

# **J.P. Giroud**

## **Statement of Qualifications**

### **Liner Systems**

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Dr. J.P. Giroud is certainly one of the engineers who had the deepest influence on the design of liner systems. Dr. Giroud, considered the “father of geosynthetic liner systems” by *Waste Age* magazine, has developed many of the methods used for the design of geosynthetic liner systems for landfills such as: stability analysis of liner systems on slopes, liner anchor trench design, leachate collection system design, leakage detection system design, design of liner systems over weak foundations, design of geotextile filters. He received the International Geosynthetics Society Award for the design method he developed for the evaluation of leakage through liners; this method has now been incorporated in the HELP model for landfill design of the U.S. Environmental Protection Agency (USEPA). The design methods developed by Dr. Giroud for liner systems have been published in more than 60 papers and are used worldwide.

Dr. Giroud has extensive experience in liner system design. He has designed, or conducted a performance analysis for, more than 100 liner systems. Dr. Giroud has originated innovative applications such as: the protection of geomembranes using geotextiles (1971), the double geomembrane liner system with granular leakage detection layer (1974), and the double geomembrane liner system with geosynthetic leakage detection layer, using a geonet (1980). He played a key role in the development of the use of geonets and geocomposite drainage systems in landfills. Dr. Giroud is also recognized for his pioneering work in construction quality assurance of liner systems.

Dr. Giroud has unique experience in performing forensic analyses and performance evaluation of liner systems. He has performed more than 30 of these forensic analyses and performance evaluations, and has presented several keynote lectures on the subject. Also, Dr. Giroud is currently working on a 1000-page book on the subject.

Dr. Giroud has actively participated in the development of regulations for liners. He was a consultant to the USEPA on the agency’s Liner Leak Detection Rule, Double-Liner Rule, and the related technical background documents. He also was a member of the task force developing the landfill rules for the Florida Department of Environmental Protection; his role in the task force was to develop a rationale for the liner system regulations. Dr. Giroud has also been asked on numerous occasions to develop “equivalency demonstrations” to show that an alternate solution for a liner system is equivalent to the liner system prescribed by regulations. He has written several papers on liner system comparison and equivalency demonstrations.

Dr. Giroud has extensive experience in teaching courses on liner systems: he has taught more than 50 courses on this subject for the USEPA, the Florida Department of Environmental Protection, the U.S. Bureau of Reclamation, the Association of State Dam Safety Officials, the Industrial Fabrics Association International, the Swedish Geotechnical Institute, and many other organizations.

## **Design and Innovative Practice on Liner Systems**

As a researcher, Dr. Giroud developed many methods of design for liner systems:

- Evaluation of rate of leakage through liner systems.
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- Design of drainage layers for leakage detection.
- Design method and charts for the determination of stresses and strains in geosynthetics caused by a localized subsidence of the supporting ground.
- Stability and differential movements of earth and concrete covers on geomembrane - geotextile - geonet systems.
- Design of structures connected with geomembrane liners.
- Uplift of geomembrane by wind.

Dr. Giroud is the principal author of three special issues of *Geosynthetics International*: “Design of Geomembrane Applications” (1995, 285 pages), “Control of Liquid Migration Using Geosynthetics Liner Systems” (1997, 251 pages), and “Liquid Collection Systems” (2000, 320 pages). These three volumes can be considered as the state of the art of liner system design. In particular, these three volumes present the detailed methodology for liner system design and performance evaluation, and for the rational comparison of liner systems.

As a practicing engineer, Dr. Giroud developed the double liner concept, which he presented in a paper in 1973. He used a double liner in a project constructed in 1974, which has performed well ever since. This was the first double geomembrane liner ever constructed. Applications related to liner systems originated by Dr. Giroud include:

- First use of a geotextile associated with a geomembrane (1971).
- First use of a double geomembrane liner (1974).
- First use of a geonet associated with two geomembranes to form an entirely geosynthetic double liner system (1980).

In addition, Dr. Giroud has been instrumental in the development of the use of geonets and geocomposite drainage systems in landfills in the United States and in the acceptance of this technique by the U.S. Environmental Protection Agency (EPA) (1984-1985).

## **Design of Projects Incorporating Geosynthetic Liner Systems**

Dr. Giroud has designed projects with geosynthetics since 1969, including Valcros Dam where a geotextile was used for the first time in a dam (1970). His design work has included a wide variety of projects with geosynthetic liner systems, such as: reservoirs for water and chemicals, waste water lagoons, evaporation ponds, brine ponds with floating covers, underground cavities, hazardous waste and municipal solid waste landfills, ore leach pads, tailings dams, earth and rockfill dams, canals, and secondary liner containment for underground fuel tanks. Typical projects include:

- Technical assistance for the design of a series of water reservoirs where geotextiles and geomembrane liners were associated for the first time (1971).
- Site investigations and design of Rhone-Progil Reservoir, which is a large industrial water reservoir on a steep slope, in Pont de Claix, France; this project included the first double geomembrane liner with intermediate drainage to detect leakage (1974).
- Preparation of detailed specifications for the liner system of Esfahan Canal, Iran, which was the largest canal in the world lined with a geotextile-geomembrane system (1975).
- Conceptual design of canal liner system for the Balikh Irrigation Project, Syria, for the World Bank (1977).
- Review of liner system design for two evaporation ponds for a uranium processing plant, Narbonne, France (1980).
- Design of underground water reservoir liner system for the Proton Decay Experiment, Lake Erie, Ohio; this project included the first use of a geonet leakage detection layer between two geomembrane liners and was exceptionally difficult because of the shape, size and location of the cavity, which was excavated in a salt mine (1981).
- Conceptual and detailed design of a geomembrane/geotextile lined and reinforced large evaporation pond for sulfuric acid, Arlit, Niger (1981).
- Review of the design of the liner system for a demolition debris landfill, in Birchwood, Rhode Island (1987).
- Review of the conceptual design of the liner system for a hazardous waste landfill in Hazleton, Pennsylvania (1987).
- Review of the design of a geomembrane-lined ash landfill in Long Island, New York (1987).

- Review of the conceptual design and guidance for the detailed design of the liner system for a gold mine heap leach pad, in Lead, South Dakota (1987).
- Review of the conceptual design of the liner system for a municipal waste landfill in Foster County, Pennsylvania (1987).
- Review of the conceptual design and guidance for the detailed design of a liner system for heap leach pads for two different gold mines, near Lead, South Dakota (1988).
- Review of liner material selection for a municipal waste landfill, Gloucester County, New Jersey (1988).
- Assistance for geomembrane selection and specifications for a lined potable water reservoir with floating cover, Nassau, Bahamas (1988).
- Review of preliminary design of a geomembrane-lined municipal waste landfill, Cumberland, New Jersey (1988).
- Review of detailed design for a geomembrane-lined municipal waste landfill, West Palm Beach, Florida (1988).
- Conceptual design for the liner system of a municipal waste landfill, Monroeville, Pennsylvania (1988).
- Preliminary design of the liner system of a municipal waste landfill resting on existing waste, Long Island, New York (1988).
- Review of conceptual design of hazardous waste disposal landfill, Augusta, Michigan (1988).
- Conceptual design for a geomembrane-lined ashpond for a utility company, Binghamton, New York (1988).
- Review of construction quality audit for mine heap leach pad and associated ponds, Lawrence County, South Dakota (1988).
- Conceptual design of the rehabilitation of brine ponds using geomembrane liners, Fresno, California (1989).
- Review of conceptual design and expert testimony for a geomembrane-lined municipal solid waste landfill, Edmonton, Canada (1989).
- Review of problems caused by vegetation growth to the geomembrane cap of a large municipal waste landfill, Fresh Kills, New York (1989).
- Design of liner system for a large municipal solid waste landfill, Guaynabo, Puerto Rico (1991).
- Design of a removable landfill cap for a landfill with waste mining/recycling, Collier County, Florida (1991).
- Review of design of a test pad for evaluating effectiveness of liquid collection in the geosynthetic-lined cap of a sludge pond, Ohio (1992).
- Technical assistance for the design of geomembrane-lined Lopez Canyon Landfill, California (1993).
- Technical assistance for the selection and specification of geomembrane for a large water reservoir in Ismailia, Egypt (1993).

- Evaluation of long-term performance of a geomembrane liner for a low-level radioactive waste repository, Martinsville, Illinois (1993).
- Design assistance for very large ponds lined with a geomembrane in Wilmington, North Carolina (1994).
- Evaluation of long-term performance of geomembrane liner and geosynthetic clay liner for a low level radioactive waste disposal facility, North Carolina (1994).
- Design assistance to Chem Nuclear Systems, Inc. for the development of “high-integrity vaults” for the storage of low-level radioactive waste (1994-1998).
- Design assistance for detailed design of a geomembrane-lined solid waste landfill, Calce, France (1995).
- Design assistance for wind effect on geomembrane-lined pond, Paris Airport, France (1995).
- Evaluation of the action of PCBs on HDPE geomembranes (1995).
- Development of design criteria and design methodology, design assistance and design review for geomembrane-lined low-level radioactive waste disposal landfill, Fernald, Ohio (1996).
- Liner system comparison, Tesoro tank farms, Alaska (1996).
- Design review for geomembrane-lined ponds, Anne Arundel County, Maryland, USA (1997).
- Design assistance for pond liner associated with above ground tanks, for BP, Algeria (1997).
- Review of the design of an exposed geomembrane cap for a large municipal solid waste landfill in Sussex County, Delaware (1998).
- Review of design of use of geosynthetic clay liner encapsulated between two geomembranes for two landfills, Keystone and Commonwealth (2001).
- Member of the design team of Lachenaie Landfill Northern Extension, Montreal, Canada (2001).
- Design assistance for geomembrane-lined underground Kildare Motorway Bypass, Ireland (2001).
- Design assistance for Bryn Pica Landfill, UK (2001).
- Design assistance for two large water reservoirs for pump-storage station, Afourer, Morocco (2003).
- Analysis of geomembrane resistance to soil cracking for the design of the rehabilitation of White Tanks flood control dam, Arizona (2004).
- Design review for a large geomembrane-lined water reservoir, Newark, Delaware (2004).
- Design assistance for the closure of a solid waste landfill, Guam (2004-2005).
- Review of design of use of geosynthetic clay liner encapsulated between two geomembranes for two landfills, Keystone and Commonwealth (2001).
- Member of the design team of Lachenaie Landfill Northern Extension, Montreal, Canada (2001).

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As a result of his recognized expertise, Dr. Giroud has been involved in the design or the performance evaluation of liner systems installed in unusual conditions, such as: liner systems installed on vertical concrete walls; liner systems installed in a very large underground mine cavity; liner systems installed on highly compressible waste; liner systems located in extreme climates; etc.

## **Performance and Forensic Analyses**

Dr. Giroud has extensive experience in performing forensic analyses and providing expert testimony. He has performed approximately fifty forensic analyses and performance evaluations. His first participation in a court case dates back to 1962. The first failure analysis of a geomembrane lined facility by Dr. Giroud dates back to 1972. Since then, Dr. Giroud has investigated more than 30 failures of structures incorporating geosynthetics, including a number of liner systems.

With his in-depth knowledge of geotechnical engineering and geosynthetics, Dr. Giroud is considered one of the foremost international authorities on the performance of geotechnical structures incorporating geosynthetics: keynote lecturer on geosynthetic failures at the conference “*Foundation of Success: Lessons Learned from Failures*” organized by the Colorado Section of the American Society of Civil Engineers (ASCE) (1992); keynote speaker on “*Lessons Learned from Failures Associated with Geosynthetics*” at the French Conference on Geosynthetics in Tours (France, 1993); keynote lecturer on “*Lessons Learned from Failures Associated with Geosynthetics*” at Geosynthetics '99, the bi-annual conference of the North American Geosynthetics Society, held in Boston, USA, and author of the 66-page paper on the subject in the proceedings of the conference; keynote lecturer on “*Lessons Learned from Failures and Successes Associated with Geosynthetics*” at “Eurogeo 2”, the Second European Conference on Geosynthetics, held in Bologna, Italy, in 2000, and author of the 42-page paper on the subject in the proceedings of the conference. Also, Dr. Giroud is a frequently invited lecturer on the performance of structures incorporating geosynthetics

and lessons learned from failures: “Kersten Lecture”, University of Minnesota/Minnesota Geotechnical Society, 1999; “Jack Hilf Memorial Lecture” The University of Colorado/US Bureau of Reclamation, 1999; and “The Nete Lecture”, Three Gorges Dam, China, 2000. Dr. Giroud is currently working on a 1000-page book on failures associated with geosynthetics, and he is co-author of a 210-page report on “Waste Containment Systems: Problems and Lessons Learned” (1999) for the US EPA (to be released in 2002).

Dr. Giroud has worked in many parts of the world. In particular, he has performed forensic analyses or performance evaluations on liner systems in various countries, such as Argentina, Jordan, Niger, France, the United States, etc. Furthermore, as President of the International Geosynthetics Society, or on other occasions, Dr. Giroud has chaired, or participated in, numerous international meetings and panels. As a result of this international experience, Dr. Giroud feels comfortable working everywhere in the world, and his authority and arbitration skills are instrumental in difficult situations, in particular when international participants are involved. Also, as a result of the work he has done for regulatory agencies (preparation of background documents to support regulations, report and manual preparation, training courses), Dr. Giroud is highly respected by representatives of governmental agencies, which is helpful in case problems linked to the performance of regulated facilities, such as landfills.

Examples of liner system performance evaluation and forensic analyses include:

- Tancarville (1972) and Hauterives (1978) reservoirs, France.
- Avoriaz Dam, France, (1980)
- Evaporation ponds for sulfuric acid in Arlit, Niger, (1981-1983)
- Evaporation ponds for phosphoric acid in Aqaba, Jordan , (1984)
- Manure reservoir in Groisy, France, (1983)
- Wastewater ponds, Idaho, (1984)
- Wastewater storage and treatment reservoirs, Vermont, (1985)
- Four reservoirs of sulfuric acid in San Onofre, California, (1985)
- Landfill in Norridgewock, Maine, (1986)
- Six reservoirs of wastewater in Long Beach, California, (1986)
- Secondary containment liners for underground fuel tanks in Emeryville, California, (1986)
- A pond at a gold mine, near Nye, Montana, (1987)
- A concrete vault for low-level nuclear waste placed in a liquid state, Hanford, Washington, (1987)
- Design and interpretation of a full scale test to evaluate landfill cap stability, New Milford, Connecticut (1987-88).
- Review of monitoring data for a hazardous waste landfill, Peoria, Illinois (1989).

- Analysis of the failure of a liner system in a landfill (sideslope stability, leakage), Fulton County, New York (1989).
- Analysis of potential leakage out of a geomembrane-lined municipal landfill and potential ground water contamination, Azusa, California (1989).
- Analysis of the failure (stress cracking) of an installed geomembrane liner exposed to extremely cold temperatures, Delta, Utah (1989).
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- Analysis and remedial measures for liner system instability in a landfill, Babylon, New York (1990).
- Analysis of a waste slide and liner system failure in a hazardous waste landfill, Kettleman Hills, California (1990).
- Analysis of the failure of a geomembrane liner in a large waste water reservoir, Canton, Mississippi (1990).
- Analysis of failures of geomembrane seams and definition of remedial measures at a uranium mine pond, Blanding, Utah (1991).
- Preparation of remedial measures for a pond in Soldotna, Alaska (1993).
- Investigation of foundation soil, waste slide, and liner system failure in a landfill, Portugal (1995-1996).
- Expert testimony on the evaluation of the design of a waste disposal landfill, including comparison of two liner systems, St. Etienne, Canada (1995-1996).
- Design of 12 m deep excavation into waste to repair the liner system in a landfill, Michigan (1997).
- Review of the analysis of the failure of a geomembrane liner in two wastewater lagoons, Ridgely, Maryland (1998).
- Performance evaluation of 16 evaporation ponds in Salar, Argentina (1998).
- Design of a long-term (300-year) monitoring plan for the cover geomembrane of a large mine tailings storage facility (1998).
- Performance evaluation of two lagoons for deicing fluid, Dayton Airport, Ohio (1999).
- Performance evaluation of a landfill cap geomembrane liner with substandard seams, Clarkstown, New York (1999).
- Performance evaluation of a landfill cover system with defective drainage geocomposite, Buckeye, Ohio (2001).

## **Expert Testimony**

Dr. Giroud has personal experience in providing expert testimony at administrative and judicial hearings. Dr. Giroud has also presented project descriptions and design concepts at public information meetings. Many of these hearings and meetings were related to liner systems.

## **Experience with US EPA and Regulatory Agencies**

Dr. Giroud has worked extensively with the US Environmental Protection Agency (US EPA) and other regulatory agencies, as indicated below:

- Report on the selection and installation of geomembranes to line experimental solar ponds, for the Solar Energy Research Institute, SERI (1981).
- Report on the performance of geomembrane liners as part of a contract between Battelle Northwest Institute and the Nuclear Regulatory Commission (1982).
- Preparation of “Guide Specifications for Geomembrane Installation in Hazardous Waste Disposal Facilities”, as part of a contract between the EPA and TRW (1983).
- Preparation of “Assessment of Synthetic Membrane Performance at Waste Disposal Facilities” for the US EPA (1984).
- Review of the “Permit Writer's Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities”, as part of a contract between the EPA and GCA (1984).
- Participation in meetings with the US EPA for the revision of leachate collection and leakage detection rules to incorporate synthetic drainage layers (1984-1985).
- Review of “Design, Construction, Inspection, Maintenance and Repair of Leachate Collection and Cap Drainage Systems”, as part of a contract between the EPA and A.D. Little (1985). Subcontract through Peer Consultants.
- Review of “Construction Quality Assurance for Hazardous Waste Land Disposal Facilities”, as part of a contract between the EPA and the Research Triangle Institute (1985).
- Review of “Avoiding Failure of Leachate Collection and Cap Drainage Systems” for the US EPA (1986).
- Review of “Background Document: Bottom Liner Performance in Double-Lined Landfills and Surface Impoundments”, EPA/530-SW-87-013, April 1987, 301 p., Subcontract through NUS.
- Preparation (co-author) of the “Background Document: Proposed Liner and Leak Detection Rule”, EPA/530-SW-87-015, May 1987, 526 p., Subcontract through NUS.
- Review of “Background Document: Comparative Performance of Single-Liner and Double-Liner Systems”, October 1987, 76 p., Subcontract through NUS.
- Evaluation of Birchwood demolition debris landfill permit application for Rhode Island Department of Environmental Management (RIDEM) (1988).
- Participation in the Technical Advisory Task Force of the Florida Department of Environmental Regulations for the preparation of new landfill rules (1990-1992).
- Review of “Leakage Detection, Collection, and Removal System Flow Data from Operating Units — Technical Support for Proposed Liner/leak Detection System Rule”, for the USEPA (1991).

- Review of “Action Leakage Rates for Leak Detection Systems, Supplemental Background Document for the Final Double Liners and Leak Detection Systems Rule for Hazardous Waste Landfills, Waste Piles, and Surface Impoundments”, for the US EPA (1992).
- Participation in “Performance Criteria for Landfill Cover”, for the California Integrated Waste Management Board (1992-1993).
- Participation in the preparation of the national guidelines on geomembrane construction quality assurance for the French environmental regulatory agency, ADEME (1996).
- Co-author of a comprehensive survey of problems in landfills, titled “Waste Containment Systems: Problems and Lessons Learned” (1999), for the US EPA (to be released in 2002).

Also, Dr. Giroud has been a peer reviewer of the work by the GeoSyntec Consultants team that evaluated under contract for the US EPA monitoring data from more than a hundred landfill cells or liquid impoundments.

As a result of all this work J.P. Giroud is in a unique position to deal with regulatory agencies.

## **Quality Assurance of Liner System Installation**

Dr. Giroud became involved in quality assurance of liner system installation as early as 1980. The report “*Guide Specifications for Geomembrane Installation in Hazardous Waste Disposal Facilities*”, prepared by Giroud and Kastman in 1982 and published as part of a state-of-the-art report for the EPA, laid the foundations for modern geosynthetic quality assurance. Dr. Giroud also prepared a general quality assurance manual for the installation of geosynthetic liner systems for a major US waste management firm. Finally, Dr. Giroud was instrumental in forming, at GeoSyntec Consultants, a Quality Assurance Division which, from 1984 on, has been involved in more than 500 projects, totaling approximately 80 million square meters (875 million square feet) of geosynthetics.

Typical projects where Dr. Giroud was personally involved in quality assurance field work include:

- Two evaporation ponds with a butyl rubber liner for a uranium processing plant, Narbonne, France (1980).
- A large evaporation pond for sulfuric acid, Arlit, Niger (1981).
- Geomembrane-lined brine reservoirs with floating covers in Kirkuk, Iraq (1982).
- NIES hazardous waste landfill with a geomembrane liner and drainage geonets, Wichita, Kansas (1983).

- A double-lined storage pond and two evaporation ponds for phosphoric acid, Aqaba, Jordan (1984).
- Hazardous waste landfill with a geomembrane liner and drainage geonets, Emelle, Alabama (1984).
- Hazardous waste landfill with a double geomembrane liner and drainage geonets, Arlington, Oregon (1985).
- Tailing dam with a single geomembrane liner, Summitville, Colorado (1986).
- Landfill for waste from utility companies, Norridgewock, Maine (1986).
- Hazardous waste landfill with a double geomembrane liner and drainage geonets, Baton Rouge, Louisiana (1986).
- A very large gypsum pond in Rock Springs, Wyoming (1986).
- Low-level radioactive waste disposal landfill, Fernald, Ohio (1996).

## **Training Courses on Landfills and Liner Systems**

Dr. Giroud has taught training courses on landfills and liner systems for the personnel of the EPA and state regulatory agencies. These include:

- Geomembrane Liners, Properties, Design and Installation in Landfills, presented in all 10 regions of USEPA (1983-1984).
- Permit Writer's Training Seminar on Synthetic Liners, presented to: EPA Region 4 in Atlanta, EPA Region 10 in Sacramento, EPA Region 3 in Philadelphia, EPA Region 2 in New York, and EPA Region 6 in Dallas (1985); EPA Region 7 in Kansas City, and EPA Region 5 in Chicago (1986).
- Permit Writer's Training Seminar on Landfill Covers, presented to: EPA Region 2 in Puerto Rico, EPA Region 10 in Sacramento, and EPA Region 5 in Chicago (1986).
- Course on liner systems in landfills in all 8 states of EPA Region 4 under contract with EPA Region 4 (1994).
- Every other year since 1992, Dr. Giroud teaches a landfill course sponsored by Florida DEP (in conjunction with the University of Florida).

In addition, Dr. Giroud has taught short courses or presented seminars as follows:

- Seminar on geomembrane liners for EnviroSAFE, a waste management company, Horsham, Pennsylvania (1982).
- Seminars on geomembrane liners for IBM, Austin, Texas (1985).
- Short course on geomembrane liners organized by the Industrial Fabrics Association International (IFAI), Cincinnati, Ohio (1985), and New Orleans, Louisiana (1987).

- Seminar on geosynthetic liner systems for Waste Management Inc., Chicago (1986, 1988).
- Five short courses on geosynthetic liner systems for the University of Wisconsin, Madison (1986, 1987, and 1988).
- Short courses on geosynthetic liner systems for the University of Lehigh (1986, 1987, 1988).
- Short course on geosynthetic liner systems for the U.S. Bureau of Reclamation, Denver, Colorado (1988).

In addition, Dr. Giroud teaches every year a short course on liner systems for landfills as part of the Landfill Course of the University of Wisconsin, Madison (from 1986).

## **Selected References of Publications Related to Liner Systems**

- Huot, P. et Giroud, J. P., 1973, "Perméabilité à l'eau de la feuille de butyl", *Comptes-Rendus du 11eme Congres International des Grands Barrages*, 5, Madrid, Juin 1973, pp. 556-558. (in French)
- Huot, P. et Giroud, J.P., 1973, "Position du dispositif d'etancheite", *Comptes-Rendus du 11eme Congres International des Grands Barrages*, 5, Madrid, Juin 1973, pp. 558-562. (in French)
- Giroud, J.P., 1973, "L'etancheite des retenues d'eau par feuilles déroulées", *Annales de l'ITBTP*, 312, TP 161, Decembre 1973, pp. 94-112. (in French)
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- Giroud, J.P., 1982, "Filter Criteria for Geotextiles", *Proceedings of the Second International Conference on Geotextiles*, Vol. 1, Las Vegas, NV, Aug 1982, pp. 103-108.

- Giroud, J.P., 1982, "Discussion on Design of Geotextiles Associated with Geomembranes", *Proceedings of the Second International Conference on Geotextiles*, Vol. 4, Las Vegas, Aug 1982, p. 25.
- Giroud, J.P., 1982, "Discussion on Filter Criteria for Geotextiles", *Proceedings of the Second International Conference on Geotextiles*, Vol. 4, Las Vegas, Aug 1982, pp. 36-38.
- Giroud, J.P., 1984, "Analysis of Stresses and Elongations in Geomembranes", *Proceedings of the International Conference on Geomembranes*, Vol. II, Denver, CO, Jun 1984, pp. 481-486.
- Giroud, J.P. and Goldstein, J.S., 1982, "Geomembrane Liner Design", *Waste Age*, Vol. 13, No. 9, Sep 1982, pp. 27- 30.
- Giroud, J.P., 1983, "Rapport général sur les bassins revêtus de geomembranes", *Comptes-rendus du colloque sur l'étanchéité superficielle des bassins, barrages et canaux*, Volume II, Paris, Fevrier 1983, pp. 75-90d. (in French)
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- Giroud, J.P., 1984, "Aging of PVC Geomembranes in Uranium Mine Tailing Ponds", *Proceedings of the International Conference of Geomembranes*, Vol. 2, Denver, CO, Jun 1984, pp. 311-316.
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