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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket Nos. 50-454 OL
COMMONWEALTH EDISON COMPANY	)	50-455 OL
	)	
(Byron Nuclear Power Station, Units 1 and 2)	)	

SUMMARY OF THE DIRECT TESTIMONY OF DR. DEV S. KOCHHAR
ON CONTENTION 1 (REINSPECTION PROGRAM)

I. Dr. Dev S. Kochhar is an Associate Professor of Industrial and Operations Engineering at the University of Michigan. He has engaged in extensive research and consultation activities on how human factors affect quality control inspector performance.

II. Dr. Kochhar describes how human factors can affect job performance, the typically monotonous nature of the inspection task and his familiarity with the Byron reinspection program.

III. Dr. Kochhar identifies and discusses three particular human factors affecting inspector and reinspector performance that are apparent in the design methodology of the Byron reinspection program:

A. Limiting the reinspections to the inspectors' first three months of job performance.

B. That, in most cases, the reinspectors knew the names of the original inspectors.

C. That, in most cases, the reinspectors knew the results of the original inspectors.

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IV. Dr. Kochhar describes why inspector performance reaches its highest proficiency level in the period following completion of training. Inspectors are more attentive due to the novelty of the new job. The inspection task is monotonous, and as sensory stimulation declines over time, the level of performance effectiveness correspondingly declines.

Reliance on reinspection of the first three months of inspector performance and the corresponding assumption that this would lead to a conservative bias in the reinspection program results are highly questionable. It is likely that the reinspection program results reflect an opposite bias. The program would have more accurately examined inspector performance if the reinspections had been conducted over an extended range of the work period.

V. Dr. Kochhar describes why the reinspection program results were biased because in most cases the reinspectors knew the identities of the original inspectors. This knowledge most probably led to a higher percentage of conforming reinspections.

VI. Dr. Kochhar describes why the reinspection program results were biased because in most cases the reinspectors knew the original inspection results. This knowledge most probably led to a higher percentage of conforming reinspections.

VII. Dr. Kochhar concludes that the cumulative effect of these three human factors on the Byron reinspection program results most probably increased the percentage of the original inspectors' work found to be acceptable by the reinspectors. Reliable conclusions about the reinspection program results can be made only after the biases from these human factors are taken into account.

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TESTIMONY OF DR. DEV S. KOCHHAR

Q1: Please state your full name and place of employment.

A1: My name is Dev S. Kochhar. I am an Associate Professor of Industrial and Operations Engineering at the University of Michigan, Ann Arbor, Michigan.

Q2: Please describe your educational and professional background.

A2: I hold both a Ph.D. and M.A.Sc. in Systems Design Engineering from the University of Waterloo (Canada). Previously, I received a B.Tech. (Honors) in Mechanical Engineering from the Indian Institute of Technology (India).

Prior to obtaining my current faculty position at the University of Michigan in 1980, I was employed as an Associate Professor of Systems Engineering at the University of Regina (Canada) (1978-80), as an Assistant Professor of Industrial Engineering at the University of Windsor (Canada) (1976-78), as an Assistant Professor of Systems Design at the University of Waterloo (Canada) (1974-76) and as an engineer for the Canadian government (1970).

Q3: Please describe your recent reseach and consulting activities.

A3: My research and consulting activities are on human performance and job design. Since 1974, I have particularly studied the importance of human factors on performance of quality control inspectors. I have consulted extensively with a number of private companies and public agencies on various issues pertaining to these subjects. Among others, I have been retained by the Firestone Rubber and Tire Company, ITT Continental Baking Company, the United States Department of Labor, the Equal Employment Opportunity Commission, Ford Motor Company, Monsanto Company and Kaiser Aluminum and Chemical Company. A more detailed listing of my consultations appear on page 3 of my resume that is Attachment A to this testimony.

I have also published a number of scholarly papers and handbook chapters on the subject of human factors and worker performance in industrial settings. In particular, I have conducted several studies and published several papers on the effects of human factors on quality control inspector performance. A more detailed listing of my research activities in this and other areas and my published papers appears on pages 5-9 of my resume that is Attachment A to this testimony.

Q4: Please describe your teaching duties.

A4: My teaching duties include classes on industrial work performance, ergonomics, human performance and industrial engineering systems and design. A principal focus of my research

and consultation activities has been on human factors affecting industrial engineering systems and design, generally, and quality control inspections and worker performance in particular.

Q5: Please describe what you mean by the terms "human factors" and "ergonomics".

A5: "Human factors" is concerned with human psychological and mental limitations and capabilities in relation to work tasks and job performance. Human factors research focuses on the effect on job performance of the type, amount and form of information presented to a worker, training, visual design and extrinsic and intrinsic values which a worker derives from his task.

Ergonomics traditionally has been predominantly concerned with the physiological and biological aspects of work performance, such as human limitations in lifting, pushing, pulling or standing during work performance.

Q6: Please describe your particular area of specialization in human factors and ergonomics.

A6: For over 8 years, I have examined how human factors can affect worker performance in the field of quality control inspections. I have designed and analyzed laboratory simulations of worker performance on different inspection tasks and have consulted with various private companies in applying my analytical experience to their industrial processes. I have examined the design of various inspection

tasks in order to facilitate performance and increase effectiveness. My most recent research activities have focused on developing a mathematical model to evaluate the number of repeat inspections necessary to achieve a defined level of product quality. The thrust of my research and some of my consulting activities has been to improve the design of inspection tasks in order to promote inspection effectiveness.

Q7: Have you previously examined quality control inspections in nuclear power plants?

A7: No.

Q8: Is your general expertise in the field of human factors affecting quality control inspector performance applicable to inspections of nuclear power plants?

A8: Yes. Although my exposure to inspections of nuclear power plant construction activities is limited, my experience in the field of human factors affecting quality control inspections at industrial plants is applicable. The work environment at nuclear power plant construction sites may be different from that in manufacturing facilities, but the human factors relating to quality control inspections have common elements. In both environments, the inspection task undertaken is often characterized by the same monotony, in which the worker repeatedly undertakes the same decision-making task -- an item is viewed, measured and then determined to be acceptable or unacceptable (a binary decision) in accordance with specified criteria. Regardless of the environ-

ment or the particular pace of work, the operational task of inspection is the same. In both cases, inspection is a process of selection.

Q9: Are you familiar with the standard reference books and articles in the field of quality control inspection?

A9: Yes.

Q10: Are you familiar with a book authored by Harris and Cheney, Human Factors In Quality Assurance?

A10: Yes.

Q11: Do you regard Human Factors In Quality Assurance as reflecting the latest research in this field?

A11: No. This book was published in 1969 and is outdated. Subsequently, there have been substantial advancements of knowledge in this field.

Q12: Are you familiar with the Byron reinspection program? If so, please describe your review of the program.

A12: Yes. I have reviewed Edison's Report on the Byron QC Inspector Reinspection Program (February, 1984) and the Supplement to that report (June, 1984). I have also reviewed the testimony of Edison's witnesses Del George, Hansel, Laney and Singh, and the testimony of the NRC Region III Staff on the reinspection program. In my review, I have examined the human factors affecting inspector and reinspector performance and biases the reinspection program results that are likely to e attributable to these factors.

Q13: What is the purpose of your testimony?

A13: The purpose of my testimony is to express concern about several human factors affecting inspector and reinspector performance, that are apparent in the design methodology of the Byron reinspection program. My review indicates that three such human factors -- limiting the reinspections to the inspectors' first three months of job performance; that, in most cases, the reinspectors knew the names of the original inspectors; and that, in most cases, the reinspectors knew the original inspection results -- biased the program results most probably in a manner contrary to that suggested by Edison and the NRC Staff. When such biases are properly taken into account, the reinspection program results appear less positive.

Q14: What do you understand to have been Edison's purpose in undertaking the Byron reinspection program?

A14: I understand that a Nuclear Regulatory Commission inspection report identified certain deficiencies in the training and certification of quality control inspectors at Byron. Pursuant to negotiations with the Nuclear Regulatory Commission Region III Staff, Edison initiated the reinspection program to evaluate the adequacy of the training and certification of various quality control inspectors.

Q15: Please describe why your experience and research activities directed to simulated laboratory inspections are applicable to your assessment of the human factors affecting the inspections and reinspections at Byron.

A15: Actually there is little difference between the tasks being performed by the individual under examination in the laboratory and the inspector at Byron. The individuals are performing a mundane task in which a decision is to be made based on certain criteria. In fact, the impact of various human factors can be studied more precisely in a controlled laboratory setting than in the workplace environment where many more variables are present that affect observation but not performance. In the laboratory setting, the experimenter is able to manipulate various details more efficiently. Knowledge of the human factors affecting inspector performance obtained from laboratory experiments can then be applied to workplace settings.

Q16: Are you generally familiar with the procedures and protocols used in the Byron reinspection program?

A16: Yes.

Q17: Please describe the time period over which the Hatfield, Hunter and PTL inspectors' performance was reinspected.

A17: The Byron reinspection program focused on the first three months of inspector performance. The only circumstances in which reinspections were conducted beyond that time period were when an inspector's performance was found to be unsatisfactory.

Q18: Are you familiar with the testimony of Edison's witnesses and the NRC Staff witnesses as to why the first three

months of inspector performance were selected for reinspection?

A18: Yes. They believed that any deficient work by an inspector is most likely to occur during the early months on the job, and that performance would improve as the inspectors continued their work at the site. Following that assumption, they viewed reliance on evaluations of the first three months of inspector performance as leading to a conservative bias in the reinspection program results. I disagree with their view.

Q19: Please describe your view of the human factors affecting performance of quality control inspectors over the period of their employment.

A19: Inspector performance can be expected to attain its highest proficiency level in the period following completion of training. Newly trained individuals generally perform better during the initial inspection period because they are more attentive due to the novelty of their new job; it begins as stimulating activity that provokes interest. The novelty and sensory stimulation decline over time, and the level of performance effectiveness correspondingly declines. The reason for this pattern of performance is the repetitive, dull and unstimulating nature of the inspection task.

Inspectors and reinspectors are engaged in a monotonous work activity that provokes little sensory interest. Even

if there is some variation of the precise attributes inspected, the actual inspection task is essentially the same and remains monotonous.

Numerous research studies have demonstrated this effect of human factors on inspector performance. Even though these studies have principally focused on fairly short performance periods, the results obtained may well be applied to inspector performance over a longer time period. However, I am not aware of any longitudinal studies that have directly examined inspector performance over an extended time period.

In many industrial and manufacturing settings, it is not uncommon to rotate individuals between inspections and hardware work tasks in order to mitigate the tedium of inspection tasks.

The assumption by the Edison and NRC Staff witnesses that the inspectors would perform at their lowest level of effectiveness in the first three months following training, and their corresponding conclusions that conducting the reinspections in this period would lead to a conservative bias in the reinspection program results are highly questionable. Since inspectors generally perform at their highest proficiency level in the period following completion of training, and performance effectiveness declines over time, it is likely that the reinspection program results reflect an opposite bias.

The reinspection program would have more accurately examined inspector performance and qualifications if the

reinspections had tested inspector performance over an extended range of the work period.

Q20: Are you aware that in most cases the reinspectors knew the names of the inspectors whose work they were reinspecting?

A20: Yes. According to Edison, virtually all types of reinspections were performed with the original inspection reports, and thus the reinspectors were aware of the names or initials of the original inspector. The reinspector received this original report before conducting the reinspection.

The only common exception to these circumstances was for the reinspection of "as built" dimensions, which were performed without previously-generated data from inspectors. Instead, drawings and other information were provided to reinspectors. I also understand that Mr. Hansel has testified that in some cases, involving Hunter, inspectors were identified by number.

Q21: How are the reinspection program results affected by the reinspector having known the name of the original inspector?

A21: The reinspector's knowledge of the identity of the original inspector of an attribute can lead to a bias in the reinspection results. Workplace dynamics and social associations can influence the reinspector's decision-making criteria.

The Byron reinspection program assigned site contractors responsibility to reinspect their own inspections. I recog-

nize that some procedures in the reinspection program may have mitigated these biases. For example, reinspectors were not permitted to verify their own inspections, (in accordance with NRC regulations), and PTL conducted a limited number of over-inspections. Moreover, the NRC Staff witnesses testified that approximately sixty percent of the Hatfield, Hunter and PTL inspectors were no longer on-site during the reinspections; that still leaves a large number of original inspectors on-site at the critical time, and these inspectors and reinspectors may have continued social associations with the off-site inspectors.

To have the maximum confidence in the validity of the reinspection results, the reinspector should be "independent" of the original inspector. Not only should the inspector's name be concealed, but to minimize bias the reinspector should have no previous involvement at the site, and thus no economic incentive to demonstrate a high level of work quality. That reinspectors were employed by site contractors, and received their initial instructions and general supervision from these same contractors, also may have led to bias of the reinspection results.

I am aware that the NRC regulations (10 CFR Part 50, Appendix B) permit site contractors to do both inspections and reinspections, but nevertheless the reinspectors' knowledge of the inspectors' names led to bias.

In practice, it might be difficult to undertake a completely independent reinspection program, but preventing

the reinspectors from knowing the names of the original inspectors would lessen the potential for a non-conservative bias resulting from reinspectors being more lenient. Even if the goal of complete independence cannot be achieved, it should be recognized that, in most cases, the reinspectors knew the names of the inspectors whose work they examined. This biased the Byron reinspection program results and most probably led to a higher percentage of conforming reinspections.

Q22: Are you aware that in most cases the reinspectors knew the original inspection results?

A22: Yes. For most of the reinspections in which the reinspectors were aware of the identities of the original inspectors, they likewise were aware of the original inspection results.

Q23: How are the reinspection program results affected by the reinspector having known the original inspection results?

A23: It is neither typical, nor desirable, industry practice to permit the reinspectors to know the original inspection results. This knowledge can lead to a phenomenon best described as a "mimic" effect in which reinspectors conform their results to the original inspection results. Various studies have shown that, in such circumstances, the reinspector will tend to shift his acceptance criteria toward reconfirmation because of a general human tendency to avoid deviation from a prior determination. Moreover, the reinspector might be somewhat reluctant to criticize the past

work of his employer, the site contractor, because of possible adverse economic consequences.

In most cases, the reinspectors knew the original inspection results. This biased the Byron reinspection program results and most probably led to a higher percentage of conforming reinspections.

Q24: What is your overall conclusion respecting the effects of human factors on quality control inspectors as applied to the Byron reinspection program results.

A24: The cumulative effect of these three particular human factors present in the structure and implementation of the Byron reinspection program -- reliance on reinspections of the inspectors' first three months of job performance; that, in most cases, the reinspectors knew the names of the original inspectors; and that, in most cases, the reinspectors knew the original inspection results -- biased the program results, and most probably led to a higher percentage of conforming reinspections. The percentage of the original inspectors' work found to be acceptable by the reinspectors thus would be higher than otherwise would have been justified by the circumstances. Reliable conclusions about the reinspection program results can be made only after the biases from these human factors are taken into account.

ATTACHMENT A

Revised 03/84

CURRICULUM VITAE

Dev S. Kochhar
3341 Bluett Drive (313) 763-0133 (off.)
Ann Arbor, MI 48105 (313) 995-3156 (res.)
USA

U.S. resident, Canadian citizen, born 1948, married, one child

A. EDUCATION

Ph.D.	1974:	Systems Design, University of Waterloo, Ontario, Canada
M.A.Sc.	1972:	Systems Design, University of Waterloo, Ontario, Canada
B.Tech(Hons)	1970:	Mechanical Engineering, Indian Institute of Technology, Kharagpur, India

B. POSITIONS HELD

Associate Professor (1980 - present)	of Industrial & Operations Engineering, The University of Michigan, Ann Arbor, Michigan.
Adjunct Professor (1980 - 1981)	of Systems Engineering, Univeristy of Regina, Canada.
Associate Professor (1978 - 1980)	of Systems Engineering, University of Regina, Canada.
Assistant Professor (1976 - 1978)	of Industrial Engineering, University of Windsor, Canada.
Assistant Professor (1974 - 1976)	of Systems Design, University of Waterloo, Canada.
Engineer (Summer 1970)	Department of Public Works, Govt. of Canada.
Engineer (Summer 1968)	Gear manufacturing division, Premier Automobiles Ltd. (Division of FIAT of Italy), Bombay, India.
Engineer (Summer 1967)	Pressure die-casting division, Orient General Industries Ltd., Calcutta, India.

C. TEACHING AREAS (recent)

- Man-Machine Systems, Industrial Work Performance
- Ergonomics, Human Performance
- Reliability and Engineering Design
- Engineering Statistics
- Industrial Engineering Systems

Class size varied from 3 to 200 students
Very Good to Excellent evaluations as teacher

D. RESEARCH AND CONSULTATION ACTIVITIES

D.1. Research

Principal Sub-Investigator, Data display in Automotive Assembly, Project funded by Ford Motor Company. April 1983 - present.
Principal Investigator, Human-Robot Design and Task Allocation. Internal funding, The University of Michigan, March 1982 - December 1982.
Principal Sub-Investigator, Human-Computer Interface Design for Manufacturing Information Systems. Large-scale interdisciplinary project funded by Air Force Office of Scientific Research, August 1982 to present.
Principal Investigator, User Problems of Software for Manufacturing. Project funded by Manufacturing Data Systems Incorporated. April 1982 to present.
Principal Sub-Investigator, Rehabilitation of Perceptually Disabled Drivers, Health and Human Services, Washington, D.C. September 1980 to August 1983.
Principal Investigator on several projects funded through the National Research Council of Canada. April 1975 to August 1981.
Principal Investigator, Work Simplification in Saskatchewan's Mineral Industry. Project funded through Saskatchewan Research Council. April 1979 to August 1981.
Co-Investigator, Monocular Peripheral Vision as a Factor in Flight Safety, Ministry of Transport, Civil Aviation, Ottawa. November 1974 to June 1976.
Principal Investigator, Productivity and Product Mix, Kitchener Center for Disabled Citizens. September 1974 to August 1975.

D.2. Other Proposals Prepared/In-preparation

Age and work with VDTs in offices- NIA (in preparation '83-'84).
NASA Training Grant- Team Effort (in preparation) '83-'84.
Training in Quality Control and Reliability for GM Engineers, '82-'83.
Faculty Initiated Development Grant; IOE Department, U of M; '81-82.
Conference Grant to hold Joint USA/Sweden Workshop on Productivity and Automation; National Science Foundation; Nov. 1, '81.
Management Effectiveness in Adopting Computer-Aided Manufacturing; Team Project, National Science Foundation, '81-'82.

Human Considerations in Nuclear Power Plant Control Room Design; Phoenix Memorial Project; U of M; '81-'82.
A Task Analysis for Certification and Training of Spent Fuel Storage Operators; Sandia National Laboratories; '82-'83.

D.3. Consultation

Ford Motor Company, Dearborn, MI
Control Panels for Automated Assembly; Display of assembly information.
Equal Employment Opportunity Commission, Detroit, MI
Analysis of Skill Requirements in Tool Bit Manufacture.
ITT - Continental Baking Company, Little Rock, AK
Job Design/Placement of Hearing Impaired Worker.
Metro Canada/Urban Transportation Development Corp.
Human Factors in Control room design.
Burroughs Corporation, Detroit, MI
Human Considerations in the Design of a Communications Center.
U.S. Department of Labor, Cleveland, OH
Job Design/Placement of Visually Impaired Worker.
Michigan Bell, Southfield, MI
Integration of VDT's into the Workplace.
The Monsanto Company, St. Louis, MO
Staffing and Maintenance Requirements for Transfer Lines in Silicon Wafer Manufacture.
Vlasic Foods, Inc., Southfield, MI
Human Factors in Quality Control.
Bell-Northern Research, Ottawa, Canada
Evaluation of Visual Display Terminals.
Communication Workers of America, Inc., Cincinnati, OH
Workplace Usage of VDT's.
Firestone Tire and Rubber Company, Wilson, SC
Job Design/Job Analysis/Placement of Visually Impaired Workers.
Kaiser Aluminum and Chemical Co., Spokane, WA
Job Design/Job Analysis/Placement of Visually Impaired Workers.
Health and Welfare Canada, Civil Aviation, Ottawa, Canada
Flight Performance/Visual Impairment and Age Based Retirement of Airline Pilots.
Ontario Provincial Police, Toronto, Canada
Planning and Implementation of Mobile Communication Systems.
MacDonald, Dettwiler and Associates, Vancouver, BC, Canada
Human Considerations in the Design of a Police Communications Center.

E. ACADEMIC AND RESEARCH INTERESTS

- Human performance in industry, industrial productivity as it relates to the worker, human and equipment reliability, workplace design, visual factors in design.

- Man-machine interaction, modelling and computer simulation, human factors in transportation, industrial and workplace safety.

F. OTHER HONORS AND ACTIVITIES

Conference Honors: Arrangements Chairman, Session Chairman, Panel Member for various national and international conferences (1975 to present).

Editor: Book Reviews, Ergonomics Division of AIIE, 1981-1983.
Communique, Bulletin of the Human Factors Association of Canada 1978-79

Reviewed several proposals for The National Science Foundation since 1981.

Reviewer for AIIE Transactions.

Outstanding Young Men of America, listed in 1981 Edition.

Administrative

Served as member/chairman of several university and faculty committees.

Served as Tutor and Don in Residence at The University of Waterloo, and Divisional Manager in Residence, September 1972 - August 1976.

Served as Member, CUSO (Canadian University Student Overseas) Interview Board, 1974-1976.

G. PROFESSIONAL MEMBERSHIPS

Registered Professional Engineer, Province of Ontario
Senior Member, American Institute of Industrial Engineers
Member, Human Factors Society, USA
Member, IEEE Systems Man and Cybernetics Group
Senior Member, Robotics International of SME
Member, Operations Research Society of America.

H. OTHER COURSES ATTENDED

Institute for Professional Education

Linear and Non-Linear Model Fitting, Washington, D.C., August 1978

Simulation Modeling and Analysis, San Francisco, March 1980

AIIE, Developing and Managing an Effective Work Measurement Program, Atlanta, May 1980.

I. CONTINUING EDUCATION/COURSES PRESENTED

Firemen's Fund Insurance Company, November 1980.

Summer Course on Occupational Ergonomics, U of M, June 1981, 1982.

Working Women of America, Inc., May 1981.

South East Michigan Conference on Occupational Safety and Health (SEMCOSH), May & Nov. 1981.

AFL-CIO, December 1981.

SEMCOSH, March 1982.

Harvard University, Continuing Education, June 1982.

Management Briefing Seminar, U of M, August 1982.

American Chiropractic Association, February 1983.

Ford Motor Comapny, 1983, 1984.

J. Ph.D. COMMITTEES

Terry Truax	(Member)
Yvonne Abdoo	(Member)
Majid Jaraiedi	(Member)
Min Chung	(Member)
Joe Goldberg	(Member)
J. Mahajan	(External Examiner)
Amjad Umar	(Member)

K. PAPERS PRESENTED/PUBLISHED

Kochhar, D.S. and Wills, D.L., Simulation of a Two-man Interaction System. Proceedings, Fifth Conference on the Applications of Simulation, New York, December, 1971. pp. 56-62.

Kochhar, D.S. and Fraser, T.M., The effect of a simulated driving task on signal monitoring in the peripheral visual field. Presented at the Annual Conference of the Ergonomics Research Society, Cardiff, Wales, April 1972.

Kochhar, D.S. and Fraser, T.M., Observations on a simulated driving task and its effects on response times to peripheral visual stimuli for left and right handed subjects. Proceedings, Sixteenth Conference of the Human Factors Society, Los Angeles, October 1972. pp 40-43.

Fraser, T.M., Kochhar, D.S. and Smiley, A.M., Peripheral Vision--shrinkage of the peripheral field as a result of central task loading. Proceedings, 44th Annual Scientific Meeting of the Aerospace Medical Association, Las Vegas, May 1973. (Abstract only).

Kochhar, D.S. and Fraser, T.M., Some limitations of the visual process in a dynamic situation. Proceedings, Tenth Annual Meeting of the Traffic Injury Research Foundation of Canada, Ottawa, June 1973. pp 48-52.

Kochhar, D.S. and Fraser, T.M., Peripheral visual performance in a simulated tracking task...some quantitative aspects. Proceedings, First International Conference on Driver Behavior, Zurich, Switzerland, October 1973.

Kochhar, D.S. and Fraser, T.M., Models of Response Time to Peripheral Stimuli. Proceedings, Eighteenth Conference of the Human Factors Society, Huntsville, Alabama, October 1974, p. 533 (Abstract only).

Alliston, D.J. and Kochhar, D.S., Public Safety Communications Systems Simulation. Proceedings, Winter Computer Simulation Conference, Sacramento, California, December 1975. pp. 297-300.

Kochhar, D.S., Human Factors Considerations in the Design of MRDS Comjunications Center. Tech. Rep. #1, MacDonald Dettwiler & Associated Ltd., Vancouver, B.C., January 1976.

Kochhar, D.S., The Use of a Joystick for Data Entry in the Mobile. Tech. Rep. #2, MacDonald Dettwiler & Associates Ltd., Vancouver, B.C., April 1976.

Kochhar, D.S., Field Evaluation of the Informer In-car Terminal System. Tech. Rep. #3, MacDonald Dettwiler & Associates Ltd., Vancouver, B.C., May 1976.

Rabideau, G.F. and Kochhar, D.S., Human Engineering, Human Factors and Psychological Considerations with Respect to MRDS Design and Prototype Trials. Tech. Rep., MacDonald Dettwiler & Associates Ltd., Vancouver, B.C., May 1976.

Kochhar, D.S. and Fraser, T.M., Monocular Peripheral Vision as a Factor in Flight Safety. Tech. Rep. #3037, Waterloo Research Institute, University of Waterloo. Prepared for Ministry of Transport, Government of Canada, June 1976.

Kochhar, D.S., Models for the prediction of human response time to visual targets. Applications & Research in Information Systems and Sciences: Proceedings of the First International Conference on Information Sciences and Systems, Patras, Greece, August 1976. Hemisphere Publishing Corp., Washington, D.C. pp. 884-888.

Kochhar, D.S., Aspects of pilot monocularity in relation to flying. Proceedings, Ninth Annual Conference of the Human Factors Association of Canada, Bracebridge, Ontario, September 1976. pp. 20-26.

Colonna, J. and Kochhar, D.S., Communication System Simulation. Tech. Rep. #5012-2, Waterloo Research Institute, University of Waterloo. Prepared for Ontario Provincial Police, Systems Planning and Research, Toronto, November 1976.

Kochhar, D.S. and Fraser, T.M. Monocular Peripheral Vision as a Factor in Flight Safety. Aviation, Space and Environmental Medicine, 49(5):698-706, 1978.

Kochhar, D.S., Age and Task Performance: a survey of past and future research. Presented at the International Conference of the International Ergonomics Association/Ergonomics Society, Slough, U.K., September 1977.

Kochhar, D.S. and Aly, I., Understanding Social change through Simulation. Presented at the Ninth Annual Simulation and Modeling Conference, Pittsburgh, April 1978.

Kochhar, D.S. and Woode, J., Fault Information, Display Density and Inspector Performance. Proceedings, 29th Annual Conference of AIIE, Toronto, May 1978 p. 90 (Abstract only).

Kochhar D.S., Age, Accidents and Industrial Productivity. Presented at the 11th Conference of the Human Factors Association of Canada, Bracebridge, Ontario, September 1978.

Kochhar, D.S. and Ali, H., Information Content and Task Performance: a study of the older worker. Proceedings, 22nd Annual Conference of the Human Factors Society, Detroit, October 1978, pp. 558-563.

Kochhar, D.S. and Jaisingh, S.C., Contemporary Approaches to Paced Visual Inspection. AIIE Transactions, 12(1):38-46, 1980.

Kochhar, D.S. and Ali, H., Age as a Factor in Combined Manual and Decision Tasks. Human Factors, 21(5):595-603, 1979.

Kochhar, D.S., Age and Dysfunction in Airline Pilots. Tech. Rep. #11-34, The Industrial Research Institute, University of Windsor. Prepared for Health & Welfare Canada, October 1978.

Kochhar, D.S. and Abbondi, G., FM Channel Allocations on a Wired Cable Distribution System. Proceedings, Tenth Annual Pittsburgh Conference, 10(5), 1979, 2163-2169 (sponsored jointly by IEEE, ISA, SMC, SCS, IAMCS).

Kochhar, D.S., Driver Training Using Part-Task Simulators, Presented at the 2nd Annual Interagency Conference on Rehabilitation Engineering, Atlanta, Georgia, August, 1979.

Kochhar, D.S., Visual Requirements for Potroom Jobs, Tech. Rep. Prepared for Kaiser Aluminum and Chemical Co., Spokane, Washington, August 1979.

Kochhar, D.S. and Abbondi, G.A., Channel Allocations on a Cable Distribution System. International Journal of Computers and Industrial Engineering, Vol. 4, 173-184, 1980.

Kochhar, D.S., Driver Behaviour and Performance: past and future research, 22nd Annual Conference, Western Canada Traffic Association, Regina, Saskatchewan, October 1979.

Kochhar, D.S., Visual Job Analysis of Potroom Jobs, Tech. Report., Prepared for Kaiser Aluminum and Chemical Co., Spokane, Washington, April 1980.

Kochhar, D.S., "Improving Inspection Effectiveness - A Simulation Approach," Joint Quality Control & Ergonomics Session, Proceedings, AIIE, Atlanta, GA, May 1980, pp. 500-507.

Armstrong, T., Kochhar, D.S. Work Performance and Handicapped Persons, in Handbook of Industrial Engineering. John Wiley & Sons, Inc., 1982.

Kochhar, D.S., A Unified Approach to Inspection Task Design. Proceedings, 5th International Conference on Automated Inspection and Product Control. Stuttgart, West Germany, June 1980, pp. 327-338.

Kochhar, D.S., Human Factors in the Design of Work Inspection and Quality Control Systems. Invited Presentation, 7th Annual Ira Symposium, Tel Aviv, Israel, June 1980.

Kochhar, D.S., Ergonomic Work Design for Effective Employment of the Aged. Invited Presentation, 7th Annual Ira Symposium, Tel Aviv, Israel, June 1980.

Kochhar, D.S., An Analysis of Age and Information Load in Type II Tasks. International Journal of Production Research, (accepted for publication, to appear).

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket No. 50-454 OL '84 AUG 16 P1:15
COMMONWEALTH EDISON COMPANY	)	50-455 OL
	)	
(Byron Nuclear Power Station, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify I served copies of the Testimony of Dr. Dev S. Kochhar on the following persons by having said copies placed in envelopes, properly addressed and postaged (first class) and having them deposited in the U.S. mail at 109 North Dearborn (or, as indicated by an asterisk, sent by Purclator Courier or Federal Express), except that Mr. Miller's copy was hand-delivered.

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