# CHRISTOPHER P.L. BARKAN, PH.D.
## PROFESSOR – UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

**GEORGE KRAMBLES FACULTY FELLOW**

**EXECUTIVE DIRECTOR** – RAIL TRANSPORTATION AND ENGINEERING CENTER (RAILTEC)

**DIRECTOR** – NATIONAL UNIVERSITY RAIL (NURAIL) CENTER

**DIRECTOR** – ASSOCIATION OF AMERICAN RAILROADS AFFILIATED LABORATORY AT UIUC

**DEPUTY DIRECTOR** – RAILWAY SUPPLY INSTITUTE–ASSOCIATION OF AMERICAN RAILROADS: RAILROAD TANK CAR SAFETY RESEARCH AND TEST PROJECT


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## EDUCATION

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|---|---|---|
| **Ph.D.** | **1987** | **Biology - State University of New York at Albany**<br>Quantitative ecology, stochastic optimization modeling, experimental design, statistical analysis |
| **M.S.** | **1984** | **Biology - State University of New York at Albany**<br>Behavioral ecology, social behavior, optimality theory, statistical analysis |
| **B.A.** | **1977** | **Goddard College, Plainfield, VT**<br>Ecology and environmental studies |

## POST-DOCTORAL EMPLOYMENT

University of Illinois at Urbana-Champaign, Urbana, IL
Department of Civil and Environmental Engineering
2010 – Present: Executive Director – Rail Transportation and Engineering Center (RailTEC)
2009 – Present: Professor
2001 – 2009: Associate Professor (granted tenure 2004)
2006 – Present: George Krambles Faculty Fellow
1998 – 2010: Director – Railroad Engineering Program
1998 - 2001: Senior Scientist

Association of American Railroads, Washington, DC
Research & Test and Safety & Operations Departments
1997 – 1998: Director - Risk Engineering
1995 – 1997: Senior Manager – Environment and Hazardous Materials
1990 – 1994: Manager – Environment and Hazardous Materials
1989 – 1990: Assistant Manager – Environment and Hazardous Materials
1988 – 1989: Environmental Scientist

Smithsonian Environmental Research Center, Edgewater, MD
1987 - 1988: Postdoctoral Research Fellow



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## Professional Summary

Christopher P.L. Barkan is a professor in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign (UIUC) where he also serves as Executive Director of the Rail Transportation and Engineering Center (RailTEC). Prior to this he was Director of Risk Engineering at the Association of American Railroads (AAR) in Washington, DC where he was employed for ten years in their Research & Test and Safety & Operations Departments. At the AAR he had principal responsibility for the railroad industry's cooperative research programs in environment, hazardous materials and tank car safety. He moved to UIUC in 1998 and his current research interests are in railroad transportation safety and risk analysis, train derailment analysis, hazardous materials transport, tank car safety, energy efficiency, rail line capacity, railroad infrastructure and operating economics, and the development and cost-effectiveness of new rail technologies. He has supervised six Ph.D. students and 49 M.S. students, all of them in rail engineering and transportation subjects. He is also Director of the National University Rail (NURail) Center, a consortium of seven colleges and universities focused on rail research and education funded by the US DOT. He continues to serve the rail industry as Director of the AAR Affiliated Lab at UIUC, and Deputy Director of the Railway Supply Institute-AAR Railroad Tank Car Safety Research and Test Project. Dr. Barkan is an author or editor of more than 100 railroad-engineering papers, reports, chapters or books on a range of topics. He and his students have won several awards for research presented at international conferences and papers published in peer-reviewed journals. He has been an invited speaker at conferences, universities and corporations throughout North America, as well as Europe and Asia. He completed his B.A. at Goddard College in 1977, and his M.S. in 1984 and Ph.D. in 1987, both in biology at the State University of New York at Albany and then held a Postdoctoral Research Fellowship at the Smithsonian Environmental Research Center before beginning at AAR.

## Honors and Awards

### Teaching

George Krambles Faculty Fellow: 2006 - present

Teachers Ranked as Excellent by their Students: Spring 2005, Fall 2015

### Research

2016 - Outstanding Contribution Award
Transportation Research Board - Committee on Transportation of Hazardous Materials

2012 - Academic Award
National Association of Railroad Passengers, Washington, DC

2008 - Co-recipient - T.A. Stewart-Dyer/Frederick Harvey Trevithick Award
Institution of Mechanical Engineers, London, England

2008 - Co-author - Young Researcher Prize
Eighth World Congress on Railway Research, Seoul, South Korea

2007 - Co-recipient - William Alexander Agnew Meritorious Award/Clarence Noel Goodall Award
Institution of Mechanical Engineers, London, England

2005 - Coauthor – Best Environmental Paper Award
International Heavy Haul Association conference, Rio de Janeiro, Brazil



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## INVITED COMMITTEE MEMBERSHIPS, TESTIMONY AND PRESENTATIONS

Invited Speaker – Rail Transportation of Crude Oil and Ethanol
Transportation Research Board – Special Committee for the Domestic Transportation of Petroleum, Natural Gas, and Ethanol

Invited Speaker – Crude by Rail: Findings from Risk Research
Special Session – Crude by Rail: Opportunities and Challenges in North America
Transportation Research Board, 95th Annual Meeting, Washington, DC – 10 January 2016.

Invited Speaker – Risk Analysis of Rail Transport of Flammable Liquids
Special Session – Crude Oil by Rail Shipments: Logistics and Community Impacts
Transportation Research Board, 94th Annual Meeting, Washington, DC – 11 January 2015.

Invited Member – American Petroleum Institute/Association of American Railroads, Joint Working Group on Crude Oil Transportation by Rail, Mitigation Sub-Group, April – July 2014.

Invited Testimony – U.S. House of Representatives, Committee on Science, Space and Technology, Subcommittee on Research and Technology, Washington, DC, 18 June 2014.

Invited Testimony – Optimizing Rail Transportation Safety Improvement, National Transportation Safety Board (NTSB) Forum- Rail Safety: Transportation of Crude Oil and Ethanol, 22-23 April 2014 Washington, DC.

Invited Testimony – U.S. House of Representatives, Committee on Transportation and Infrastructure, Subcommittee on Railroads, Pipelines and Hazardous Materials, Springfield, IL, 11 June 2013.

Invited Member – Oversight Committee, National Cooperative Rail Research Program 2012 – present.

Invited Member – Technical Oversight Panel, Hazardous Materials Cooperative Research Program 2011 – present.

Invited Member – Committee for Review of the U.S. Department of Transportation - Research, Development and Technology Strategic Plan – Research and Innovative Technology Administration 2010 – 2011.

Invited Member – Committee for Review of the FRA Research and Development Program 2005 – 2008, 2008 – 2011, 2012 – present.

Invited Member – Committee for Review of the U.S Department of Transportation Strategic Research Plan, 2006.

Invited Member – Advisory Panel - Next Generation Rail Tank Car for Toxic Inhalation Hazard (TIH) Materials, Flammable Gases and Environmentally Sensitive Chemicals, Dow Chemical, Midland, MI, 2006 – 2008.

Invited Member – Special TRB Panel Evaluating the Feasibility of a Hazardous Materials Transportation Cooperative Research Program, 2004. TRB special report 283 published April 2005.

Invited Member – Special Panel on Hazardous Materials Transportation Safety & Security, US Government Accounting Office, Washington, DC, June 2002.



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## QUALIFICATIONS AND RELEVANT EXPERIENCE

**University of Illinois at Urbana-Champaign**

1998 – Present, *Department of Civil & Environmental Engineering*

*Professor 2009 to present*
*Associate Professor 2001 – 2009*
*Senior Scientist 1998 – 2001*

Dr. Barkan's research at UIUC encompasses railroad transportation safety and risk analysis, hazardous materials transport, railroad energy efficiency, rail line and terminal capacity, railroad infrastructure and operating economics, and the development and cost-effectiveness of new rail technologies. Dr. Barkan teaches courses in railroad transportation engineering, railway signaling and operation, shared rail corridor engineering and operation, and advances in rail technology. Since coming to the University of Illinois, he and his colleagues have expanded the rail curriculum from one course to twelve, the largest of any North American university. He is also working with colleagues at other colleges and universities, leading efforts to expand rail transportation and engineering academic programs and opportunities nationwide.

2010 – Present, *Executive Director, Rail Transportation & Engineering Center (RailTEC)*
1998 – 2010, *Director, Railroad Engineering Program*

In addition to his research and teaching activities at UIUC, Dr. Barkan has served as director of UIUC's railroad engineering program since 1998. With the formation of RailTEC in 2010, this responsibility was expanded to encompass all rail engineering and transportation research and academic activities at UIUC. He promotes and coordinates the development of the rail curriculum and supports faculty and students conducting research on a wide range of topics to improve rail safety, reliability and efficiency.

1998 – Present, *Director, Association of American Railroads Affiliated Laboratory*

Dr. Barkan directs the rail-industry sponsored research activities at UIUC, serving as Director of the AAR Affiliated Laboratory at UIUC. He maintains frequent contact, coordination and collaboration with the railroad research staff at the Transportation Technology Center Inc. in Pueblo, Colo., and with AAR headquarters staff in Washington, D.C., as well as senior engineering and technical staff and the major North American railroads and the rail supply industry.

1990 – Present, *Deputy Director, Railway Supply Institute - Association of American Railroads Railroad Tank Car Safety Research and Test Project*

Dr. Barkan has served as Deputy Director of the RSI-AAR Railroad Tank Car Safety Research and Test Project for over 20 years. The RSI-AAR Tank Car Project is a cooperative program of the tank car and railroad industries conducting research on improving tank car safety. In this role he has been extensively involved in statistical, engineering, safety and risk analyses evaluating railroad tank car transportation of hazardous materials on behalf of the two project sponsor organizations and their members. The results of this work are extensively used by industry and government stakeholders concerned with tank car safety improvement.

2012 – Present, *Director, National University Rail (NURail) Center*

Dr. Barkan is the Director of the NURail Center, the first, rail-focused, Tier-1 University Transportation Center funded by the Office of the Secretary of the U.S. Department of Transportation. In 2011, he led the consortium of seven colleges and universities that developed the successful proposal for the NURail Center that was awarded in early 2012 and renewed in 2013.

The principal objectives of the NURail Center are to improve and expand U.S. academic rail education, research, workforce development and technology transfer. Rail education is being enhanced through development of new, full-semester courses, continuing education programs and on-line educational opportunities. The NURail consortium selected "Shared rail corridors" as the central theme of its research



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program and is developing a series of strategic development plans in key areas related to the center theme, including: Integrated rail vehicle-infrastructure design, dynamics and interaction; Railroad safety and risk; Rail network capacity analysis and planning; Urban, regional and high-speed passenger rail implementation; Multi-modal freight transportation; and Rail transport funding, finance, community and economic development . These topics are critically important to sustaining and expanding U.S. freight railroad transportation excellence while at the same time developing commuter and intercity passenger rail.

1988 – 1998, *Association of American Railroads - Research and Test Department and Safety and Operations Department*

From 1988 through 1998, Dr. Barkan was employed in positions of increasing responsibility by the Association of American Railroads in Washington, DC. Beginning in 1989 he had principal responsibility for direction and management of the railroad industry's cooperative research programs in environment, hazardous materials transportation risk and tank car safety. In this position he worked extensively on research projects with major railroads, the railway tank car industry, chemical and petroleum shippers, government agencies in the U.S. and Canada and other organizations concerned with improving railroad environmental and safety performance.

## PUBLICATIONS

### PEER-REVIEWED JOURNAL ARTICLES

Greve, M.J., M.S. Dersch, J.R. Edwards, C.P.L. Barkan, J. Mediavilla and B. Wilson. 2016. Effect of particle intrusion on rail seat load distributions on heavy haul freight railroads. *In Press*, International Journal of Rail Transportation. DOI: 10.1080/23248378.2016.1157048.

Lin, C., M.R. Saat and C.P.L. Barkan. 2016. Fault tree analysis of adjacent track accidents on shared-use rail corridors. *Accepted.* Transportation Research Record: Journal of the Transportation Research Board 2546. DOI: 10.3141/2546-16.

Tang, H., C.T. Dick, B.M. Caughron, X. Feng and C.P.L. Barkan. 2016. A model for optimal selection of projects to improve running time and operating cost efficiency on passenger rail corridors. *Accepted.* Transportation Research Record: Journal of the Transportation Research Board. 2546 DOI: 10.3141/2546-05.

Van Dyk, B.J., J.R. Edwards, M.S. Dersch, C.J. Ruppert and C.P.L. Barkan. 2016. Evaluation of dynamic and impact wheel load factors and their application in design processes. *In Press*, Journal of Rail and Rapid Transit. DOI:10.1177/0954409715619454.

Greve, M.J., M.S. Dersch, J.R. Edwards, C.P.L. Barkan, H. Thompson, T. Sussmann and M. McHenry. 2015. Examination of the effect of concrete crosstie rail seat deterioration on rail seat load distribution. Transportation Research Record: Journal of the Transportation Research Board. 2476: 1-7.

Lovett, A.H., C.T. Dick, C.J. Ruppert, Jr. and C.P.L. Barkan. 2015. Cost and delay of railroad timber and concrete crosstie maintenance and replacement. Transportation Research Record: Journal of the Transportation Research Board. 2476: 37-44.

Shih, M.-C., C.T. Dick and C.P.L. Barkan. 2015. Impact of passenger train capacity and level of service on shared rail corridors with multiple types of freight trains. Transportation Research Record: Journal of the Transportation Research Board. 2475: 63-71.

Sogin, S., Y-C Lai, C.T. Dick and C.P.L. Barkan. 2015. Analyzing the transition from single to double track railway lines with non-linear regression analysis. *In Press*, Journal of Rail and Rapid Transit.



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Van Dyk, B.J., A.J. Scheppe, J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Methods for quantifying rail seat loads and a review of previous experimentation. *In Press*, Journal of Rail and Rapid Transit.

Williams, B.A., D. Holder, J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Quantification of the lateral forces in concrete sleeper fastening systems. *In Press*, Journal of Rail and Rapid Transit.

Dingler, M.H., Y-C. Lai and C.P.L Barkan. 2014. Effect of train-type heterogeneity on single-track heavy haul railway line capacity. Journal of Rail and Rapid Transit. 228 (8): 845-856.

Kernes, R.G., A.A. Shurpali, J.R. Edwards, M.S. Dersch, D.A. Lange and C.P.L. Barkan. 2014. Investigation of the mechanics of rail seat deterioration and methods to improve the abrasion resistance of concrete sleeper rail seats. Journal of Rail and Rapid Transit. 228 (6): 581-589.

Liu, X., A. Lovett, C.T. Dick, M.R. Saat and C.P.L. Barkan. 2014. Optimization of ultrasonic rail-defect inspection for improving railway transportation safety and efficiency. ASCE Journal of Transportation Engineering. 140 (10) 04014048.

Liu, X., M.R. Saat and C.P.L. Barkan. 2014. Probability analysis of multiple-tank-car release incidents in railway hazardous materials transportation. Journal of Hazardous Materials. 276: 442-451.

Saat, M.R., C. J. Werth, D. Schaeffer, H. Yoon and C.P.L. Barkan. 2014. Environmental risk analysis of hazardous material rail transportation. Journal of Hazardous Materials. 264: 560-569.

Shih, M-C., C.T. Dick, S.L. Sogin and C.P.L. Barkan. 2014. Comparison of capacity expansion strategies for single-track railway lines with sparse sidings. Transportation Research Record: Journal of the Transportation Research Board. 2448: 53-61.

Shurpali, A., J.R. Edwards, R. Kernes, D. Lange and C.P.L. Barkan. 2014. Investigation of material improvements to mitigate the effects of abrasion mechanisms of concrete crosstie rail seat deterioration. ASCE Journal of Transportation Engineering. 140 (2) DOI: 10.1061/TE.1943-5436.0000616.

Van Dyk, B.J., M.S. Dersch, J.R. Edwards, C.J. Ruppert, Jr. and C.P.L. Barkan. 2014. Load characterization techniques and overview of loading environment in North America. Transportation Research Record: Journal of the Transportation Research Board. 2448: 80-86.

Dingler, M.H., Y-C. Lai, and C.P.L. Barkan. 2013. Mitigating train-type heterogeneity on a single-track line. Journal of Rail and Rapid Transit 227: 140-147.

Liu, X., M.R. Saat, C.P.L. Barkan and X. Qin 2013. Analysis of U.S. freight-train derailment severity using zero-truncated negative binomial regression and quantile regression. Accident Analysis and Prevention 59: 87–93.

Liu, X., M.R. Saat and C.P.L. Barkan 2013. Integrated risk reduction framework to improve railway hazardous materials transportation safety. Journal of Hazardous Materials 260: 131-140.

Liu, X., M.R. Saat and C.P.L. Barkan 2013. Safety-effectiveness of integrated risk reduction strategies for rail transport of hazardous materials. Transportation Research Record - Journal of the Transportation Research Board 2374: 102-110.

Lovett, A., G. Munden, M.R. Saat and C.P.L. Barkan 2013. High-speed rail network design and station location evaluation: a model and sensitivity analysis. Transportation Research Record - Journal of the Transportation Research Board 2374: 1-8.

Rapp, C.T., M.C. Dersch, J.R. Edwards, C.P.L. Barkan, B. Wilson and J. Mediavilla 2013. Measuring concrete cross-tie rail seat pressure distribution with matrix-based tactile surface sensors. Transportation Research Record - Journal of the Transportation Research Board 2374: 190-200.



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Sogin, S.L., Y-C Lai, C.T. Dick and C.P.L. Barkan 2013. Comparison of capacity of single- and double-track rail lines. Transportation Research Record - Journal of the Transportation Research Board 2374: 111–118.

Liu, X, M.R. Saat and C.P.L. Barkan 2012. Analysis of major causes of train derailments and their effect on accident rates. Transportation Research Record - Journal of the Transportation Research Board 2289: 154-163.

Marruffo, A., H. Yoon, D.J. Schaeffer, C.P.L. Barkan, M.R. Saat and C.J. Werth 2012. NAPL source zone depletion model and its application to railroad-tank-car spills. Ground Water 50: 627–632.

Zeman, J.C., J.R. Edwards, D.A. Lange and C.P.L. Barkan 2012. Hydraulic pressure cracking in rail seats of concrete crossties. ACI Materials Journal 109: (6) 639-646.

Lai, Y-C, A. Kawprasert, C.Y. Lin, M.R. Saat, C.H. Liang and C.P.L. Barkan 2011. Integrated optimization model to manage risk of transporting hazardous materials on railroad networks. Transportation Research Record - Journal of the Transportation Research Board 2261: 115-123.

Lai, Y-C. and C.P.L Barkan. 2011. Comprehensive decision support framework for strategic railway capacity planning. ASCE Journal of Transportation Engineering 137: 738-749.

Liu, X, C.P.L. Barkan and M.R. Saat 2011. Analysis of derailments by accident cause: Evaluating railroad track upgrades to reduce transportation risk. Transportation Research Record - Journal of the Transportation Research Board 2261: 178–185.

Saat, M.R, and C.P.L. Barkan 2011. Generalized railway tank car safety design optimization for hazardous materials transport: addressing the trade-off between transportation efficiency and safety. Journal of Hazardous Materials 189: 62–68.

Schlake, B.W., C.P.L. Barkan and J.R. Edwards 2011. Train delay and economic impact of in-service failures of railroad rolling stock. Transportation Research Record - Journal of the Transportation Research Board. 2261: 124-133.

Dingler, M.H., Y-C. Lai and C.P.L. Barkan 2010. Effects of communications-based train control and electronically controlled pneumatic brakes on railroad capacity. Transportation Research Record - Journal of the Transportation Research Board 2159: 77-84.

Kawprasert, A. and C.P.L Barkan. 2010. Effect of train speed on risk analysis of transporting hazardous materials by rail. Transportation Research Record - Journal of the Transportation Research Board 2159: 59-68.

Schlake, B.W., S. Todorovic, J.R. Edwards, J.M. Hart, N. Ahuja, and C.P.L Barkan. 2010. Machine vision condition monitoring of heavy-axle load railcar structural underframe components. Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit (Special Issue on Heavy Haul and Innovative Development) 224: 499-511.

Dingler, M.H., Y-C. Lai, and C.P.L. Barkan 2009. Impact of train type heterogeneity on single-track railway capacity. Transportation Research Record - Journal of the Transportation Research Board. 2117: 41–49

Kawprasert, A. and C.P.L Barkan 2009. Communication and interpretation of results of route risk analyses of hazardous materials transportation by railroad. Transportation Research Record - Journal of the Transportation Research Board 2097: 125-135.

Lai, Y-C., and C.P.L. Barkan 2009. Enhanced parametric railway capacity evaluation tool. Transportation Research Record - Journal of the Transportation Research Board. 2117: 33-40.

Ouyang, Y., X. Li, Y-C. Lai, C.P.L. Barkan, and A. Kawprasert 2009. Optimal locations of railroad wayside defect detection installations. Computer-Aided Civil and Infrastructure Engineering 24: 1–11.



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Peltier, D.C. and C.P.L. Barkan 2009. Characterizing and inspecting for progressive epoxy debonding in bonded insulated rail joints, Transportation Research Record - Journal of the Transportation Research Board. 2117: 85-92.

Yoon, H., Werth, C.J., Barkan, C.P.L., Schaeffer, D.J. and Anand, P. 2009. An environmental screening model to assess the consequences to soil and groundwater from railroad-tank-car spills of light non-aqueous phase liquids. Journal of Hazardous Materials 165: 332-344.

Barkan, C.P.L. 2008. Improving the design of higher-capacity railway tank cars: optimizing the trade-off between weight and safety. Journal of Hazardous Materials 160: 122-134.

Kawprasert, A. and C.P.L. Barkan 2008. Effects of route rationalization on hazardous materials transportation risk. Transportation Research Record - Journal of the Transportation Research Board 2043: 65-72.

Schafer, D.H. and C.P.L. Barkan 2008. Relationship between train length and accident causes and rates. Transportation Research Record - Journal of the Transportation Research Board 2043: 73-82.

Barkan, C.P.L., S. Ukkusuri and S.T. Waller 2007. Optimizing the design of railway tank cars to minimize accident-caused releases. Computers & Operations Research 34: 1266–1286.

Dirnberger, J.R. and C.P.L. Barkan 2007. Lean railroading for improving railroad classification terminal performance. Transportation Research Record - Journal of the Transportation Research Board 1995: 52-61.

Lai, Y-C., C.P.L. Barkan, J. Drapa, N. Ahuja, J.M. Hart, P.J. Narayanan, C.V. Jawahar, A. Kumar, L. Milhon and M.P. Stehly 2007. Machine-vision analysis of the energy efficiency of intermodal freight trains. Journal of Rail and Rapid Transit 221: 353-364.

Anand, P. and C.P.L. Barkan 2006. Exposure of soil and groundwater to spills of hazardous materials transported by rail: A geographic information system analysis. Transportation Research Record - Journal of the Transportation Research Board 1943: 12-19.

Chen, Y., F.V. Lawrence, C.P.L. Barkan and J.A. Dantzig 2006. Heat transfer modeling of rail thermite welding. Journal of Rail and Rapid Transit 220: 207-217.

Chen, Y., F.V. Lawrence, C.P.L. Barkan and J.A. Dantzig 2006. Weld defect formation in rail thermite welds. Journal of Rail and Rapid Transit 220: 373-384.

Grimes, G.A. and C.P.L. Barkan 2006. Cost-effectiveness of railway infrastructure renewal maintenance. ASCE Journal of Transportation Engineering 132: 601-608.

Lai, Y-C. and C.P.L. Barkan 2005. Options for improving the energy efficiency of intermodal freight trains. Transportation Research Record - Journal of the Transportation Research Board 1916: 47-55.

Saat, M.R. and C.P.L. Barkan. 2005. Release risk and optimization of railroad tank car safety design. Transportation Research Record - Journal of the Transportation Research Board 1916: 78-87.

Anderson, R. and C.P.L. Barkan. 2004. Railroad accident rates for use in transportation risk analysis. Transportation Research Record - Journal of the Transportation Research Board 1863: 88-98.

Barkan, C.P.L. 2004. Cost effectiveness of railroad fuel spill prevention using a new locomotive refueling system. Transportation Research, Part D. Transport and Environment 9: 251-262.

Barkan, C.P.L., C.T. Dick and R. Anderson 2003. Analysis of railroad derailment factors affecting hazardous materials transportation risk. Transportation Research Record; Journal of the Transportation Research Board 1825: 48-55.

Day, K.R. and C.P.L. Barkan 2003. Model for evaluating cost-effectiveness of retrofitting railway bridges for seismic resistance. Transportation Research Record; Journal of the Transportation Research Board 1845: 203-212.



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Dick, C.T., C.P.L. Barkan, E. Chapman and M.P. Stehly 2003. A multivariate statistical model for predicting the occurrence and location of broken rails. Transportation Research Record; Journal of the Transportation Research Board 1825: 64-74.

Bendixen, L., T. Treichel, C. Barkan and C. Burke 2001 (Discussors of paper by Hwang S.T., D.F. Brown, J.K. O'Steen, A.J. Policastro, and W.E Dunn "Risk assessment for national transportation of selected hazardous materials") Transportation Research Record 1763: 122-124.

Barkan, C.P.L., T.T. Treichel and G. W. Widell 2000. Reducing hazardous materials releases from railroad tank car safety vents. Transportation Research Record 1707: 27-34.

Barkan, C.P.L., T.S. Glickman and A.E. Harvey 1992. Benefit cost evaluation of using different specification tank cars to reduce the risk of transporting environmentally sensitive chemicals. Transportation Research Record 1313: 33-43.

## RECENT CONFERENCE PROCEEDINGS PAPERS AND PRESENTATIONS

Greve, M.J., M.S. Dersch, J.R. Edwards and C.P.L. Barkan. 2015. Evaluation of Laboratory and Field Experimentation Characterizing Concrete Crosstie Rail Seat Load Distributions. Accepted, In: Proceedings of the 2015 Joint Rail Conference, San Jose, CA, March 2015.

Lovett, A.H., C.T. Dick and C.P.L. Barkan. 2015. Determining Freight Train Delay Costs on Railroad Lines in North America. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.

Scheppe, A.J., J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Quantifying Lateral Wheel Loading Variation Using Truck Performance Detectors. In: Proceedings of Transportation Research Board 94th Annual Conference, Washington, D.C, January 2015.

Tang, H., C.T. Dick, B.M. Caughron, X. Feng and C.P.L. Barkan. 2015. A Project Selection Model for Improving Running Time and Operating Cost Efficiency on a Passenger Rail Corridor. In: Proceedings of the International Association of Railway Operations Research (IAROR) 6th International Conference on Railway Operations Modelling and Analysis, Tokyo, Japan, March 2015.

Williams, B.A., M.S. Dersch, J.R. Edwards and C.P.L. Barkan. 2015. Quantification of Lateral Forces in Concrete Crosstie Fastening Systems. In: Proceedings of Transportation Research Board 94th Annual Conference, Washington, D.C, January 2015.

Wolf, H.E., S. Mattson, J.R. Edwards, M.S. Dersch and C.P.L. Barkan. 2015. Flexural Analysis of Prestressed Concrete Monoblock Crossties: Comparison of Current Methodologies and Sensitivity to Support Conditions. In: Proceedings of Transportation Research Board 94th Annual Conference, Washington, D.C, January 2015.

Atanassov, I., C.T. Dick and C.P.L. Barkan. 2014. Siding Spacing and the Incremental Capacity of the Transition From Single to Double Track. In: Proceedings of the 2014 Joint Rail Conference, Colorado Springs, USA, April 2014.

do Carmo, T.B., J.R. Edwards, R.G. Kernes, B.O. Andrawes and C.P.L. Barkan. 2014. Mechanistic Behavior of Concrete Crosstie Fastening System Rail Pad Assemblies. In: Proceedings of the 93rd Annual Meeting of the Transportation Research Board, Washington, DC, January 2014.

do Carmo, T.B., J.R. Edwards, R.G. Kernes, B.O. Andrawes and C.P.L. Barkan. 2014. Laboratory and Field Investigation of the Rail Pad Assembly Mechanistic Behavior. In: Proceedings of the 2014 Joint Rail Conference, Colorado Springs, CO, April 2014.

Greve, M.J, J.R. Edwards, R.G. Kernes, M.S. Dersch, C.P.L. Barkan, J. Mediavilla and B.M. Wilson 2014. Analysis of the Relationship Between Rail Seat Load Distribution and Rail Seat Deterioration



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in Concrete Crossties. In: Proceedings of the 2014 Joint Rail Conference, Colorado Springs, CO, April 2014.

Williams, B., J.R. Edwards, R.G. Kernes and C.P.L. Barkan. 2014. Analysis of the Lateral Load Path in Concrete Crosstie Fastening Systems. In: Proceedings of the 2014 Joint Rail Conference, Colorado Springs, USA, April 2014.

Atanassov, I., C.T. Dick and C.P.L Barkan. 2013. Incremental Capacity of Single to Double Track with Variable and Sparse Siding Spacing. Presented at the 2013 INFORMS Conference, Minneapolis, MN, October 2013.

Caughron, B.M., C. T. Dick and C.P.L. Barkan. 2013. A Project Selection Model for Improving Running Time on Passenger Rail Corridors. In: Proceedings of the American Railway Engineering and Maintenance-of-Way Association Annual Conference, Indianapolis, Indiana, September 2013.

Caughron, B.M., C. T. Dick and C.P.L. Barkan. 2013. A Project Selection Model for Improving Running Time on Passenger Rail Corridors. Presented at the ASME Joint Rail Conference, Knoxville, TN, April 2013.

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