

IN RE: PROVIDENCE WATER SUPPLY BOARD
MULTI-YEAR RATE FILING – RATE YEAR 2
Docket No. 4994
Witness: Dr. Ivor Ellul

**GREENVILLE WATER DISTRICT and LINCOLN WATER COMMISSION'S
PRE-FILED DIRECT TESTIMONY
OF
DR. IVOR ELLUL**

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1 **I. Introduction**

2 **Q. Please state your full name and business address.**

3 A. Dr. Ivor Ellul, 4265 San Felipe Street, Suite 1100, Houston, Texas 77027.

4 **Q. By whom are you employed and in what capacity?**

5 A. I am employed by Cisk Ventures, Ltd., in the capacity of Managing Director.

6 **Q. What are your principal responsibilities in your positions?**

7 A. I am the owner of, and principal consultant for, the company.

8 **Q. Please describe your educational background and professional experience.**

9 A. I received a B.S. degree in Mechanical Engineering from the University of Malta
10 in 1980, and M.S. and Ph.D. degrees in Petroleum Engineering from Imperial
11 College, London in 1982 and 1989 respectively. I am a Chartered Engineer in the
12 United Kingdom and a Registered Professional Engineer in the State of Texas. A
13 copy of my curriculum vitae is attached to this testimony as Exhibit A.

14 **Q. Have you previously testified before the Rhode Island Public Utilities
15 Commission (the “PUC”), Rhode Island Division of Public Utilities and
16 Carriers (the “Division”), or any other regulatory commissions?**

17 A. No, I have not. While I have not testified before other regulatory commissions, I
18 have testified, in Aberdeen, at the Public Enquiry into the 1988 North Sea Piper
19 Alpha Disaster. I have also testified before the ICSID in Paris, in 2015, in the case
20 of The Republic of Ecuador v Burlington.

21

1 **II. Purpose of Testimony**

2 **Q. What is the purpose of your testimony?**

3 A. My testimony analyzes the hydraulic modeling performed by Pare Corporation
4 (“Pare”) and used by the Providence Water Supply Board (“Providence”) when it
5 prepared its April 21, 2021 new Cost of Service Study (the “New COSS”). My
6 testimony demonstrates the flaws in using a steady state model instead of a
7 dynamic or pseudo-dynamic model such as an Extended Period Simulation
8 (“EPS”) model. My testimony also demonstrates the limitations and potential
9 inaccuracies that arise from the back-tracing analysis Pare performed, particularly
10 in combination with the use of the steady state hydraulic modeling methodology.
11 My testimony also calls into question the validity of the inch-mile calculations.
12 Finally, my testimony addresses the concerns raised by the use of draw rate
13 instead of actual demand rate.

14 **Q. How is your testimony organized?**

15 A. Section I sets forth my credentials and experience. Section II is a summary of my
16 testimony. Section III sets forth my analysis. Section IV is the conclusion.

17
18 **III. Analysis of Hydraulic Modeling and New COSS**

19 **Q. What form of hydraulic modeling did Pare perform?**

20 A. Pare elected to perform steady state simulations of Providence’s water
21 transmission and distribution (“T&D”) network that calculate the flow of water in
22 each leg of the network. The network, as modeled, comprises 37,344 pipe

1 segments. To cover the wide range of behavior of the network, Pare adopted an
2 approach wherein they selected three steady-state demand scenarios, Average Day
3 Demand, (“ADD”), Maximum Day Demand, (“MDD”), and Peak Hour Demand,
4 (“PH”).

5 **Q. Does that form of modeling accurately capture the behavior of the T&D**
6 **network?**

7 A. Whether modeling these three steady state scenarios accurately captures the
8 behavior of the T&D network is unclear and can only be fully ascertained if the
9 changing state of the pipeline network system is taken into account during the
10 analysis. Thus the approach taken by Pare represents, at best, an approximation of
11 the manner in which the pipeline network actually behaves. Pipeline networks
12 tend to operate in a highly dynamic manner. As Pare showed during its
13 demonstration at the technical session in this docket, in a situation with multiple
14 pumps running, the demand pattern for a customer can change from 40% to 170%
15 in a time span of 6 hours. This calls into question the accuracy of the steady-state
16 approach Pare undertook.

17 **Q. Is there a better modeling approach that would have been feasible?**

18 A. Yes. The EPS modeling approach would have more accurately portrayed the
19 dynamics of the T&D system. Such a model would have analyzed all customer
20 usage over a 24-hour period accounting for high/low usage as appropriate. Pare used
21 a software tool, WaterGEMS, to model the T&D system. The developer of the tool,
22 Bentley Systems, confirms that WaterGEMS incorporates EPS modeling capabilities.

1 This functionality is in use in the US and worldwide to model pipeline network
2 systems with more than 400,000 pipes. Water utilities use the software on a daily
3 basis for operations support pulling data in from SCADA systems and running
4 regular EPS models. Although building such capability comes at a cost, that is
5 mitigated because Pare has already developed the system model and will simply
6 require the addition of time-dependent data input which may be sourced directly from
7 a SCADA system, a common approach. Taking this approach will allow for a more
8 accurate and dependable model of system usage.

9 **Q. In your opinion, is the steady-state hydraulic modeling performed by Pare**
10 **reliable?**

11 A. It is unclear whether it is reliable because of the limitations of the steady-state
12 modeling approach. Pare should have performed EPS modeling to get a more
13 complete picture of the behavior of the system.

14 **Q. Do you have any concerns with the back-tracing approach performed by**
15 **Pare?**

16 A. Yes.

17 **Q. What are those concerns?**

18 A. The approach hinges on the arbitrary assignment of the flows to the branches of
19 the splits in the T&D network based on the assumption that the network is
20 operating in steady state. As discussed, pipeline T&D systems do not generally
21 operate in steady state, which, therefore, raises a question as to the validity of the
22 approach taken by Pare.

23 **Q. What flaws does the assumption of steady state operation create?**

1 A. The split of flow at a pipeline junction depends on the pressure gradient in the lines
2 coming into the junction as well as the pressure and flow constraints into and out of
3 the junction. Assuming steady state, the flows will equilibrate. However, in a
4 dynamic frame of reference the flows to a particular customer may derive from
5 sources in a manner that does not necessarily align with the steady state flow split.
6 This phenomenon can only be investigated by means of a pseudo-dynamic analysis,
7 which an EPS model provides.

8 **Q. Do you have any concerns with Pare's inch-mile analysis?**

9 A. Yes.

10 **Q. What are those concerns?**

11 A. Although as a general matter, the inch-mile approach appears to be a reasonable
12 basis to normalize the usage of wholesale customers, it creates a bias in favor of
13 customers using larger and longer pipes. Additionally, the inch-mile value for each
14 pipe segment is pro-rated by the percentage of flow that can be attributed to each
15 wholesale customer. Because that attribution arises from the back-tracing work
16 discussed previously, and which derived from the steady-state modeling performed,
17 there is reason to believe that the inch-mile calculations do not accurately portray the
18 actual usage of the T&D infrastructure by the wholesale customers, thus giving a
19 sense of false precision to the overall analysis.

20 **Q. Do you have any concerns about the use of draw rate as opposed to demand?**

21 A. Yes.

22 **Q. What are those concerns?**

1 A. In their development of the ADD, MDD, and PH scenarios, Pare differentiated
2 between Demand Rate and Draw Rate in that Demand Rate is the actual rate at
3 which water is extracted off the pipeline distribution system. When modeling the
4 system in steady state, a constant rate must be used as input to the model. This
5 rate would, typically, represent the average of the Demand Rate over 24 hours.
6 Pare postulate that in the case where customers utilize one or multiple pumps, the
7 actual Draw Rate should be used in the steady state modeling with the rate being a
8 calculated average.
9
10 In Pare’s illustrative presentation, it is unclear as to what data were used to
11 establish a suitable Draw Rate and wherefrom they were derived. The actual,
12 somewhat arbitrary, choice of Draw Rate will have a significant impact on the
13 eventual analysis. I have approximately calculated the areas under the various
14 curves (generally representing volumes) for the illustrative case Pare presented,
15 and I have determined that, although the average demand approximates the
16 demand pattern well, both are much higher than the Draw Rate shown with the
17 two pumps running. So, choosing a higher Draw Rate than the Average Demand
18 will significantly overestimate the flows through the system.
19
20 Additionally, this approach appears to unduly penalize the higher service area
21 customers that employ pumping systems on their lines.

22

1 **IV. Conclusion**

2 **Q. Can you summarize your analysis?**

3 A. Yes. The analysis performed by Pare, including the steady-state hydraulic
4 modeling approach that they employed, gives rise to concern as to the
5 appropriateness and validity of the analysis. There is a lack of integrity in the flow
6 calculations that ultimately drive the cost allocations to the various customers. In
7 particular:

- 8 1. A pipeline network that typically behaves in a dynamic manner is
9 singularly being modeled in steady state;
10 2. The results of the steady state analysis are being used in allocating flows
11 within pipes to the various customers network wide; and
12 3. Assumptions of draw rate for customers using pumps to drive water flow
13 are unclear and may require review.

14
15 My conclusion is that it would be appropriate to model the Providence T&D
16 system using the pseudo-dynamic simulation provided by an EPS model. After
17 performing that analysis, there would be more reliable data from which to
18 perform the system-usage calculations Providence employed for the new COSS.

19 **Q. Does this conclude your testimony?**

20 A. Yes.

 OVERVIEW

Dr. Ellul maintains a unique capability to meld technical expertise with financial acumen within a context of international experience and appreciation of cultures. Of European origin, he has been instrumental in building and growing successful enterprises across the major continents of the world. With recognized proficiency in numerical modeling, he has held various leadership positions in energy and has founded, and successfully exited, a number of companies in the technology and oil and gas space among them Knowledge Reservoir which became the pre-eminent international oil and gas consulting enterprise over a span of 15 years. He successfully exited the company in 2013 by merger with RPS, a UK publicly listed company. More recently, Dr. Ellul has been involved in a number of international tribunal and court cases in the capacity of expert witness and technical advisor to the legal team.

 EXPERIENCE

<p>ORO Acquisitions I, LLC <i>Partner</i></p> <ul style="list-style-type: none"> • Texas oil and gas producer 	2021 - Present
<p>Prudent Resources, LLC <i>Advisor</i></p> <ul style="list-style-type: none"> • Texas oil and gas producer 	2021 - Present
<p>West Titan Energy <i>Member of Board of Directors</i></p> <ul style="list-style-type: none"> • Upstream company established in Mauritius with planned producing assets in Nigeria 	2019 - Present
<p>Mistral Energy, LLC <i>Partner</i></p> <ul style="list-style-type: none"> • Upstream company developing assets onshore Ecuador 	2016 - Present
<p>Promethean Energy Corporation <i>Executive Advisor and CTO</i></p> <ul style="list-style-type: none"> • Upstream development and production company focused on the deepwater Gulf of Mexico 	2017 - 2019
<p>CiSK Ventures, Ltd. <i>Managing Director</i></p> <ul style="list-style-type: none"> • Providing advisory services to the upstream, midstream, and downstream segments of the energy industry including technical support in the areas of field development, production optimization, carbon minimization, and commercial review of assets for the purpose of acquisition and divestiture. Served as Expert Witness on a number of cases involving asset expropriation, pipeline rupture and spillage, wellbore leakage and toxic gas release, and non-compliance with contractual delivery commitments. • Involved in multiple Asset Integrity Assessment (AIA) studies over the course of three years involving onshore and offshore assets in the US, Denmark, Equatorial Guinea, and Malaysia. Work culminated in the hosting of a multidisciplinary workshop to assess and establish next generation EHS Risk Management guidelines 	2003 - Present
<p>RPS Knowledge Reservoir <i>Chief Executive Officer</i></p> <ul style="list-style-type: none"> • Responsible for overall management of and business development for the group delivering expertise in the areas of oil and gas exploration and production, reserves certification, knowledge-management, and flow assurance. 	2013 - 2015
<p>Knowledge Reservoir <i>Founder and Chief Executive Officer</i></p> <ul style="list-style-type: none"> • Knowledge Reservoir was founded in Houston, Texas in March of 1999 with the aim of filling a void in deep-water consulting expertise. That accomplished, the company evolved into all aspects of advisory for onshore and offshore exploration and production both conventional and unconventional. Furthermore, Knowledge Reservoir established an impressive database of geoscience and engineering resources that were called on to staff projects worldwide. At its peak, the company employed close to 200 staff with revenues approaching USD 40 million. • Knowledge Reservoir established subsidiaries in the UK (Aberdeen and London), Oman (Muscat), and Malaysia (Kuala Lumpur) securing major contracts in all regions and establishing a global footprint and excellent reputation for the company. In addition to multiple engagements in the US (onshore and offshore), the company executed projects in Argentina, Bolivia, Ecuador, Peru, Mexico, Venezuela, Chile, Nigeria, Angola, Libya, Oman, Saudi Arabia, Yemen, Malaysia, Indonesia, Papua New Guinea, Japan, and China. • The company merged with RPS Group, a London Stock Exchange listed international consulting group. 	1999 - 2013

Smedvig Technologies, Inc. (now Roxar)

1997 - 1998

President

- Responsible for all aspects of management and operation of the Americas Division, serving North and Latin America. Smedvig commanded a majority share in the geological modeling market with its RMS product prior to the eventual development of Petrel (by the developers of RMS). Under Dr. Ellul the company grew, in one year, from 8 to 38 staff expanding into consulting services and securing major contracts in Venezuela, Mexico, Bolivia, and Chile. Annual revenue of USD 8 million was registered of which 40% derived from software sales.

Schlumberger GeoQuest (Intera Information Technologies)

1995 - 1996

Vice President, Sales and Marketing

- Managed worldwide Reservoir Technologies Sales and Marketing department in coordination with GeoQuest regional management. Dr. Ellul's brief was to ensure the effective integration of Intera's software and consulting sales into Schlumberger's worldwide operations. ECLIPSE has delivered, by far, the highest ROI for Schlumberger among all of the acquisitions that it has conducted.
- Managed worldwide Sales and Marketing department for Intera, the developer of the ECLIPSE product, which to this day, is the worldwide market leader in reservoir simulation software. Dr. Ellul was hired to establish a global sales and marketing division to efficiently and effectively grow revenue. This was successfully accomplished, leading to the acquisition of the company by Schlumberger GeoQuest in late 1995. At the time of the sale, annual revenues stood at USD 32 million split evenly between consulting and software.

Scientific Software – Intercomp, Inc.

1988 - 1994

Division Vice President (Houston)

- Managed the Pipeline and Facilities Division with worldwide responsibility for all aspects of product development, support and marketing, project execution, and consulting.

Senior Consultant, Manager (London)

- Managed various projects including pipeline leak detection analysis, multiphase flow studies, and new product development. Developed single and multiphase pipeline network analysis software.

Imperial College, London

1984 - 1987

Research Fellow, Mineral Resources Engineering Department

- Developed multiphase fluid flow computer code to solve three-dimensional two-phase turbulent recirculating flows in complex geometries.

Petrochem Engineering & Construction Co. Ltd., Malta

1983 - 1984

Technical Manager

- Responsible for design and engineering, manufacturing, construction, and commissioning of petroleum pipeline and tankfarm installations.

MPM Plate & Welding Co. Ltd., Malta

1982 - 1983

Project Engineer

- Responsible for new project investigation, feasibility analysis and tendering, contract coordination, design and monitoring of manufacture and erection of petroleum storage facilities.

Jan-Peter Meyer KG, West Germany

1980 - 1981

Design Engineer

- Designed oil storage tanks, low-temperature storage tanks, pressure vessels, chemical plants, and refinery systems.

EDUCATION

Imperial College, London

1989

Ph.D. in Petroleum Engineering

Imperial College, London

1982

M.Sc. in Petroleum Engineering

University of Malta

1980

B.Sc. (Hons.) in Mechanical Engineering

PROFESSIONAL QUALIFICATIONS

Professional Engineer (State of Texas)

2002 - Present

Chartered Engineer (United Kingdom)

1992 - Present

Member of the Institute of Energy (United Kingdom)

1992 - Present

Member of the Society of Petroleum Engineers

1980 - Present

ADVISORY / EXTRACURRICULAR POSITIONS

Imperial College, London – Visiting Professor & Lecturer to MSc Program	2000 - 2017
University of Houston – Petroleum Engineering Advisory Board	2005 - 2007
Energy Ventures Advisory Board, Stavanger Norway	2005 - 2011
Pipeline Simulation Interest Group (Chairman of Board of Directors)	2000 – Present
Society of Petroleum Engineers – Member of SPE.org Board	2005 - 2007
Society of Petroleum Engineers – GCS Web Committee Chair	2004 - 2006
Society of Petroleum Engineers – GCS Vice Chair / Chair / Past Chair	2014 - 2017
Society of Petroleum Engineers – Regional Director	2019
SPE Journal of Petroleum Technology – Knowledge Management Editor	2006 - 2009
Member of Board of Trustees – Duchesne Academy of the Sacred Heart	2009 - 2015

LANGUAGES

English, Italian, French, Maltese, German, Spanish

EXPERT WITNESS ENGAGEMENTS

North East USA Gas Transmission Grid	2019	Gas supply outage cause and analysis
Union Fenosa Gas v Egyptian Natural Gas Holding Company	2017	Expert witness technical support related to deepwater gas field productivity offshore Egypt
State of California	2016-2021	Estimation of gas escape from ruptured well in gas storage field. Analysis of possible environmental damage cause and effect resulting of seismic activity
State of California	2015-2018	Estimation of oil spillage volumes from damaged pipeline with eventual passage to the ocean
Republic of Ecuador v Perenco	2014-2016	Estimation of damages and expert witness support at Paris Arbitration Tribunal
Republic of Ecuador v Burlington	2014-2016	Estimation of damages and expert witness support at Paris Arbitration Tribunal including provision of expert witness testimony
Piper Alpha disaster victims v Elf Aquitaine	1991	Expert technical support
Piper Alpha North Sea Disaster	1988-1989	Engaged by DOE to ascertain cause of disaster. Testimony at Lord Cullen Enquiry in Aberdeen in 1989

PUBLICATIONS

1. Ellul, I.R., Issa, R.I., Looney, M.K., *"Numerical Computation of Multi-Dimensional Multi-Phase Flow"*, Fourth Int. Conf. on Numerical Methods in Laminar and Turbulent Flow, Swansea July 1985.
2. Ellul, I.R., Issa, R.I., *"Prediction of the Flow of Interspersed Gas and Liquid Phases through Pipe Bends"*, Chem. Eng. Res. Des, Vol 65, January 1987.
3. Ellul, I.R., Issa, R.I., *"The Prediction of Interspersed Two-Phase Flow through Pipes with Obstructions"*, 3rd Int. Conf. on Multi-Phase Flow, the Hague, Netherlands, May 1987.
4. Ellul, I.R., Issa, R.I., *"The Modelling of Gas-Liquid Bubbly Flow in Vertical Flow Lines with and without Constrictions"*, Proc. 4th Int. Conf. on Multi-Phase Flow, Nice, France, June 1989.
5. Ellul, I.R., *"The Prediction of Dispersed Gas-Liquid Flow in Complex Pipe Geometries"*, Ph.D. Thesis, University of London, 1989.
6. Ellul, I.R., *"Selection Criteria in the Sizing of Gas-Oil Separators"*, M.Sc Dissertation, University of London, 1982.
7. Ellul, I.R., *"The Sizing of Gas-Oil Separators – and Integrated Approach"*, Offshore Europe Conf. Aberdeen, September 1985.
8. Ellul, I.R., *"The Utilization of Pipe Curvature to obtain Gas-Oil Separation"*, European Petroleum Conference, London, October 1986.
9. Ellul, I.R., *"Computer-Aided Pipeline Facilities and Control Systems"*, in *Underground Storage of Natural Gas*, (Ed. M.R. Tek), 1989.
10. Ellul, I.R., *"Pipeline Leak Detection"*, The Chemical Engineer, June 1989.
11. Ellul, I.R., *"Advances in Pipeline Leak Detection Techniques"*, Pipes and Pipelines International, May-June 1989.
12. Ellul, I.R., Jacobsen, K.A., Pauchon, D., Mackay, D.C., Sugarman, P., *"A Study of Transient Multiphase Effects in the Operation of Rich Gas Pipelines"*, ASME Petroleum Division Conference, January 1990.
13. Ellul, I.R., *"Online Leak Detection on Gas Transmission Systems"*, Symposium on the Use of Computers for Gas Transmission and Distribution Systems, Budapest, October 1990.

14. Ellul, I.R., *"Advances in Pipeline Leak Detection Techniques"*, ASME Petroleum Division Conference, January 1991.
15. Rygg, O.B., Ellul, I.R., *"The Dynamic Two-Phase Modelling of Offshore Live Crude Lines under Rupture Conditions"*, 23rd Annual Offshore Technology Conference, Houston, May 1991.
16. Ellul, I.R., King, P.E., Findlay, W.A., Delacroix, M.P., *"The Use of Dynamic Simulation in Offshore Multiphase Pipeline Design"*, 5th International Conference on Multiphase Production, Cannes, June 1991.
17. Finch, L., Ellul, I.R., Gochnour, R., *"Implementation of Mechanistic Flow Models in a Practical Multiphase Flow Simulator"*, PSIG 1991 Annual Meeting, Minneapolis, October 1991.
18. Iwere, F., Ellul, I.R., *"The Adoption of Gas Storage As a Means of Operation within a Rule 636 Environment"*, PSIG 1995 Annual Meeting, Albuquerque, New Mexico, October 1995.
19. Thomassen, P.R., Ellul, I.R., *"Technology Tips The Scales For Improved Recovery Rates"*, The American Oil & Gas Reporter, September 1997.
20. Ellul, I.R., *"Mejores tasas de recuperacion"*, Petroleo International, September-October 1998.
21. Ellul, I.R., Yarus, J.M., Zamora, D.H., *"Pemex uses Step-by-Step Approach"*, Knowledge Management in the E & P Marketplace, October 2000.
22. Schmadeka, W., Ellul, I.R., *"Enlivening Hardcopy Documents for Web Delivery"*, STC Region 5 Conference, Albuquerque, New Mexico, October 2000.
23. Ellul, I.R., Brooker, P.B., *"The Prediction of Liquid Dropout and Associated Slugging in Offshore Pipeline Gathering Systems"*, PSIG 2002 Annual Meeting, Portland, Oregon, October 2002.
24. Ellul, I.R., *"An Enterprise-Wide System to Share Knowledge and Accelerate Development for Deepwater and Non-Conventional Wells"*, Knowledge Management in Oil & Gas, Houston, January 2003.
25. Ellul, I.R., Smith, C.M.S, Bradberry, C., *"Hydrodynamic Flow Assurance and How it Affects Facilities Design: Achieving Optimum Operability"*, Flow Assurance – A Holistic Approach, Houston, May 2003.
26. Ellul, I.R., Smith, C.M.S, *"Offshore Facilities Design Under Upset Operating Conditions"*, Flow Assurance Conference, Kuala Lumpur, September 2003.
27. Ellul, I.R., Saether, G., Shippen, M.E., *"The Modeling of Multiphase Systems under Steady-State and Transient Conditions - A Tutorial"*, PSIG 2004 Annual Meeting, Palm Springs, California, October 2004.
28. Ellul, I.R., *"The Role of a Consultant – What is it Really?"*, SPE Journal of Petroleum Technology, July 2006.
29. Ellul, I.R., *"Knowledge Management Editorial"*, SPE Journal of Petroleum Technology, October 2006.
30. Ellul, I.R., Hughes, Y. Asante, B., *"Natural Gas Training 101 – Training in Paradise"*, PSIG 2007 Annual Meeting, Calgary, Alberta, October 2007.
31. Ellul, I.R., *"Knowledge Management Editorial"*, SPE Journal of Petroleum Technology, December 2007.
32. Ellul, I.R., *"Knowledge Management Editorial"*, SPE Journal of Petroleum Technology, October 2008
33. Ellul, I.R., *"Knowledge Management Editorial"*, SPE Journal of Petroleum Technology, October 2009.
34. Ellul, I.R., *"Dynamic Multiphase Simulation – The State of Play"*, PSIG 2010 Annual Meeting, Bonita Springs, Florida, May, 2010
35. Ellul, I.R., *"Knowledge Management Editorial"*, SPE Journal of Petroleum Technology, October 2010.
36. Ellul, I.R., Asi, S.R., *"Can Dynamic Complex Multiphase Phenomena Be Modeled?"*, PSIG 2011 Annual Meeting, Napa Valley, California, May, 2011.
37. Ellul, I.R., *"Knowledge Management Editorial"*, SPE Journal of Petroleum Technology, October 2011
38. B.Calgaro, P.Andreussi, M. Bonizzi, V. Faluomi, M.Margarone, I. Ellul, *"Simulation of Stratified Gas-liquid Flow in Near-horizontal Pipes"*, PSIG 2012 Annual Meeting, Albuquerque, New Mexico, May, 2012.
39. Ellul, I.R., *"Aftermath of the Piper Alpha Disaster – Forensic Analysis"*, HSE Safety Workshop, Lagos, Nigeria, September, 2013.
40. Ellul, I.R., Matlock, M., Archer, T.C., *"Challenges in Operating Onshore Multiphase Systems"*, PSIG 2014 Annual Meeting, Baltimore, Maryland, May, 2014.
41. Ellul, I.R., *"The Piper Alpha Disaster - A Forensic Pipeline Simulation Study"*, PSIG 2014 Annual Meeting, Baltimore, Maryland, May, 2014.
42. Mack Shippen, Ivor R. Ellul, William Bailey, *"Flow Assurance – At What Cost?"*, PSIG 2016 Annual Meeting, Vancouver, May 2016.
43. Ellul, I.R., Zaldivar, M., McLawhon, K., *"Mitigation of Slugging Phenomena in Offshore Oil Export Lines"*, PSIG 2018 Annual Meeting, Deer Valley, Utah, May 2018.

PROJECTS			
YEAR	CLIENT	TYPE OF STUDY	POSITION
1981	Oil Tanking – Amsterdam	Design and construction of fixed and floating roof storage tanks	Design Engineer
1982	Oasis Oil Company – Libya	Design of storage tanks	Project Manager
1988	Department of Energy – UK	Analysis of Piper Alpha pipeline system	Project Manager, Expert Witness
1988	Dow Chemical – Holland	Pipeline leak detection study	Project Manager
1989	BP	Hides gas condensate pipeline analysis	Project Manager
1990	Unocal – UK	Pipeline riser rupture analysis	Project Manager
1990	BP/Britoil – UK	Pipeline riser rupture analysis	Project Manager
1990	Shell Expro – UK	Brent pipeline system safety analysis	Project Manager
1991	Shell BP Todd – New Zealand	Pipeline hydrate dynamic analysis	Project Manager
1992	PTT – Thailand	Transient pipeline system analysis	Project Manager
1993	Aramco – Saudi Arabia	Zuluf pipeline system analysis	Project Manager
1993	Arco – Indonesia	Multiphase pipeline system analysis	Project Manager
2001	Murphy E and P	Liquid dropout analysis	Project Manager
2001	El Paso Corporation	Dynamic liquid dropout analysis	Project Manager
2002	El Paso Corporation	Dynamic liquid dropout analysis - network	Project Manager
2003	Murphy E and P	Subsea tie-back engineering and analysis	Project Manager
2003	DeepStar	Deepwater GOM Knowledge Base development	Project Manager
2004	Government of Papua New Guinea	Training in gas processing, transportation, and regulation	Project Manager
2005	Murphy E and P	Subsea tie-back engineering and analysis	Project Manager
2005	Husky Energy	Blowdown Analyses	Project Manager
2005	PetroQuest	Subsea tie-back engineering and analysis	Project Manager
2005	Enterprise Products	Single and multicomponent multiphase line analyses	Project Manager
2006	EDG Consulting Engineers	Chevron Cabinda flow assurance	Project Manager
2006	EDG Consulting Engineers	CNR Olowi flow assurance	Project Manager
2006	EDG Consulting Engineers	VietSovPetro Hoan Vu flow assurance	Project Manager
2006	Saudi Aramco	Seawater Injection System analysis	Project Manager
2007	EDG Consulting Engineers	VietSovPetro Hoan Vu subsurface review	Project Manager
2008	Noble Energy	Various international Flow Assurance projects	Consultant
2009 - 2013	InterOil	Elk – Antelope field development	Consultant
2010	EDG Consulting Engineers	Southern Malongo Area Development Project	Project Manager
2011 - 2013	InterOil	Triceratops field development	Project Manager
2012	Yemen – Petroleum Exploration & Production Authority	Countrywide Reserves Certification	Project Director
2012	EDG Consulting Engineers	Marcellus Shale Gas Pipeline Flow Assurance	Project Manager
2012	EDG Consulting Engineers	Takula Water Injection Expansion	Project Manager
2012	XTO Energy	XTO Berwyn - ETC Gas Pipeline Flow Assurance Study	Project Manager

Year	Client	Type of Study	Position
2012	EDG Consulting Engineers	Red River Flow Assurance	Project Manager
2012	EDG Consulting Engineers	Chevron NEMBA Stage II MeOH	Project Manager
2012	EDG Consulting Engineers	Marathon Alba Flow Assurance	Project Manager
2013	Devon Energy	Cana Pipeline System Flow Assurance	Project Manager
2013	Audubon Engineering	CrossTex Bearkat Flow Assurance	Project Manager
2013	EDG Consulting Engineers	Vaalco Etame Flow Assurance	Project Manager
2014	Dechert (Paris) LLP	International Tribunal – Ecuador vs Burlington	Expert Witness
2014	Devon	Dewitt Pipeline System Flow Assurance	Project Manager
2014	EDG Consulting Engineers	Maersk Chissonga Flow Assurance	Project Manager
2014	Secretariat for Hydrocarbons Ecuador	Ultra Heavy Oil Block 20 Review	Project Director
2014	Total Paris	Unconventional Resource US Basin Review	Project Director
2015 – 2016	EDG Consulting Engineers	Hess Okume – Ceiba Pipeline Flow Assurance	Project Manager
2015	Dechert (Paris) LLP	International Tribunal – Ecuador vs Perenco	Expert Witness
2015	EDG Consulting Engineers	PetroVietnam – PQPOC Pipeline Analysis	Project Manager
2015	Epsilon Energy	Gas Gathering Pipeline System Analysis	Project Manager
2015	Oando Energy Resources	Nigeria asset production optimization	Project Manager
2015	Oando Energy Resources	OML 138 Block M&A Review	Project Manager
2016	Plains All American Pipeline	California Pipeline Oil Spill Analysis	Project Manager
2016	Hides Gas Development	Papua New Guinea Exploration Work Program	Project Director
2016	Olympic Peru	Waterflooding Review	Project Manager
2016	Tecnie / Altamesa Ecuador	A&D review of Cuyabeno Sansahuari asset (20,000 BOPD)	Project Director
2016	Hess	Asset Integrity Assessment of all Hess assets worldwide	Consultant
2016	Morgan Lewis (SoCalGas)	Study of Aliso Canyon well leak	Expert Witness
2016	Mistral Energy	A&D review of multiple field clusters – Brazil (15,000 BOPD)	Project Director
2016	Mistral Energy	A&D review of GoM shelf asset (1,000 BOPD)	Project Director
2016	RPS	Technical review of Zohr field offshore Egypt development program	Project Director
2017	RPS	Review of FDP aspects of Leviathan project offshore Israel	Technical Expert
2017	Shearman & Sterling	International Tribunal – UFG vs EGas	Expert Witness
2017	Mistral Energy	A&D review of US Permian assets, Alabama asset, Brazil assets	Project Director
2018	RPS	Technical training in Pipeline & Process Engineering	Course Instructor
2018	Cisk Ventures	A&D analysis – US deepwater GoM	Project Director
2018	Mistral Energy	Completion of WI acquisition in Cuyabeno field in Ecuador	Technical Director
2019	Hess	Risk assessment workshop	Consultant
2019	Mistral Energy	Distressed asset assessment - Ecuador	Technical Director
2019	West Titan Energy	FLNG development offshore Nigeria	Technical Director
2019	NE USA Gas Transmission	Gas supply outage cause and analysis	Expert Witness