors. As a consequence plastic encapsulated ICs are being subjected to qualification and screening tests almost as rigorous as those of hermetic packages intended for military usage. To eliminate potential defects the following vendor performed test sequence was recommended: 100% precap visual; lead bond integrity (50% higher stress than military specs.); 100% temperature cycling; 48 hour 150°C bake; 100% electrical; 100% high temperature continuity; and tightened AQL and LTPD levels.

The results of a 2 year comparative test program, to determine the effects of temperature, humidity and salt atmosphere, including a simulated field test, were presented by Ed Hakim of U.S. Army Electronics Command. An empirical relationship has been derived relating failure rate to the sum of temperature and humidity, wherein long term reliability can be estimated, similar to Arrhenius methods employed for hermetic devices. Mr. Hakim concluded that plastic ICs are acceptable for certain non-critical environments providing rigid qualification and lot acceptance procedures are employed.

M. C. Halleck of Honeywell Information Systems described an empirical method for determining resistance to moisture environments. In this method the natural logarithm of the observed times to 50% failure is plotted against the reciprocal of net vapor pressure. The latter is determined from the vapor pressure level below which the moisture reaction becomes insignificant which is not the same for all vendors.

Three additional panel members gave short pre-discussion presentations. R. B. Sundius of Singer-Friden discussed the reliability-cost trade offs of ceramic vs plastic DIP devices for consumer applications concluding that present plastic devices are a poor risk. C. R. Gray of Fairchild reiterated the consumers problems indicating them to be catastrophic failure of

which intermittent opens are a major contributor. He recommended 5 steps to be considered in selecting devices, tending toward the conclusion that plastic encapsulated devices have yet to prove themselves. An opposite view was taken by J. Flood of Motorola SPD. Although acknowledging the consumers concerns, he contended that with adequate controls desired reliability can be achieved.

The rump session, moderated by A. Procassini of Fairchild was lively, lengthy and touched on a broad range of subjects. One attendee, E. Herr of GE took the opportunity to present test results on his company's plastic-encapsulated configuration. The session perhaps demonstrated that no one can agree on exactly what is needed and what can be expected from plastic encapsulated devices in the industrial/consumer market. In conclusion, plastic encapsulated devices still suffer from a lack of hermeticity and thermal intermittents. With consumer demands approaching those of the military, claims must be proven before plastic devices can be accepted without reservations.

Interfaces

RADC's John Haberer reported use of small-spot (10μ) light scanning, with detection of the induced photocurrent, in analysis of instability of the offset voltage of a group of 709 operational amplifiers. The fault was identified by this technique as inversion of the isolation between sections of the input-stage collector load resistors; the same effect was obtained by introducing electronic charge into the passivation layer, using an electron-beam microprobe. It was concluded that trapped electronic charge, rather than chemical contamination, caused the inversion, and it is suspected that the charge is trapped at or near the interface of the thermal and deposited oxide passivations. The photoscan yields both topological-distribution and charge-density information.

Eugene Lampi of BTL has studied the aging behavior of p-channel $Al_2O_3-SiO_2$ IGFETS, having PtSi-Ti-Pt-Au metallization, in the 100-300°C range. He finds that gain and leakage currents do not change significantly, but that a short-term threshold-voltage drift can cause device failure. This rapid V_T shift is attributed to polarization and charge motion in the Al_2O_3 . Charge motion, observed only under positive gate bias, corresponds to movement of charge (build-in during processing) from the $Al_2O_3-SiO_2$ interface to the gate electrode. With negative bias the polarization shift occurs and saturates within 300 hours at 100°C. Slow drift, ascribed to charge injection at the Si-SiO₂ interface as in SiO₂-insulated structures, was also observed; its magnitude was so small as to be negligible in most applications.

The more-important rapid polarization shift can be tested for during production, if desired. The methods of failure-rate prediction for continuously-degrading devices are novel and appear workable.

Murray H. Woods of RCA-Princeton has investigated aging of MNOS transistors during long-term pulsed operation. He observes negative V_T shift, reduced charge-storage time, and closure of the "window" between high and low output states. These degradations, which occur more rapidly with higher-voltage pulses and with increasing temperature, are annealable by overnight 125°C storage (without bias) but cannot be recovered by application of a DC field. The degradation mechanism is creation of fast surface states at the oxide-silicon interface. It is concluded that the devices tested would not be suitable for RAM's, but could be used in ROM's which would not be pulsed more than 107 times.

J. Lebailly of RTC - Laradiotechnique Compelec (France) cited the results of temperature (25-85°C) and forward-current (100-300A/cm²) tests on Ga As, LED's. Investigation of diodes whose light output was degraded after testing showed that their tunnel currents and space-charge-recombination currents had

increased, while the thermal-injection current remained stable. The degradation is believed to be caused by point defects (of unspecified origin) near the junction. Operation below 100A/cm² at 55-85° T_j is recommended for satisfactory life.

R. L. Hartman of BTL has isolated three features of "standard" Ga P red LED's which contribute to an observed rapid degradation of luminescence, followed by a slower, nearly-exponential long-term decrease. These features are exposure of a p-[111] face to the ambient, non-uniformity of current density in the p-layer at 7A/cm², and a strain field in the p-LPE junction. While design changes have substantially relieved these degrading factors, injection efficiency is still a problem and the surface contributions are not understood.

A reasonable summary of this session is: 1) Bipolar IC's are not immune to poor packaging and ambient control; they fail just as discrete devices would under similar conditions. 2) The understanding of MIS-device degradation causes is sufficient to permit confident extrapolation of their reliability under operating conditions, and 3) the mechanisms of luminescence degradation in GaX LED's are not yet clear, but the degradation is a very significant (albeit unpredictable in degree) fact of life.

Bonding and Metallization

This session considered techniques for determining failure mechanisms of wire bonds and deposited thin metal film such as aluminum and molybdenum.

Mr. K. V. Ravi of Motorola Semiconductor in a paper entitled "Reliability Improvement of Wire Bonds Subjected to Fatigue Stresses" observed that aluminum wire bonds fail when subjected to intermittent operation within manufacturer ratings. Accelerated fatigue testing was discussed and correlation data relating flexing due to intermittent operation and the fatigue testing apparatus was presented. A SEM film was presented demonstrating the motion and failure of 1 mil aluminum wire when power is applied. Variables affecting flexural fatigue of wire bonds were also discussed, including different wire material, and aluminum doping constituents, such as copper and magnesium doping. It was shown that the magnesium doped aluminum wire has the best fatigue characteristics.

This paper presented by A. Horning of IBM concerns the reliability of molybdenum thin film under the effects of temperature and relative humidity. A physical model was presented to explain the reactions. It was shown that when moly thin films were exposed to 85°C/85 R.H. the structure of the film was drastically altered. SEM photos also confirmed these structural changes. Curves illustrating the corrosion rate may be expressed by $K(t) = A \exp(-\Delta E/KT)$ as a function of temperature and a relative humidity between 60% and 90%. The physical model is based on the adsorption of H₂O into the moly film where electro-chemical action takes place. The corrosion rate is characterized by an activation energy of 1.06eV.

C. W. Horsting of RCA presented the results of bond studies performed with materials that were not extremely pure but "commercial grade gold." The bonds were exposed to 390°C for 1 hour with pull tests made before and after this bake. Significantly reduced pull strengths were observed as a function of the amount of impurities contained in the gold. As impurities were added, the number of bond lifts significantly increased. Also, differences in the microstructure of the bonds were observed. It was stated that the mechanism is not completely understood, but when pure metals are used, bond lifts are significantly reduced.

This paper titled "A Statistical Model for Electromigration - Induced Failure in Thin Film Conductors" was presented by Dr. John Venables of the Martin Marietta Company. The physical model and mathematical calculations were presented. The equation $\frac{dp}{dt} = cn j \rho \mu$ basically describes a thermal runaway condition of the aluminum stripe where $j = j_0 / (1 - \rho)$. A curve expressing mean time to failure vs. current density and an arrhenius plot of the mean time to failure vs. the reciprocal of temperature were shown. It was hypothesized that this model may be used for any thin film metal that migrates with an accompanying void formation.

A. Gangulee and F. M. d'Heurle of IBM presented a paper describing a study to determine if the lifetime of aluminum thin films can be increased by adding such metals as copper, magnesium and combination of these metals with nickel. It was observed that in most cases the stripes failed randomly throughout their length. The magnesium aluminum films gave very good life characteristics. However, it was observed that the mg reacted with the underlying SiO₂ to form magnesium silicate type glass. It was shown that a strong correlation of failure at the cathode end of the quaternary metal system occurred due to a thermal mechanism. It was hypothesized that the resistivity of the AL-Mg system is significantly lowered by the addition of copper because of an AL₂ CuMg alloy formation.

In a late news paper, R. C. Pitetti of BTL discussed the electromigration of titanium palladium gold conductors. Large temperature gradients were measured at glazed - unglazed steps of the ceramic substrate. Conclusions drawn were: 1) gold is not immune to electromigration failure and 2) pattern defects lead to early failures.

Hybrids, Multi-layer Boards and Passive Components

The first paper, by D. Grabbe, Maine Research Corp., elaborately described the processing of an 86-layer board. This experimental specimen was intended to demonstrate ability to attain layer-to-layer registration. Severe thermal cycling of multilayer boards may result in increased contact resistance, electrical noise and in some instances, rectifying effects through hole metalization-copper interfaces. Two mechanisms are responsible: one is initiated by microscopic movements of the dendritic copper underlayer from repeated thermal stresses and the other, formation of complex chemical compound layer on the dendritic surface from interaction of free radicals in the epoxy resin and adsorbed moisture.

The results of qualification type high temperature stress and special low temperature tests of radiation-hardened ICs were described by V. C. Kapfer of Rome Air Development Center. Corrosion failures of thin film nichrome resistors predominate. These were found to result when ambient moisture (up to 1.68% vapor content in failed devices) penetrates microcracks in the glassivation layer and attacks the film. Sodium from the glasses accelerate the corrosive attack by ionizing the water. To prevent corrosion failures, the author recommended 1) improved glassivations and package seals, 2) a special qualification test and 3) screening procedures and micro-analytic methods for monitoring fabrication/processing steps.

"Failure Characteristics of Thin-Film Capacitors" was presented by J. S. Fisher (BTL). The speaker scrutinized the reliability behavior of tantalum thin film capacitors, stating that failures can be represented by a lognormal distribution and one of several proposed models. One described as a "simple reaction case" involves the kinetics of concentration and rate constants. The other termed a "simple diffusion case" leads to derivation of the activation energy of the process. Little is presently known of long life breakdown characteristics under low stress conditions.

In a study of contact physics, W. T. Byrne of Memorex Corp., evaluated commercial grade edge-connectors, from eight manufacturers, under a 5% SO₂ corrosive atmosphere designed to simulate a polluted, urban environment. Microscopic porosity of the gold plating is the dominant element leading to contact corrosion. The author concluded that manufacturing quality-control is more important to product reliability than differences in design. Accordingly, specification provisions were recommended such as maximum acceptable contact resistance, gold plating properties (i.e., hardness, thickness, porosity), and resistance to corrosive atmospheres.

In the first of two late news papers, R. S. Spriggs, Aerojet Electro-Systems provided a scholarly presentation on the contribution of organic adhesives on metalization failures. It was found that metalization corrosion is most prevalent when 1) aluminum metalization is in direct contact with epoxy, 2) the metalization surface is scratched, 3) excessive hardener in epoxy mix, 4) a positive potential difference between several elements and 5) moisture is present. A final design utilizing alumina substrates, gold metalization and single part epoxy solved the corrosion problems.

The final technical paper by G. H. Abel, Singer-Kearfott, described a method for burning in chips prior to assembly. A 2nd level aluminum metalization is added above the chip circuit element to serve as electrical interconnects for applying electrical power. The metalization is then removed after burnin and normal processing proceeds. The technique is still in early stages of development so its full capability has not been evaluated.

Failure Analysis Workshops

The Workshop, scheduled for two morning sessions, was continued by popular demand for a 3rd session after the symposium was officially closed. A few of the topics covered are:

- a) electrical verification
- b) radiography and particle identification
- c) gas chromatography
- d) hermeticity testing
- e) decapping
- f) electrical circuit probing
- g) SEM and Auger Electron analysis
- h) film thickness measurements
- i) voltage gradient and photo voltage/current sensing.

Extensive audience participation brought out a wide variety of unique autopsy techniques used by different failure analysis laboratories. These are too numerous to describe in this summary, but will be included in the Symposium Proceedings.

- October 30-
November 1 NBS Conference on Dimensional Accuracy in Manufacturing, National Bureau of Standards, Gaithersburg, Maryland
- November 13-15 1972 IEEE Conference on Automatic Support Systems for Advanced Maintainability (G-AES and Philadelphia Section), Holiday Inn - Penn Center, Philadelphia, Pennsylvania
- December 4-6 National Telecommunications Conference (G-AES, G-CT, G-GE), Astroworld Hotel, Houston, Texas
- December 4-6 1972 IEEE International Electron Devices Meeting (G-ED), Washington Hilton Hotel, Washington, D. C.
- December 5-7 1972 Fall Joint Computer Conference (AFIPS), Anaheim Convention Center, Anaheim, California
- 1973
- January 23-25 1973 Annual Reliability and Maintainability Symposium (G-R, ASQC, ASME, AIIE, SAE, IES, AIAA), Bellevue-Stratford Hotel, Philadelphia, Pennsylvania
- February 14-16 1973 IEEE International Solid-State Circuits Conference (Solid-State Circuits Council, Philadelphia Section, University of Pennsylvania), Sheraton Hotel, Philadelphia, Pennsylvania
- March 4-10 First International Congress on Technology Assessment (International Society for Technology Assessment), The Hague, The Netherlands
- April 3-5 1973 Reliability Physics Symposium (G-R, G-ED), Dunes Hotel, Las Vegas, Nevada
- April 9-11 1973 IEEE International Symposium on Circuit Theory (G-CT), Four Seasons Sheraton Hotel, Toronto, Canada
- April 11-12 1973 IEEE-ASME Joint Railroad Conference, Chase Park Plaza Hotel, St. Louis, Missouri
- May 14-16 1973 Electronic Components Conference (G-PHP, EIA), Statler-Hilton Hotel, Washington, D. C.
- May 15-17 1973 Electrical & Electronic Measurement & Test Instrument Conference (G-IM, Ottawa Section), Skyline Hotel, Ottawa, Canada
- June 4-7 1973 IEEE Power Industry Computer Applications Conference (PES), Radisson Hotel, Minneapolis, Minnesota
- June 25-29 1973 IEEE International Symposium on Information Theory (G-IT), Ashkelon, Israel

Employment advertising

The Newsletter accepts both "Help Wanted" and "Position Wanted" on a no-charge basis, subject to the following rules:

- Ads will appear in two successive issues unless cancellation notice is received before editorial deadlines.
- Text for each ad will be limited to ten lines plus identification, with a maximum of 45 characters and spaces per line.
- Ads may be open or blind, but blind "Help Wanted" ads should identify the type of business and the general geographic location of the vacancy.
- Submittals of "Position Wanted" ads should include IEEE membership number.
- "Help Wanted" advertising must fall in the "Equal Opportunity - M&F" category. Agreement to this requirement will be considered to be implied by the submittal of the ad and need not appear in the text.

Position wanted

15 years of experience in engineering and manufacturing of electro-mechanical systems, including 10 years in management of product assurance activities (Quality Assurance, Rel./Maint., Quality Control and Test Programs). Have received corporate commendation as Director of Q. A. and earned Reliability Incentive bonus for company as supervisor Rel./Maint. 40 years old - B.S. in Industrial Engineering and Administration.

Reply to Box 1 c/o Editor.

• short COURSES

Newsletter policy with respect to short-course announcements, as established by the AdCom, is to provide publication for information only. No endorsement is implied, and no check on course content or instructor qualifications has been accomplished.

University of Arizona

10th Annual Reliability Engineering and Management Institute: November 6-10, (Co-sponsored by Honeywell Information Systems). Five days, \$300. Contact: Gen. B. H. Pochyla, Director of Conferences and Institutes, Division of Continuing Education, The University of Arizona, Tucson, Arizona 85721.

From AFIPS Press, 210 Summit Avenue, Montvale, New Jersey 07645:

Proceedings of the 1972 Spring Joint Computer Conference, 1217 pages, \$15 members of AFIPS constituent societies (including IEEE Computer Society), \$30 nonmembers.

From the MIT Press, Massachusetts Institute of Technology, Cambridge, Massachusetts 02142:

Analysis of Public Systems, edited by Alvin W. Drake, Ralph L. Keeney, and Philip M. Morse, \$14.95.

From the National Academy of Sciences, available through the National Technical Information Service, Springfield, Virginia 22151:

Testing for Prediction of Material Performance in Components and Structures (NMAB 288), 132 pages, \$3.00.

From the National Bureau of Standards, available through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402:

The International System of Units (SI), NBS Special Publication 330, 1972 Edition, SD Catalog No. C13.10:330/2, 45 pages, 30 cents.

Methods of Measurement for Semiconductor Materials, Process Control, and Devices (Quarterly Report October 1 - December 31, 1971), NBS Tech Note 727, SD Catalog No. C13.46:727, 79 pages, 70 cents.

WR 15 Thermal Noise Standard, NBS Tech Note 615, SD Catalog No. C13.46:615, 154 pages, \$1.25.

Frequency Standards and Clocks: A Tutorial Introduction, NBS Tech Note 616, SD Catalog No. C13.46:616, 69 pages, 65 cents.

HELP FOR FLOOD-STRICKEN COLLEGE LIBRARY

The basement and first-floor levels of the Wilkes College library were inundated by the flood resulting from Hurricane Agnes. All current and back-issue periodicals and other serial publications were lost.

Anyone wishing to donate materials should contact the librarian directly at the following address and arrange for shipment:

Mrs. Marie Byczkowski
The Eugene Shedden Farley Library
Wilkes College
Wilkes-Barre, Pennsylvania 18703
(717) 824-4651

Roster

Region 1

BERKSHIRE

LEONARD W HUBAND
A A TIEZZI
R R WARRINER

BINGHAMTON

PALMER W AGNEW
D C BAKER
B H BALDRIDGE
J B BIRD
LEIGHTON B BROWN
ROBERT TODD DOWNEY
J T GURMAN
L D HALL
G HESS
E P HOJAK
E F JAHR
CURT I JOHNSON
W D KINSOLVING
GEORGE J KLIR
R E KUEHN
NELSON S LAWRENCE
K A LYMAN
J PAULSON JR
JOSEPH J REXFORD
S R ROMAN JR
SALVATORE F SARACENO
C B STIEGLITZ
THOMAS J ULRICH
A Z WALACH
M A YOUNG

BOSTON

W G ALBERT
THOMAS E ATKINS
R E BAYLISS
R L BEST
GEORGE J BLAKEMORE JR
R L BLANCHARD
I BOSINOFF
JOHN A BOTTARI
G A BUCCOIA
P B BUSTEED
L R CADRAN
LE R CARRUBRA
J F CHALUPA
J W CHAPIN
B M CHIN
TCHANG H CHUNG
D C COMSTOCK
ROBERT G COOK
P E CURTIS
D L DAWES
M J DEPOLITO
F J DOLAN
C DONOVAN
J DORFMAN
A DUSHMAN
CARL C ECKEL
D L ECKHARDT
J EDELMAN
J ELLISON
MICHAEL D EMELIANOFF
ROLAND F EMERO
S W FAUGHT
R A FRIEDENSON
GERALD H FULLER
A GELB
R R GORDON
RONALD D GORDON
W J GRAY
S A GREENBERG
J GRUND
P S HARRIS
C L HARRISON
ROBERT P HASSETT
P C HAYDEN
A H HEVESH
J M HOFFER
IVAR M HOLLIDAY
ROBERT N HOM
E W HODVER
ALEXANDER F JASZEK
A KAUFMAN
STANLEY KAZERMAN
JEFF L KERSEY JR
P W KIESLING JR
IAN KIRKPATRICK
ROGER E LADD
HENRY D LEDBETTER
C T LEE
MORTON H LEVIN
W E LOWERY
A L LYMAN
FRANK J MAHONEY 3RD
J P MALIZIA
N A MARTEL
W R MC CARTHY
P K MCELROY
T J MC NAMARA
J E MEKOTA
N P MILLAR

H B MORLEY
CHARLES H MOSBY JR
W E NAAS
J B NEWBOLD
THOMAS P NEWMAN JR
ELLIOTT D NICHOLS
NICHOLAS Y NIEH
WALTER D NISULA
C L NJELCKE JR
YASUSHI NOZAWA
ANTHONY R PASTORE
JOSEPH J PLANTE
A W POSTLETHWAITE
D M POWELL
R F POWELL
L F REA
V H READ
ROBERT R REEDS
H L RENFROE
WARREN ROBERTS
T B ROBINSON
GERARD S ROCHELEAU
JOHN P ROONEY
GERARD T ROSS
B A SACCO
W L SEXTON
I SHAPIRO
JACOB M SHAPIRO
JOHN C SIMONS JR
DONALD V SIMPSON
J T SPURGEON
D B SINCLAIR
B D SMITH
V SPOKIKIAN
JOSEPH J SORRENTINO
A C SPEAR
TERRY M STARK
A M SWASEY JR
Y TAKEDA
C A WALANT
C W WATT
P A WEMETT
LEWIS R WHITE
THOMAS G WOOD
DONALD WRIGHT

BUFFALO

W J ATKINS
DAVID J BLAIR
E B CLAUSEN
G B COHEN
L W HERCHENROEDER
E A MILLER
R A NOWACKI
D L PIERCE
W J WALBESSER
J P WELSH

CONNECTICUT

ALBERT J ABELE
J R BELVILLE
JOSEPH T BONNER
G J BOUCHER
J R BRETON
DAVID K CHOW
L E COUTERMASH
PHILIP G DANFORTH
JOHN J DE FRANCO
F X FINNERTY
RAYMOND W FITZGERALD
L F GILBERT
ROY E GITTER
DANIEL H GRANTHAM
E A HADDAD
GUNNAR E JORGENSEN
G C KALANDER
G T KARACHUK
E J KICZUK
R L LARSON
THOMAS E MARCHESSAULT
P N MARTIN
L PABIAN
E L PAGANO
CLAUDE L PHILIBERT
J F RAYE
JACK SHERMAN
J SHOGREN
R R SIEGERT
P B SMITH
B M TASHJIAN
JACQUES G VANDENBORRE
F C WARNER
DANIEL C ZELBO

MAINE

FRED FERNANDEZ
DAVID A FERRIS
JAMES F GROCHMAL
RALPH F SWEET
G C TIBBETTS

MID-HUDSON

V A FISCHER
J A GOETZ JR
J GOLD
J E HARRIS
F D HEATH
CLARENCE LUNGCOR
DENNIS F NUZBACK
R L PRATT
V RAUCH
SAUL TWICKEN

ELMIRA-CORNING

R R BARBER
H D HULME

ITHACA

S W ZIMMERMAN

LONG ISLAND

DUNCAN BADENIUS
ARTHUR P BARTOLOMEO
V J BONARDI
V W BOND
HAROLD BRENNER
T A BUDNE
R P BURR
J J BUSSOLINI
S J CAPEK
J H S CHIN
D CHRISTIANSEN
R W CLEMENS

IRA B COREN
G COSTIDIS
JAMES M CULLINAN
H D DAGAVARIAN
THOMAS J D AGOSTINO
P DIMATTEO
R M EMBERSON
D B ERLICHMAN
A S FEINSILVER
JOSEPH R FRAGOLA
IRVING N FRIEDLANDER
ELLIOTT D FRIEDMAN
D C GALA
GEORGE A GEDNEY
J J GERRY
N P GINEX
B GLEITNER
SIDNEY N GREENBERG
R I GROSS
ROBERT E GRURER
KENNETH A HALLER
RAYMOND HASTINGS
EDWARD B HORN
DAVID HOROWITZ
A HRYCYK
R E JACK
L JACOBSON
A C JOHNSON
M J KIRBY
R KLEIN
ARTHUR J KOPPEL
DAVID J KOVENSKY
JAMES LEGGIO
ERNEST LEONARD
E D LEVERS
W J LIGHT
COSMOS MARENTIS
N J MAROULIS
D M MARSTELLER
D W MATTESON
C W MEINEN
ISRAEL C MILLER
M J MINNEMAR
P A MONTEMURRO
HAROLD MADLER
R E OAKES
D M PASEK
DAVID G PERSANS
LEON E PHILLIPS
S PODOWITZ
TRIFON PRASINOS
G C RABIN
H E REYMERS
H E RICHTER
S A RINKEL
A RIPNITZ
STANLEY A ROSENTHAL
E J FOOTH
M RUDIS
BENJAMIN K SACHS
F R SANTASIER
B F SCHADELBAUER
RICHARD D SCHULTZ
ROBERT E SCHWARZ
J J SMITH
A W SMOOT
JEFFREY F SPAHN
A SPECTOR
H W SPENCE
JOSEPH J STAPLETON
B D SULLIVAN
J J SWATKO
SOL TENENBAUM
W WARD
W A WEISSMAN
J W WOODS
HENRY YEE
DOMINICK YODICE
F R YOUNG

NEW HAMPSHIRE

P A BOOMER
RAYMOND V CALVESIO
A F FREISINGER
WILLIAM F HASKETT
E K WIMPY
T E WOODRUFF

NEW JERSEY COAST

R J BRISSON
ANTHONY J CONSENTINO
HARRIS DRUCKER
F R DUDLEY
PAUL E GRIFFITH
S GRUBMAN
L E HUNT
RICHARD G KEENE
DONALD G KOLIBAS
C T LOMAN
T A MANCINO
F L MARTINSON
BERNARD MEYER
FRANK L MURPHY JR
R C PERLE
C C KIRCHENBAUER
LEON J KOZLOWSKI JR
EVERETT L LABAGH
S A MALLARD
ALAN K MALTZ
SIDNEY MARKOWITZ
ROBERT W MARSHALL
FREDERICK A MENDEZ
ROBERT E MORAN
CONRAD R MULLER
E C NEU
J R BAKER
RICARDO H BALLESTER
CHARLES A BENENSON
HARVEY S BERMAN
F BERZINS
G BIGEL
W E BRAUN
RONALD T BUONOCORE
R J CANIZZARO
WILLIAM R CHRISTIANSE
J J DRYOSTEP
E D EICH
FRED EICHENBAUM
R E FIELDING
MELVIN S FINKELSTEIN
J GERACI
CLAUDE E GIBSON
L GLEIMER
JALAL GOHARI
A N GOLDSMITH
D M GOODMAN
STANLEY GOODMAN
M GUERIN
KEIICHI HANDA
J HANFT
A HERSHLER
J A KALPAXIS
ROLAND KHFERA
J M KINN JR
T R KOHLER
ROBERT G KRUPP
WALTER LANDAUER
STANLEY LAUT
GEORGE A MANGIERI
ROSE CAMBRIA MATTHEWS
G B MC CARTER
F M GIMNIS
MARTIN MESSINGER
R J MOLINELLI
HENRY MOSS
JAMES J OCONNOR
E G D PATERSON
HARRY A PEARSON
R H PINTELL
MARVIN ROBINSON
CHARLES B ROSS
BRUNO RUTA
W R RYAN
RAMSARAN SAHU
A J SCHEIMAN
SAVA I SHERR
M L SHODMAN
CHARLES A STEFFENS
S M TOPRANI
C W TUTTLE
VIJAY VERMA
VERNON VIOLA
R R VITTAL
ANTHONY P VOGELPDEL
JOHN S WALTON
GEORGE D WEINSTOCK
EDWARD WILLETT
J WINTERS
F J ZGERURA

MOHAWK VALLEY

JOSEPH ARRANTE
D F BARBER
ROBERT B CHAMBERLAIN
ANTHONY COPPOLA
W H DICKSON
BRUCE W DUDLEY
ANTHONY J FEDUCCIA
ROBERT W FENK
W R FRANCHHELL
D T GEISER
ROBERT M GRAY
MILTON HAUS
V C KAPFER
GEORGE KASOUF
JEROME KLION
A R KRUEGER
H A LAUFFENBURGER

MID-HUDSON

JAMES N MC GINN
DONALD M MEHAFFY
S P MERCURIO JR
P W MILES
R J NARESKY
ANTHONY D PETTINATO JR
J L RYNNING
M J SMITH
LEON SPERLING
JOSEPH VACCARO
W F WERNER

NORTH JERSEY

JOHN W ARNOLD
H A AUGENBLICK
R A BARKER
J L BELFI

JAMES N MC GINN
DONALD M MEHAFFY
S P MERCURIO JR
P W MILES
R J NARESKY
ANTHONY D PETTINATO JR
J L RYNNING
M J SMITH
LEON SPERLING
JOSEPH VACCARO
W F WERNER

NEW HAMPSHIRE

P A BOOMER
RAYMOND V CALVESIO
A F FREISINGER
WILLIAM F HASKETT
E K WIMPY
T E WOODRUFF

NEW JERSEY COAST

R J BRISSON
ANTHONY J CONSENTINO
HARRIS DRUCKER
F R DUDLEY
PAUL E GRIFFITH
S GRUBMAN
L E HUNT
RICHARD G KEENE
DONALD G KOLIBAS
C T LOMAN
T A MANCINO
F L MARTINSON
BERNARD MEYER
FRANK L MURPHY JR
R C PERLE
C C KIRCHENBAUER
LEON J KOZLOWSKI JR
EVERETT L LABAGH
S A MALLARD
ALAN K MALTZ
SIDNEY MARKOWITZ
ROBERT W MARSHALL
FREDERICK A MENDEZ
ROBERT E MORAN
CONRAD R MULLER
E C NEU
J R BAKER
RICARDO H BALLESTER
CHARLES A BENENSON
HARVEY S BERMAN
F BERZINS
G BIGEL
W E BRAUN
RONALD T BUONOCORE
R J CANIZZARO
WILLIAM R CHRISTIANSE
J J DRYOSTEP
E D EICH
FRED EICHENBAUM
R E FIELDING
MELVIN S FINKELSTEIN
J GERACI
CLAUDE E GIBSON
L GLEIMER
JALAL GOHARI
A N GOLDSMITH
D M GOODMAN
STANLEY GOODMAN
M GUERIN
KEIICHI HANDA
J HANFT
A HERSHLER
J A KALPAXIS
ROLAND KHFERA
J M KINN JR
T R KOHLER
ROBERT G KRUPP
WALTER LANDAUER
STANLEY LAUT
GEORGE A MANGIERI
ROSE CAMBRIA MATTHEWS
G B MC CARTER
F M GIMNIS
MARTIN MESSINGER
R J MOLINELLI
HENRY MOSS
JAMES J OCONNOR
E G D PATERSON
HARRY A PEARSON
R H PINTELL
MARVIN ROBINSON
CHARLES B ROSS
BRUNO RUTA
W R RYAN
RAMSARAN SAHU
A J SCHEIMAN
SAVA I SHERR
M L SHODMAN
CHARLES A STEFFENS
S M TOPRANI
C W TUTTLE
VIJAY VERMA
VERNON VIOLA
R R VITTAL
ANTHONY P VOGELPDEL
JOHN S WALTON
GEORGE D WEINSTOCK
EDWARD WILLETT
J WINTERS
F J ZGERURA

NEW YORK

JOHN H RAUTH
MOHYI A REFAIE
A J ROSENTHAL
P L ROSS
R L SAMSON
A R SANTOPIETRO
SOL M SELTZER
FREDERIC SHAKLAN
EDWIN A SHELL
NORMAN SLURZBERG
V C SULZBERGER
MICHAEL Y SWALUK
GILBERT TINT
R S ULLMAN
EDMUND F URBAN
JOSEPH E VAN ACKER
H N WAGAR
E A WEIGNER
RICHARD N WENMAN
G L WICKLAND
RICHARD S WIENER
JOHN F WILHELM
ROBERT C WILANS
PAUL WOJNICZ

PRINCETON

WILLIAM D BROOKS
B D BUNKER
J A RUTBY
M FRIEDMAN
JOHN C HODGE
KENNETH HOFFMANN
A LOBERT
D A LUPFER
P J LYNCH
WALTER E POOLE
EDWARD C ROSS
A E SCHMIDT
A STERNBERG

PROVIDENCE

JOHN J RAILLEY JR
MICHAEL H BRANSON
W DANDRETA
R P DEMEO
STEPHEN A DIAS
DANIEL DRUMHELLER
THOMAS F MC CULLOUGH
W C SCANLON
KENNETH A TATA
RICHARD B TURCOTTE

ROCHESTER

D R BARTHOLOMAY
JAMES H BEMENT
T F BRANDT
DAVID M BRENDER
RICHARD L CUNNINGHAM
RODNEY L DUD
MALCOLM DRUMMOND
ROBERT C FOSTER
A C GOLDENBERG
D L GRIEGER

Continued...

SAN DIEGO
W C NAGY
NICHOLAS PANOS
W F PICKETT
WILLIAM A PLOCK
ALVIN L RHINER
H W ROY
KEITH N SARGENT
J P SILVERSTEIN
ALDIS E SMITH
G L STIEHL
ROBERT J STOKELY
H B STURTEVANT JR
RICHARD J TOMMEY
ROGER E TURNAGE JR
F VIRGADAMO
JAMES R WILTS
W I WOODFORD
T W WRIGHT

PHOENIX
P C BOYD JR
R D BRADLEY
MELVIN D BRAMAN
ROBERT E CHRISTENSEN
RANDALL C CORK
FRED E DRESTE
GLENN S EVENSEN
WILLIAM T FITCH
T J GLEICHHAUF
J H GOODMAN
P H GREER
M C HALLECK
THOMAS H HOWELL
EDDIE V JARRETT
M C JENSEN
R L JONES
E A JONTRA JR
H P KENYON JR
FREDERICK H KOST
V M MINKEL
DANIEL E NOBLE
LOUIS PLOTKIN
ALLAN G RIKER
R E SAMUELSON
FRANK A SCHNEIDER
W L STEINMANN

SAN FRANCISCO
W R ABBOTT
J R ALLGAIER
J K AMUNDSON
ROBERT L ANDERSEN
ALBERT F AUGUSTINE
M H BAER
ARTHUR E BAYCE
R N BEAN
R C BECKLUND
WILLIAM J BEECHER
R A BLOCKINGER
BARRY R BORGESON
G B BOWERS
HOWARD H BRAUER
J T BROTHERS
BERTRAM M BURRIS JR
FRANK C CAMERON
F CASSETTARI
H M CHANKIN
KING S CHAW
WILLIAM CHOW
GEORGE O COMPTON
A D CONNER
RICHARD C CORNWELL
W P CRAINE
E S DEAN JR
WILLIAM S DRUMMOND
H ECHENSTRIA
JOHN EFSTATHIOU
A P EGERMAN
H A EIMSTAD JR
A E EMRICH
W L FINCH
R A FOLSOM JR
THOMAS R FORRER JR
L G FREDERICK
WARREN GELLER
RICHARD E GEORGE
P J GUILLOT
FREDERICK M HALF
H W HANSEN JR
BRUCE J HARRIS
DEXTER HARTKE
J D HOFFMAN
M HONDA
R M HUBBARD
DOROTHY A HUTSON
I M JACOBS
JULIANNE J JEDEKA
S E JOHNSON
E KAPILOFF
ROBERT C KARPEN
KENNETH O KELLY
V G KIDD
JAMES H KING JR
R C KING
THOMAS J KING
S F KISS JR
MELVIN B KLINE
R S KRETSBERG
L D LANE JR
P LAZARUS
C E LEAKE
R E LEE
ROBERT O MAGATAGAN
RAY A MAGNUSON
W R MALAUN
R E MANWARING
L C MAUDENS
RICHARD L MAYEUR

SEATTLE
DOUGLAS A BENZEL
ROBERT J BURNS
V B COREY
W E CURRIE
RICHARD A DRAWZ
W F FLOWER
R E HART
ALEXANDER HENSCHEL
A F HIXENBAUGH
PAUL R MEASEL
J W MICKEL
DAVID M MOOSE
R E PATRICELLI
KI PUNCHES
P S THOMAS

SPOKANE
DWIGHT H SAWIN
LOUIS E SIMS

TUCSON
ROBERT E DAVIES JR
DIMITRI KECECIOGLU
H KOERNER
V M LOCKWOOD
A A ST GERMAIN
JOHN C VARGA

UTAH
ALFRED G BULLETT
JAMES D CLARK
J L FENTON
LEON E SABINE
FRANCIS B STUMP

LOS ANGELES COUNCIL
ANTELOPE VALLEY
JAN M HOWELL
BUENAVENTURA
F W BAUMGARTNER
JOHN A BORDERS
PAULO S CASTILLO JR
J A CONNOR
ROY E DEHM
C M DE WITT 3RD
J L GLASS
R W JACK
P PERINGER
JAMES L ORTH
T E WALENTA
CHINA LAKE
FREDERICK A JONASEN
WILLIAM A MARSH
JAMES L MUNDY
FOOTHILL
D P BOE
JOHN W CENTER
RICHARD L CRAMER
J F GRAY
B W GRAY
FRED KRALL
VIRGIL L LOVITT
D E NISSEN

DANIEL L MC NABB
JAMES W MIZERSKI
T G MOLESKI
WILLIAM J MORGENSTERN
R B MULLOCK
MUSGROVE
L C NEILSON
R NORMAN
G I OLIVIER
A M OPSAHL
A R PARK
FRANCIS J PASEK
JOHN PESCHON
B L PEUTO
E A POLGAR
R L RAPP
J H RAU
KENNETH A REYNOLDS
GIORGIO RIGA
ALFRED B ROBSON JR
WESLEY A ROOME
M B RUDIN
W C SEELBACH
RICHARD J SEGERSTROM
MEGHA SHYAM
V SIEGFRIED
W T STARR
R G STEWART
LESLIE F TAYLOR
ORLIN D TRAPP
V J VAN VELZER
F R VAN WAGNER
EDWIN C VESTAL JR
R J VIERATTIS
W H WAHRHAFTIG
P A WALLACE
R L WARE
HAROLD C WERNER
H E WESTGATE
SIDNEY WIESNER
J L WILLOWS

ORANGE COUNTY
M F ADAM
K W ANDERSON
D J ANTHONY
ROBERT E BANNICK
JOHN BOZANIC
JOHN E COOLIDGE
DOROTHY COTORA
C F DEININGER
B J DI NARDO
JOHN R DONAN
J J DUFFY
A EPP JR
DONALD L EWING
E J FARRELL
D C FLEMING
J G FOUNTAIN
LESLIE FUNG
J ROBERT FUNK
A FURSA
PATRICK E KENNEDY
PAUL B KING
THEODORE LAVOOT
VERNON S MATHISEN
JAMES L MAYBELL
DOUGLAS E MC CORMAC
C M MILLER
JEAN R MILLER
ROSS R MOORE
K F MORICK
A NEUKUCKATZ
J R NORIEGA
ELMER PHIBBS
GENE B POTTER
RALPH RONALLI
JULIUS ROSENBAUM
W G RUNGAITIS JR
CLYDE E SAMPSON
W G SCHULZ
BRUCE E SHARP
WARREN E STENSTROM
J E SWISTOK
J E VALSTAR
W Q WAGNER
G H WELLS
ROBERT E WOOD
R F YODER

SOUTH BAY HARBOR
E L AITON
FRED G ALBRIGHT
ROBERT S BABIN
RICHARD A BRUCE
R J CARY JR
R R DYE
W F DYKES
W O GEISERT
ERNEST R KARCHER
M F KRUPP
L K LEE
RAYMOND O LORENZ
S W MALASKY
THOMAS E MAY
JOHN E MC RAE
W M MICHITSCH
H E MORRISON
VANCE PURDY
ROBERT RUDICH
CLIFFORD M RYERSON
G L SANDBERG
S SHOHARA
B N THEALL
PHILIP M TURBITT JR
H K WEISS
K L WONG
D J YOUNG

SAN FERNANDO VALLEY
EDWARD J ALTHAUS
LEO A ARNDT
W H BARNHART
H J BARR
L M BAUM
I BAZOVSKY
T N BOWERS
GEORGE M BOYD
DANIEL F BRDSNAN
E D COCHRAN
JEROME L DEITZ
D EDGERTON JR
H M GORDY
ZANTINE GREENWOOD
ANDREW C GUNTHER
J A HARRINGTON
R J HERST
P L HILLMAN
WILLIAM J HODGES
JAMES E HOGSTAD
S J HORNYAK
J R ISKEN
HERBERT G JACKS
K KASAI
G F KUJAWSKI
W K LAMB
RALPH A LAMM
G R LANE
L A MATONAK
J C MC ADAM
D R MEYER
Z MILUNAS
D M PAYNE
STAN PRO
I QUART
W M QUINN
SAMUEL M RICE
D R RINGOLD
L G ROBERTSON
D K RUBIN
ALBERT H SAMUELS
JEFFREY B SCHNEIDER
J H SCHULMAN
WILLIAM F SMITH
D SWISHER
JOHN VISSER

VANDENBERG
JOHN A TRUEMAN

REGINA
R BILLINTON
MOHINDER S GROVER
H KALDOR
CHANAN SINGH

SOUTHERN ALBERTA
WHO-KEE CHUNG

VANCOUVER
R BARTHOLOMEW
J B CLAYDON
P W WADDINGTON

WINNIPEG
A A BURROW
T J HARPER
C J HOPPER
M P MUSTICK

CENTRAL CANADA COUNCIL
BAY OF QUINTE
G T DAVIS
HAMILTON
C W ELLIOT
J SPARROW
KITCHENER-WATERLOO
A S ARMSTRONG
W BARRY CLARK
ASHOK K SETH
TORONTO
HANS G BRUESCHKE
ELIZABETH CARRIERE
J ENDRENYI
JOAN A HALL
ALFRED M HASE
F J HEATH
W HRYHORIJW
J T KOSKI
J E LOCKYER
J D MARTIN
STEPHEN S MAXNER

FRANK A MACALUSO
FREDERICK E MARTIN
H MEYER
J C RADCLIFFE
RALPH E WEST
J T WILSON
SANTA BARBARA
ROBERT A ANDERSON
CLAUDIA A HUNTER
ROBERT J MC MILLIN
WILLIAM OLIVERI
C N STOLL

SANTA MONICA BAY
ROBERT ARANY
A AVIZIENIS
F I BIEN
MELVIN H COHEN
C R DERNHAM
I DOSHAY
THOMAS M DRNAS
T G EDDY
ROBERT H GACA
A L GIGHTIN
ROBERT P GAGNON
S F GENTNER
V E ISAAC
PER J JORGENSEN
AUGUSTINE P KALANZI
J H LEGERE
F MOLLER
S E PINNELL
W A RAWLINS
R W REED
NARAYAN SHANKAR
D W WEYTZE

MONTREAL
J L BOULET
D J CLARK
GUY R CUSTEAU
T G DEMERS
R A DINGWALL
ROBERT P GAGNON
S F GENTNER
V E ISAAC
PER J JORGENSEN
AUGUSTINE P KALANZI
J H LEGERE
F MOLLER
S E PINNELL
W A RAWLINS
R W REED
NARAYAN SHANKAR
D W WEYTZE

OTTAWA
J E ARSENAULT
DAVID D DAWSON
JOHN B DE MERCADO
ROBERT W DUTHIE
G D LINSKI
R C TERZIAN
MARY D THOMPSON
H B WATERMAN
R A WESTLAND
P S WOLCOTT

QUEBEC
A L LORTIE
W E SWITZER

WESTERN CANADA COUNCIL
NORTHERN CANADA
JOSEPH M GREEN
R KALVAITIS
P L STROHSCHNEIN

REGINA
R BILLINTON
MOHINDER S GROVER
H KALDOR
CHANAN SINGH

SOUTHERN ALBERTA
WHO-KEE CHUNG

VANCOUVER
R BARTHOLOMEW
J B CLAYDON
P W WADDINGTON

WINNIPEG
A A BURROW
T J HARPER
C J HOPPER
M P MUSTICK

CENTRAL CANADA COUNCIL
BAY OF QUINTE
G T DAVIS
HAMILTON
C W ELLIOT
J SPARROW
KITCHENER-WATERLOO
A S ARMSTRONG
W BARRY CLARK
ASHOK K SETH
TORONTO
HANS G BRUESCHKE
ELIZABETH CARRIERE
J ENDRENYI
JOAN A HALL
ALFRED M HASE
F J HEATH
W HRYHORIJW
J T KOSKI
J E LOCKYER
J D MARTIN
STEPHEN S MAXNER

FRANK A MACALUSO
FREDERICK E MARTIN
H MEYER
J C RADCLIFFE
RALPH E WEST
J T WILSON
SANTA BARBARA
ROBERT A ANDERSON
CLAUDIA A HUNTER
ROBERT J MC MILLIN
WILLIAM OLIVERI
C N STOLL

FRANK A MACALUSO
FREDERICK E MARTIN
H MEYER
J C RADCLIFFE
RALPH E WEST
J T WILSON
SANTA BARBARA
ROBERT A ANDERSON
CLAUDIA A HUNTER
ROBERT J MC MILLIN
WILLIAM OLIVERI
C N STOLL

Region 8

BENELUX
P BOUCHIER
W B BROUWER
J L DE KERF
FRED O DELHAYE
MAURICE C P DESIRANT
STEPHANE J DE VLEMINCK
G R DIENNE
S DUINKER
HERMAN ENGELER
L ENSING
A L FAWC
M GROENENBOOM
H H HANNESSEN
H H HEEREMA
MEINART H HUIZINGA
CHARLES J MEDART
FRANS MOHRING
ANTHONY N NZEAKO
D C SCHERING
FRANCIS D VAN DENBREDEE
A J VANDENMEERSCH
LEENDERT VAN ROOIJ
P G VAN ZANTEN
D H VAN ZUYLEN
C J D M VERHAGEN
C M J WILMERING

MIDDLE & SOUTH ITALY
MARIO BRUNELLI
A CIARAMELLA
GIUSEPPE CIRILLO
ELIO A FAGNINI
G GOMMELLINI
T LEARDINI
FRANCO MAESTRANZI
UMBERTO MENGALI
DINO OLIVETTI
U PIZZARELLI
C ROMAGNOLI
U TIBERTO
A ZANINI

NORTH ITALY
ETTORE ACCENTI
JOHN B ARNOLD
LUIGI BONAVOGLIA
G COTTAFAVA
GIORGIO DE LOTTO
A D DEROSSI
G DE VITO
C EGIDI
ENRICO GIANNINI-MOCHI
P G MORRA
G E PERONA
G QUAZZA
CARMELO RIGA
AUGUSTO RIMINI
LUIGI RIVARA
CARLO SAN PIETRO
P SCHIAFFINO
GIANFRANCO TOMMAZZOLI
GUIDO VANNUCCHI
GUIDO P VULPETTI
C ZANELLI

FRANCE
V A ALTOVSKY
JACQUES A AMANN
R L ARNAL
GEORGES ATTALI
F J BABIN
RENE BOURJON
LEON H CONSTANTIN
MICHEL P CORDELLE
CHARLES A DAVID
JACQUES J DE BARREYRAC
M DELATRE
J L DUPREZ
HERBERT H ERNYEI
ANDRE R FROLLIGER
P GANDIN
J F GASCHI
PIERRE GENKIN
JEAN-MARIE G GRANGE
P A GRIVET
MICHEL KARSKY
E LABIN
W MAZEL
DANIEL A MOREAU
P P NAMIAN
A OUDARD
MICHEL L M PESNELLE
M J H PONTE
MAURICE QUIOT
ANDRE RAULT
PIERRE RENARD
J H ROBIEUX
A SARAZIN
M TESSIER
JACQUES J TOULEMONDE
PIERRE J TOUNOIS
F P VALENTIN

NORWAY
DAG T GJESSING
E KULVIK
ERIK MACK
K R MEISINGSET
K E SORBYE
O N STABENFELDT
D J TVEIT

SPAIN
RICARDO ALVAREZ-ISASI
SANTIAGO ALVAREZ
JUAN I ASIN
G G CASTRO
J A DE ARTIGAS SANZ
JUAN A DEL GIORGIO
VALENTIN M PARRA
JOSE I PASTOR
FRANCISCO R RODRIGUEZ
PEDRO SANZ

GERMANY (WEST)
ALFRED BECKER
C W BUSCH
GOTTFRIED FARWER
K O FRAENZ
HELMUT GEISSLER
J HENRICI
HELLMUTH KUHNKE
W H SCHOENFELD
HEINZ SCHWARZER
HANS STRACK
G ULBRICHT
GUNTHER G WEBER

GERMANY (WEST)
ALFRED BECKER
C W BUSCH
GOTTFRIED FARWER
K O FRAENZ
HELMUT GEISSLER
J HENRICI
HELLMUTH KUHNKE
W H SCHOENFELD
HEINZ SCHWARZER
HANS STRACK
G ULBRICHT
GUNTHER G WEBER

GERMANY (WEST)
ALFRED BECKER
C W BUSCH
GOTTFRIED FARWER
K O FRAENZ
HELMUT GEISSLER
J HENRICI
HELLMUTH KUHNKE
W H SCHOENFELD
HEINZ SCHWARZER
HANS STRACK
G ULBRICHT
GUNTHER G WEBER

F CASPI
M DISHON
MDRDECHAI DORON
U GALIL
J GILAT
JULIAN HILMAN
LEVY KATZIR
ELIEZER J LEVY
RUBEN OREN
JACOB F RECHAVI
S SAMUEL
MEYER B SHULMAN
D SPIRA
CLARA WIDRO
JOSEPH ZADICARIO

MIDDLE & SOUTH ITALY
MARIO BRUNELLI
A CIARAMELLA
GIUSEPPE CIRILLO
ELIO A FAGNINI
G GOMMELLINI
T LEARDINI
FRANCO MAESTRANZI
UMBERTO MENGALI
DINO OLIVETTI
U PIZZARELLI
C ROMAGNOLI
U TIBERTO
A ZANINI

NORTH ITALY
ETTORE ACCENTI
JOHN B ARNOLD
LUIGI BONAVOGLIA
G COTTAFAVA
GIORGIO DE LOTTO
A D DEROSSI
G DE VITO
C EGIDI
ENRICO GIANNINI-MOCHI
P G MORRA
G E PERONA
G QUAZZA
CARMELO RIGA
AUGUSTO RIMINI
LUIGI RIVARA
CARLO SAN PIETRO
P SCHIAFFINO
GIANFRANCO TOMMAZZOLI
GUIDO VANNUCCHI
GUIDO P VULPETTI
C ZANELLI

FRANCE
V A ALTOVSKY
JACQUES A AMANN
R L ARNAL
GEORGES ATTALI
F J BABIN
RENE BOURJON
LEON H CONSTANTIN
MICHEL P CORDELLE
CHARLES A DAVID
JACQUES J DE BARREYRAC
M DELATRE
J L DUPREZ
HERBERT H ERNYEI
ANDRE R FROLLIGER
P GANDIN
J F GASCHI
PIERRE GENKIN
JEAN-MARIE G GRANGE
P A GRIVET
MICHEL KARSKY
E LABIN
W MAZEL
DANIEL A MOREAU
P P NAMIAN
A OUDARD
MICHEL L M PESNELLE
M J H PONTE
MAURICE QUIOT
ANDRE RAULT
PIERRE RENARD
J H ROBIEUX
A SARAZIN
M TESSIER
JACQUES J TOULEMONDE
PIERRE J TOUNOIS
F P VALENTIN

NORWAY
DAG T GJESSING
E KULVIK
ERIK MACK
K R MEISINGSET
K E SORBYE
O N STABENFELDT
D J TVEIT

SPAIN
RICARDO ALVAREZ-ISASI
SANTIAGO ALVAREZ
JUAN I ASIN
G G CASTRO
J A DE ARTIGAS SANZ
JUAN A DEL GIORGIO
VALENTIN M PARRA
JOSE I PASTOR
FRANCISCO R RODRIGUEZ
PEDRO SANZ

GERMANY (WEST)
ALFRED BECKER
C W BUSCH
GOTTFRIED FARWER
K O FRAENZ
HELMUT GEISSLER
J HENRICI
HELLMUTH KUHNKE
W H SCHOENFELD
HEINZ SCHWARZER
HANS STRACK
G ULBRICHT
GUNTHER G WEBER

GERMANY (WEST)
ALFRED BECKER
C W BUSCH
GOTTFRIED FARWER
K O FRAENZ
HELMUT GEISSLER
J HENRICI
HELLMUTH KUHNKE
W H SCHOENFELD
HEINZ SCHWARZER
HANS STRACK
G ULBRICHT
GUNTHER G WEBER

GERMANY (WEST)
ALFRED BECKER
C W BUSCH
GOTTFRIED FARWER
K O FRAENZ
HELMUT GEISSLER
J HENRICI
HELLMUTH KUHNKE
W H SCHOENFELD
HEINZ SCHWARZER
HANS STRACK
G ULBRICHT
GUNTHER G WEBER

BRAZIL COUNCIL SECTIONS
RIO DE JANEIRO
NICHOLAS BROOKING
RAUL COLCHER
FERNANDO A DE MORAES
M F LIPPINCOTT
SAO PAULO
NASSIM J ABDALLA
F DE MENDONCA
JOSE KOVACS
F L SHERMAN
ANGELO VIAN

UNITED KINGDOM & REPUBLIC OF IRELAND
D ASHBY
EDWARD S ATKINS
RONALD A BARRS
L F BENNETT
ROGER G BENNETTS
P CARMICHAEL
N J CLARK
ANTHONY L CONSLVI
C H CROCKER
C S DEN BRINKER
G W A DUMMER
I G GILROY
G W GRIFFITHS
A R HALFORD
R JENSEN
DAVID R MC CALL
MAURICE H MC FADDEN
M A MILLWARD
R H MURPHY
OSCAR E ORTEGA
ANTHONY N PARSONS
J R POLLARD
H B RANTZEN
H G K SCHOTTEN
RICHARD J VOWLES
J E WILKS
K F WILLIAMS

INDIA
MANGHO J KIRPALANI
K B MISRA
V S NAZIR AHMED
H B SHAH
JAY D SHARMA

TOKYO
EIZO ABE
OSAMU ABE
KENICHI AIHARA
MORIO AKIYAMA
TADAHIKO AKIYAMA
KASABURO AMAKASU
FUMIO ANDOW
SABJRE AOI
YOSHIMASA AOKI
KIYOSHIGE ECHIKAWA
YOSHIKAZU FUJINO
MASAO FUKATA
KIYOHITO HASHIGUCHI
HARUO HIROSE
KOJI HIROSE
KOICHI HOSOKAWA
MASARU IBUKA
MASAO IDE
YOSHIO IHARA
TOSHIYA INOUE
KUNIZO IWAMOTO
SHINGO IWASE
NOBORU IZEMI
IKUZO IZUMI
T KAWANO
MATSUNAGA KINASE
SHUNKICHI KISAKA
KEN-ICHI KITAMI
DAIJIRO KOBAYASHI
SATARO KONNO
OSAMU KONOSU
GENZABURO KURAISHI
K KURODA
MITSUO KUSANO
SHIGEYO KUWABARA
KUNIO MAND
TAKENORU MATSUMURA
MASAO MATSUO
T MATSUYUKI
KOICHI MIMURA
FUMIO MINOZUMA
K MITA
SHOTA MIYAIRI
E MIYAZAWA
KEITARO MORITA
TOKIO MUTO
YUKIO NAKAGOME
F NAKAHARA
T NAKAHARA
JIRO NAKAMURA
OSCAR L ROCHIN
ALFONSO SANSORES E
J C SEELIGER
P O ZAMORAMORENO

ARGENTINA
FRANCO L CAGNASSO

COLOMBIA
FERNANDO REY-URIBE

MEXICO
JORGE ANGELES-ALVAREZ
JUAN EIBENSCHUTZ
J A ESTEVA
ELOHIM JIMENEZ L
MARIO T LANG
GUILLERMO RIVERA
OSCAR L ROCHIN
ALFONSO SANSORES E
J C SEELIGER
P O ZAMORAMORENO

PUERTO RICO & VIRGIN ISLANDS
GERALD J HADDOCK

VENEZUELAN
MANUEL ACOSTA-CAZAUBON
LUIS E AGUILAR
MANUEL FLINT-HALPERN
GUILLERMO GUEDEZ-C
FRANCISCO LOPEZ-PASTOR

NO ESTABLISHED SECTION
PAUL A AYORA-GONZALEZ
JAIME I IMOTO
R RAMPERSAD

Region 10

AUSTRALIAN
R J C DAVIES
L G DOBBIE
ANGUS FOWLER
F P LEVI
ROGER J MORGAN
JAMES B RUDD
SELWYN V RUSSELL

INDIA
MANGHO J KIRPALANI
K B MISRA
V S NAZIR AHMED
H B SHAH
JAY D SHARMA

TOKYO
EIZO ABE
OSAMU ABE
KENICHI AIHARA
MORIO AKIYAMA
TADAHIKO AKIYAMA
KASABURO AMAKASU
FUMIO ANDOW
SABJRE AOI
YOSHIMASA AOKI
KIYOSHIGE ECHIKAWA
YOSHIKAZU FUJINO
MASAO FUKATA
KIYOHITO HASHIGUCHI
HARUO HIROSE
KOJI HIROSE
KOICHI HOSOKAWA
MASARU IBUKA
MASAO IDE
YOSHIO IHARA
TOSHIYA INOUE
KUNIZO IWAMOTO
SHINGO IWASE
NOBORU IZEMI
IKUZO IZUMI
T KAWANO
MATSUNAGA KINASE
SHUNKICHI KISAKA
KEN-ICHI KITAMI
DAIJIRO KOBAYASHI
SATARO KONNO
OSAMU KONOSU
GENZABURO KURAISHI
K KURODA
MITSUO KUSANO
SHIGEYO KUWABARA
KUNIO MAND
TAKENORU MATSUMURA
MASAO MATSUO
T MATSUYUKI
KOICHI MIMURA
FUMIO MINOZUMA
K MITA
SHOTA MIYAIRI
E MIYAZAWA
KEITARO MORITA
TOKIO MUTO
YUKIO NAKAGOME
F NAKAHARA
T NAKAHARA
JIRO NAKAMURA
OSCAR L ROCHIN
ALFONSO SANSORES E
J C SEELIGER
P O ZAMORAMORENO

ARGENTINA
FRANCO L CAGNASSO

COLOMBIA
FERNANDO REY-URIBE

MEXICO
JORGE ANGELES-ALVAREZ
JUAN EIBENSCHUTZ
J A ESTEVA
ELOHIM JIMENEZ L
MARIO T LANG
GUILLERMO RIVERA
OSCAR L ROCHIN
ALFONSO SANSORES E
J C SEELIGER
P O ZAMORAMORENO

PUERTO RICO & VIRGIN ISLANDS
GERALD J HADDOCK

VENEZUELAN
MANUEL ACOSTA-CAZAUBON
LUIS E AGUILAR
MANUEL FLINT-HALPERN
GUILLERMO GUEDEZ-C
FRANCISCO LOPEZ-PASTOR

NO ESTABLISHED SECTION
PAUL A AYORA-GONZALEZ
JAIME I IMOTO
R RAMPERSAD



MEMBERSHIP APPLICATION
RELIABILITY GROUP

Send to: IEEE Headquarters, 345 East 47th Street, New York, N. Y. 10017

Name _____ IEEE Membership No. _____

Mailing Address _____

Company _____

Field of Interest _____

- I am a _____ member of IEEE and hereby apply for membership in the
(Grade) Reliability Group. I enclose a check for the Group fee*
(made payable to the IEEE).
- I am not now a member of IEEE but would like to join. Please send information.
- I am interested in becoming a Reliability Group Affiliate. Please send information.

*Fee: \$5.00 for IEEE members of all grades except Student.
Student fee is \$2.00.

Full rate on payments received September 1 through February 28 (payments received
September 1 through December 31 applied through December 31 the following year).
One half rate on payments received March 1 through August 31.