

REFERENCES

1. Tamutus, T. and Ternowcheck .S.J., 2010, "Valve Leak Quantification with Acoustic Emission", **The NDT Technician**, Vol. 9, No. 2, pp. 1-9.
2. Fluid Sealing Association, 2008, **Are You Playing Offense or Defense with Your Leak Detection and Repair** [Online], Available : <http://www.pumpzone.com/.../are-you-playing-offense-or-defense-with-your-leak-detection-and-repair.html> [2010 , December 1].
3. Meland, E., Henriksen, V., Hennie, E., and Rasmussen, M., 2011, "Spectral Analysis of Internally Leaking Shut-Down Valves", **Measurement**, Vol. 44, No. 6, pp. 1059-1072.
4. Tamutus, T. and Cole, P., 2001, "Are Your Valves Burning Million in Profits", **World Refining**, May 2001, pp. 42-44.
5. Schreurs, J. and Bednar, F., 1990, "On-Line Valve Monitoring and Diagnosis", **IEEE Transactions on Computer Applications in Power**, Vol. 3, No. 1, pp. 25-29.
6. Ternowchek, S.J. and Deonarine. S., 2009, "Repair and Online Mechanical Integrity Monitoring", **Process Safety Progress**, Vol. 29, No. 1, pp. 51-54.
7. Elsevier Science Ld., 2000, "Specialist Solutions in Online & Offshore Pipe and Valve Repair", **World Pump**, October, 2000, pp 40-43.
8. **Directed Inspection and Maintenance at Compressor Stations** [Online], Available : http://www.epa.gov/gasstar/documents/l_dimcompstat [2010, December 5].
9. Sharif, M.A., Grosvenor, R.I., 1998, "Fault Diagnosis in Industrial Control Valves and Actuators", **IEEE International Conference on Instrumentation and**

Measurement Technology, May 18-21, Minnesota, United States of America, Vol. 2, No. 18-21. pp. 770-778.

10. Sharif, M.A., Grosvenor, R.I., 1998, "Sensor-Based Performance Monitoring of Control Valve Unit", **Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering**, Vol. 213, No. 2, pp 71-84.
11. Dicquemare, P., 1996, "New Test Equipment to Implement Valve Predictive Maintenance", **IEE International Conference on Sizewell B - the First Cycle**, October 28-30, London, United Kingdom, pp.56-62.
12. Sharif, M.A., Grosvenor R.I., 1998, "Process Plant Condition Monitoring and Fault Diagnosis", **Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering**, Vol. 212, No. 1, pp. 13-30.
13. Thompson, G. and Wijesundera, L.S., 1982, "Leak Rate Measurement and Leak Detection through Standard Design Process Valves by Vibration Monitoring", **The 2nd International Conference on Cairo MDP**, Cairo University, Egypt, pp. 289-296.
14. Thompson, G., 1988, "Detection of Leaks through Valves by Vibration Monitoring", **International Conference on Condition Monitoring and Diagnostic Engineering Management**, Birmingham, United Kingdom, pp. 312-317.
15. Germain, J.L., Granal, L., Provost, D. and Touillez, M., 1996, "Inspection Systems for Valves Monitoring at EDF", **International Conference on Condition Monitoring and Diagnostic Engineering Management**, Sheffield, United Kingdom, pp. 411-420.
16. Thompson, G. and Zolkiewski, G., 1997, "An Experimental Investigation into the Detection of Internal Leakage of Gases through Valves by Vibration Analysis",

Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering, Vol. 211, No.3, pp. 195-207.

17. **Acoustic Emission System for Cylinder Valve Monitoring** [Online], Available : http://site.genenergy.com/businesses/ge_oilandgas/en/literature/en/downloads/aes_cylinder_valve_monitoring.pdf [2011, January 7].
18. **Directed Inspection and Maintenance at Gas Processing Plants and Booster Stations** [Online], Available : http://www.epa.gov/gasstar/documents/ll_dimgas_proc.pdf [2011, January 7]
19. **Directed Inspection and Maintenance at Gate Stations and Surface Facilities** [Online], Available : http://www.epa.gov/gasstar/documents/ll_dimgatestat.pdf [2011, January 7].
20. Benz, A.E.G., 1998, "Use of Acoustic Emission Techniques for Detection of Discontinuities", **Material Evaluation**, Vol. 56, No. 10, pp. 1215-1222.
21. Hartman, W.F. and McElroy, J.W., 1977, "Acoustic Emission Surveillance for Improving Availability of Nuclear Power Plants", **Progress in Nuclear Energy**, Vol. 1, No. 2-4, pp. 673-680.
22. Vahaviolos, S.J., Kattis, S.E., Carlos, M.F., Kourousis, D.A., Anastasopoulos, A.A. and Dong, J.W., 2008, "Loose Parts and Valve Flow Monitoring in Nuclear Power Plants using Integrated Digital Systems", **The 17th World Conference on Nondestructive Testing**, October 25-28, Shanghai, Vol. 1, China, pp. 16-26.
23. Seong, S.H., Hur, S., Kim, J.S., Kim, J.T., Park, W.M., Lee, U.C. and Lee, S.K., 2005, "Development of Diagnosis Algorithm for the Check Valve with Spectral Estimations and Neural Network Models using Acoustic Signals", **Annals of Nuclear Energy**, Vol. 32, No. 5, pp. 479-492.

24. Tsunoda, T., Sano, K. and Nanba, H., 1985, "The Development of a BWR Main Steam Safety/Relief Valve Monitoring System", **Progress in Nuclear Energy**, Vol. 15, pp. 191-198.
25. Sharif, M.A. and Grosvenor, R.I., 1998, "Internal Valve Leakage Detection using an Acoustic Emission Measurement System", **Transactions of the Institute of Measurement and Control**, Vol. 20, No.5, pp. 233-242.
26. Pollock, A.A. and Hsu, S.Y.S., 1982, "Leak Detection using Acoustic Emission", **Journal of Acoustic Emission**, Vol. 1, No. 4, pp. 237-243.
27. Haynes, H.D., 1992, "Evaluation of Check Valve Monitoring Methods", **Nuclear Engineering and Design**, Vol. 134, pp. 283-294.
28. Lee, J.H., Lee, M.R., Kim, J.T., Kim J.S. and Luk, V.K., 2003, "Condition Monitoring of a Check Valve for Nuclear Power Plants by Means of Acoustic Emission Technique" **The 17th International Conference on Structural Mechanics in Reactor Technology**, August 17-22, Prague, Czech Republic, pp.1-8.
29. Lee, J.H., Lee, M.R., Kim, J.T. and Kim, J.S., 2004, "Analysis of Acoustic Emission Signals for Condition Monitoring of Check Valve at Nuclear Power Plants", **Key Engineering Material**, Vol. 270-273, pp. 531-536.
30. Lee, M.R., Lee, J.H. and Kim, J.T., 2005, "Condition Monitoring of a Nuclear Power Plant Check Valve Based On Acoustic Emission and a Neural Network", **Journal of Pressure Vessel Technology**, Vol. 127, No. 3, pp. 230-236.
31. Lee, J.H., Lee, M.R., Kim, J.T., Luk, V. and Jung, Y.H., 2006, "A Study of the Characteristics of the Acoustic Emission Signals for Condition Monitoring of Check Valves in Nuclear Power Plants", **Nuclear Engineering and Design**, Vol. 236, No. 13, pp. 1411-1421.

32. Nakamura, T. and Terada, M., 1985, "Development of Leak Monitoring System for Pressurizer Valves", **Progress in Nuclear Energy**, Vol. 15, pp. 175-179.
33. Kaewwaewnoi, W., Prateepasen, A. and Kaewtrakulpong, P., 2005, "Measurement of Valve Leakage Rate using Acoustic Emission" **International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology**, May 12-13, Pattaya, Thailand, pp. 412-416.
34. Xu, G., Chen, Y. and Cao, Z., 2008, "Acoustic Emission Testing of The Shell of Electromagnetic Valve" **The 17th World Conference on Nondestructive Testing**, October 25-28, Shanghai, China, Vol. 4, pp. 2619-2628.
35. Dickey, J., Dimmick, J. and Moore, P.M., 1978, "Acoustic Measurement of Valve Leakage Rates", **Material Evaluation**, Vol. 36, pp. 67-77.
36. Lee, S.G., Park, J.H., Yoo, K.B., Lee, S.K. and Hong, S.Y., 2006, "Evaluation of Internal Leak in Valve using Acoustic Emission Method", **Key Engineering Materials**, Vol. 1, No. 326-328, pp. 661-664.
37. Opal, G.R. and Ciaramitaro, W., 1977, "Experiences with Diagnostic Instrumentation in Nuclear Power Plants", **Progress in Nuclear Energy**, Vol. 1, No. 2-4, pp. 759-779.
38. Chern, M.J., Wang, C.C. and Ma, C.H., 2007, "Performance Test and Flow Visualization of Ball Valve", **Experimental Thermal and Fluid Science**, Vol. 31, No. 6, pp. 505-512.
39. Shack, W.J., Ellingson, W.A. and Youngdahl, C.A., 1980, "Development of a Noninvasive Acoustic Leak Detection System for Large High Pressure Gas Valves", **ISA Transactions**, Vol. 19, No. 4, pp. 65-71.

40. PAC, VPAC/5131 - Loss Control for Valves in Process Plants [Online], Available : <http://www.pacndt.com/index.aspx?go=technologies&focus=/Technology%20Pkgs/vpac.htm> [2009, March 28].
41. Physical Acoustic Ltd., 2002, Valve Leakage Technology Package, **Manuals/5131-VPAC**, Vol. 1-3.
42. Chen, P., Chua, P.S.K. and Lim, G.H., 2005, "An Experimental Study of Monitoring Internal Leakage in Water Hydraulic Cylinders using Acoustic Emission", **Journal of Testing and Evaluation**, Vol. 33, No. 6, pp. 445-451.
43. Singleton, E.W., 2004, "An Investigation into Control Valve-Generated Turbulence and Noise with Reference to the Performance of Downstream Instrumentation", **Measurement and Control**, Vol. 37, No. 6, pp. 182-191.
44. Gerhard, R., 1978, "Turbulence-Generated Noise in Pipe Flow", **Annual Review of Fluid Mechanics**, Vol. 10, pp. 333-367.
45. Baumann, H.D. and Hoffmann, H., 1999, "Method for the Estimation of Frequency-Dependent Sound Pressures at the Pipe Exterior of Throttling Valves", **Journal of Noise Control Engineering**, Vol. 47, No. 2, pp. 49-55.
46. Baumann, H.D., 1991, "Determination Of Peak Internal Sound Frequency Generated by Throttling Valves for the Calculation of Pipe Transmission Losses", **Journal of Noise Control Engineering**, Vol. 36, No. 2, pp. 75-83.
47. Badinier, C. and Dimmick, J.G., 1983, "Nuclear Valve Leak Detection by Passive Acoustic Spectrum Analysis", **The 6th International Conference on Nondestructive Evaluation in the Nuclear Industry and Equipment/Services Explosion**, November 28-December 2, Zurich, Switzerland, pp. 367-372.

48. Dimmick, J.G., Nicholas, J.R., Dickey, J.W., Moore P.M., 1979, "Acoustical Valve Leak Detector for Fluid System Maintenance", **Naval Engineers Journal**, Vol. 91, No. 2, pp. 71-83.
49. **Loss Control for Refineries Chemical Plant and Offshore Platforms** [Online], Available : <http://www.pacndt.com/downloads/pac102801.pdf> [2011, February 18].
50. Skousen, P. L., 2004, **Valve Handbook**, 2nd ed., McGraw-Hill Professional Publishing, New York, United States of America, pp. 85-91.
51. **Isolation Valves - Rotary Movement** [Online], Available <http://www.spiraxsarco.com/resources/steam-engineering-tutorials/pipeline-ancillaries/isolation-valves-rotary-movement.asp> [2011, February 18].
52. Morse, P.M. and Ingard, K.U., 1968, **Theoretical Acoustics**, McGraw Hill, New York, United States of America, p. 306.
53. White, R.G. and Walker, J.G., 1982, **Noise and Vibration**, Ellis Horwood Ltd., New York, United States of America, pp. 440-441.
54. Norton, M.P. and Karczubm, D.G., 2003, **Fundamentals of Noise and Vibration Analysis for Engineers**, 2nd ed., Cambridge University Press, Cambridge, United Kingdom, pp. 146-167, 347-364.
55. Russell, D., **Sound Fields Radiated by Simple Sources** [Online], Available : http://www.kemt.fei.tuke.sk/Predmety/KEMT320_EA/_web/Sound%20Fields%20Radiated%20by%20Simple%20Sources.htm [2011, February 27].
56. Crocker, M.J., 2007, **Handbook of Noise and Vibration Control**, John Wiley & Sons, Inc., New York, United States of America, pp. 22-28.

57. Gruenig, C., 1994, "Detection of Quantification of through Valve Liquid Leakage using Acoustic Emission Techniques", **British Petroleum Report No. EFR.94 ER022**, pp 1-24.
58. Bies, D.A. and Hansen C.H., 1996, **Engineering Noise Control : Theory and Practice**, 2nd ed., E & FN Spon Press, London, United Kingdom, pp. 449-457.
59. Faulkner, L.L., 1976, **Handbook of Industrial Noise Control**, Industrial Press Inc., New York, United States of America, pp. 473-505.
60. Kam, W.N, 1994, "Control Valve Noise", **ISA Transactions**, Vol. 33, No. 3, pp. 275-286.
61. Nakano, M., Outa, E. and Tajima, K., 1984, "Noise and Vibration Induced by Oscillating Supersonic Flow in a Pressure Reducing Gas Valve", **Symposium on Flow-Induct Vibrations the ASME Winter Annual Meeting**, December 9-14, New Orleans, Louisiana, United States of America, pp. 87-103.
62. Bell, L.H. and Bell, H.D., 1994, **Industrial Noise Control Fundamentals and Applications**, Marcel Dekker, New York, United States of America, pp. 419-431.
63. Püttmer, A. and Rajaraman, V., 2007, "Acoustic Emission based Online Valve Leak Detection and Testing", **IEEE Symposium on Ultrasonics**, pp. 1854-1857.
64. Pollock, A.A. and Pepper, C.E., 1998, "Quantitative Analysis of Acoustic Emission from Gas Leaks, in a Model Piping System", **The 25th International Conference on Review of Progress in Quantitative Nondestructive Evaluation**, July 19-24, Snowbird, Utah, 8p.
65. Miller, R. and McIntire, P., 1987, **Nondestructive Testing Handbook Volume 5 : Acoustic Emission Testing**, 2nd ed., American Society for Nondestructive Testing, Columbus, Ohio, United States of America, p. 12.

66. Arrington, M., 1987, "Chapter 2: Acoustic emission" In **Non-Destructive Testing of Fibre-Reinforced Plastics Composites Volume 1**, Summerscales, J. (Ed.), Elsevier, Essex, United Kingdom, pp. 25-63.
67. Scruby, C.B., 1987, "An Introduction to Acoustic Emission", **Journal of Physics E: Scientific Instruments**, Vol. 20, No. 8, pp. 946-953.
68. Physical Acoustic Ltd., 1990, **LOCAN 320 User Manual**.
69. The American Society for Testing and Materials, 1993, **Annual Book of ASTM Standards; Volume 03.03, Standard E750-88 Standard Practice for Characterizing Acoustic emission Instrument**, Philadelphia, PA, United States of America, pp. 339-347.
70. Charles, J. and Hellier, M., 2001, **Handbook of Nondestructive Evaluation**, McGraw-Hill, New York, pp. 10.1-10.39.
71. Vallen, H., **AE Testing Fundamentals, Equipment, Applications** [Online], Available : <http://www.ndt.net/article/v07n09/05/05.htm> [2010, December 1].
72. Shin, K. and Hammond, J.K., 2008, **Fundamentals of Signal Processing for Sound and Vibration Engineers**, John Wiley & Sons Ltd., West Sussex, England, pp. 277-315.
73. Therrien, C. W., 1992, **Discrete Random Signals and Statistical Signal Processing**, Prentice Hall International, Inc., Englewood Cliffs, New Jersey, United States of America, pp. 156-162.
74. Marple, S.L., 1987, **Digital Spectral Analysis with Applications**, Prentice-Hall International, Inc., Englewood Cliffs, New Jersey, United States of America, pp. 115-121.



75. Cheremisinoff, P.N. and Cheremisinoff, P.P., 1977, **Industrial Noise Control Handbook**, Technomic Publishing Company, Lancaster, United States of America, p. 273.
76. Reethofand, G. and Chow, G.C., 1980, "A Study of Valve Noise Generation Process for Compressible Fluids", **American Society of Mechanical Engineers, Winter Annual Meeting**, November 16-21, Chicago, United States of America, Issue 80, 11p.
77. Reethof, G., 1977, "Control Valve Noise Regulator Noise Generation, Propagation and Reduction", **Control Engineering**, Vol. 9, No. 2, pp. 74-85.
78. Reethof, G., 1978, "Turbulence-Generated Noise in Pipe Flow", **Annual Review of Fluid Mechanics**, Vol. 10, pp. 333-367.
79. Jenvey, P.L., 1975, "Gas Pressure Reducing Valve Noise". **Journal of Sound and Vibration**, Vol. 41, No. 4, pp.506-509.
80. Baumann, H. D., 1987, "A Method for Predicting Aerodynamic Valve Noise based on Modified Free Jet Noise Theories.", **American Society of Mechanical Engineers, Winter Annual Meeting**, Boston, United States of America, 7p.
81. IEC Standard 60534-8-3, 2000: **Industrial-Process Control Valves - Part 8: Noise Considerations- Sections 3: Control valve aerodynamic noise prediction method**. 2nd ed., pp. 1-113.
82. Lighthill M. J., 1952 "On Sound Generated Aerodynamically. I: General Theory", **Proceedings of the Royal Society of London. Series A: Mathematical and Physical Sciences**, Vol. 211, pp. 564-587.
83. Lighthill M. J., 1963, Jet Noise, **AIAA Journal**, Vol. 1, No. 7, pp.1507-1519.

84. Curle, N., 1955, "The Influence of Solid Boundaries upon Aerodynamic Sound", **Proceedings of the Royal Society of London. Series A: Mathematical and Physical Sciences**, Vol. 231, pp. 504-514.
85. Ravishankar, S.R. and Jones, B.E., 2007, "Laser Generated Acoustic Emission in Water", **NDT&E International**, Vol. 40, No. 8, pp. 602-608.
86. Hejmal, Z., Manas, P. and Zika, J., 2010, "Acoustic Emission Signal Processing of the Pressure Relief Valve", **The 13th International Symposium on Mechatronics**, June 2-4, Trencianske Teplice, Slovakia, pp. 1-3.
87. Lyons, J.L. and Askland, C.L., 1975, **Lyons' Encyclopedia of Valves**, Van Nostrand Reinhold Company, New York, United States of America, pp.90-108.
88. Chen, P., Chua, P.S.K. and Lim, G.H., 2007, "A Study of Hydraulic Seal Integrity", **Mechanical Systems and Signal Processing**, Vol. 21, No. 2, pp. 1115-1126.
89. Haykin, S. and Veen, B.V., 2003, **Signals and Systems**, 2nd ed., John Wiley & Sons, Inc., New York, United States of America, pp. 303-305.
90. Jomdecha, C., Prateepasen, A. and Kaewtrakulpong, P., 2007, "Study on Source Location using an Acoustic Emission System for Various Corrosion Types", **NDT and E International**, Vol. 40, No. 8, pp. 584-593.
91. Bayindir, R., and Ates, H., 2007, "Low-Cost and High Sensitively Microcontroller Based Control Unit for a Friction Welding Machine", **Journal of Materials Processing Technology**, Vol. 189, No. 1-3, pp. 126-131.
92. Lian, X. and Chen, L. 2009, "General Cost Models for Evaluating Dimensionality Reduction in High-Dimensional Spaces", **IEEE Transactions on Knowledge and Data Engineering**, Vol. 21, No. 10, pp. 1447-1460.

93. Prateepasen, A., Kaewwaewnoi, W., and Kaewtrakulpong, P., 2011, "Smart Portable Noninvasive Instrument for Detection of Internal Air Leakage of a Valve Using Acoustic Emission Signals", **Measurement: Journal of the International Measurement Confederation**, Vol. 44, No. 2, pp. 378-384.

Appendix A
Evaluation of AE Signal Drift in Time Domain

Some of evaluated AE signals drift during long time measurement (20 ms and 8 ms) were detected and expressed in Figures A.1 and A.2.

A.1 Duration of 20 ms

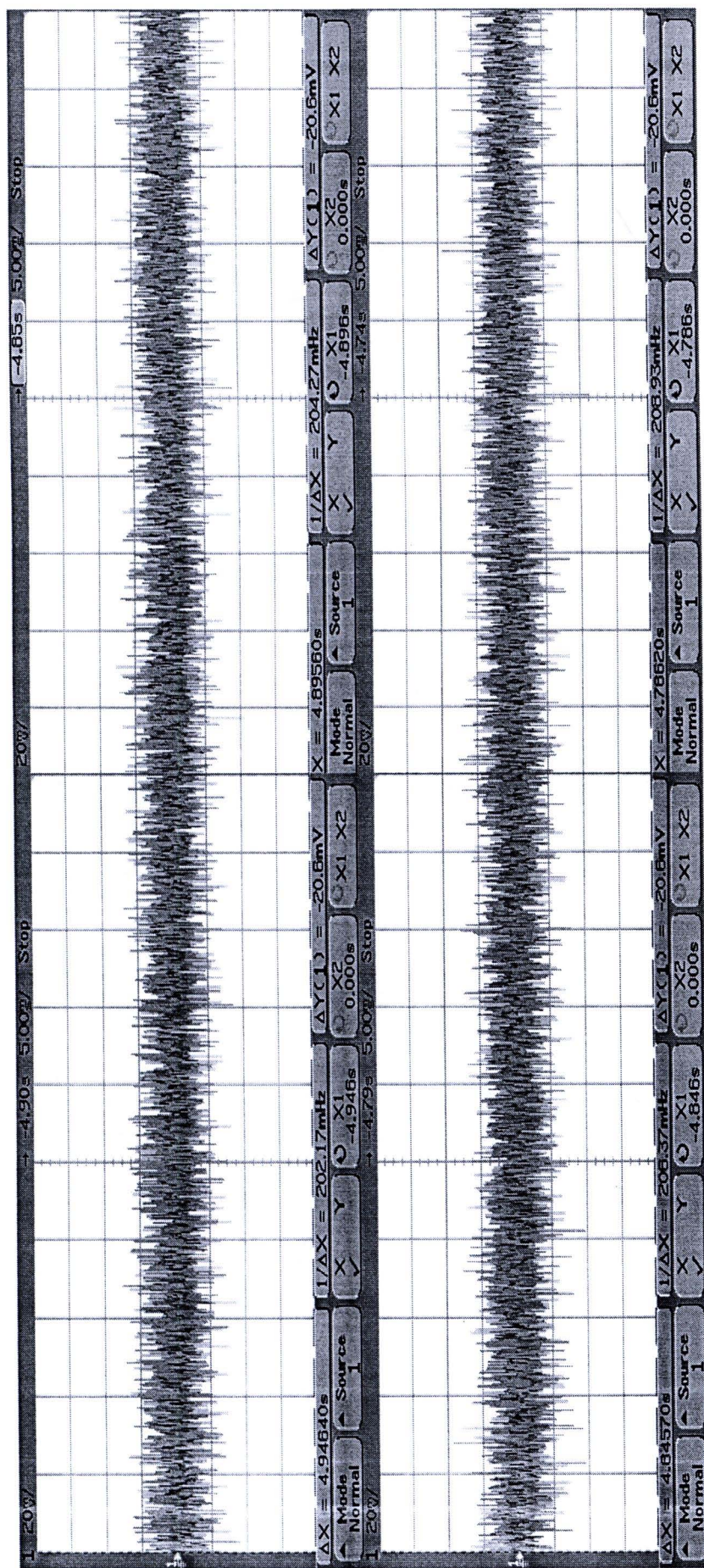
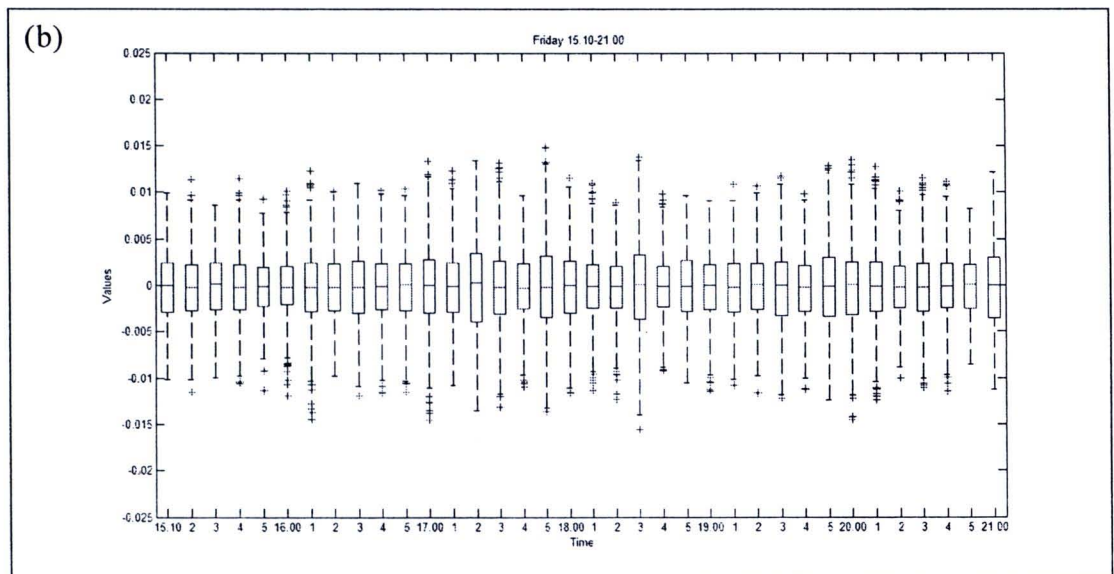
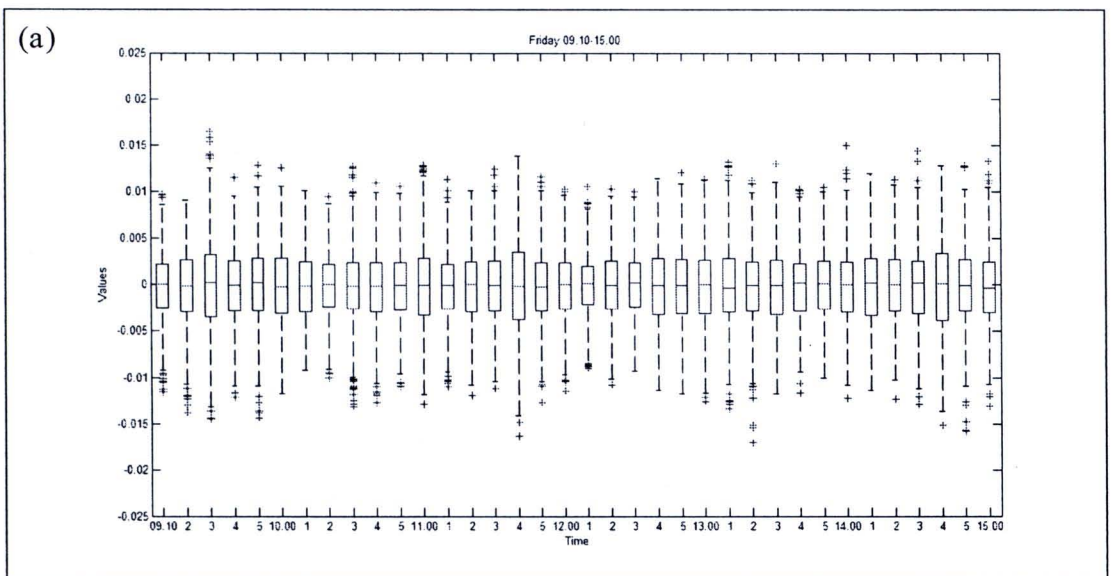


Figure A.1 AE signals with inlet pressure level of 400 kPa at 25.4 mm ball valve.

Appendix B
Statistical Properties Analysis

Before recording an experimental data, AE signals generated by valve leakage were recorded for a long time at fixed condition. Actually, the signals were collected through a week, but the collected data were shown for the period of a day in this appendix. Duration time for recording each data was 190 ms. Box plot, histogram, PDF and statistical parameters of the leakage signal were determined to confirm that valve leakage processes are (at least wide sense) stationary and time-invariant, as shown below.

B.1 Box Plot



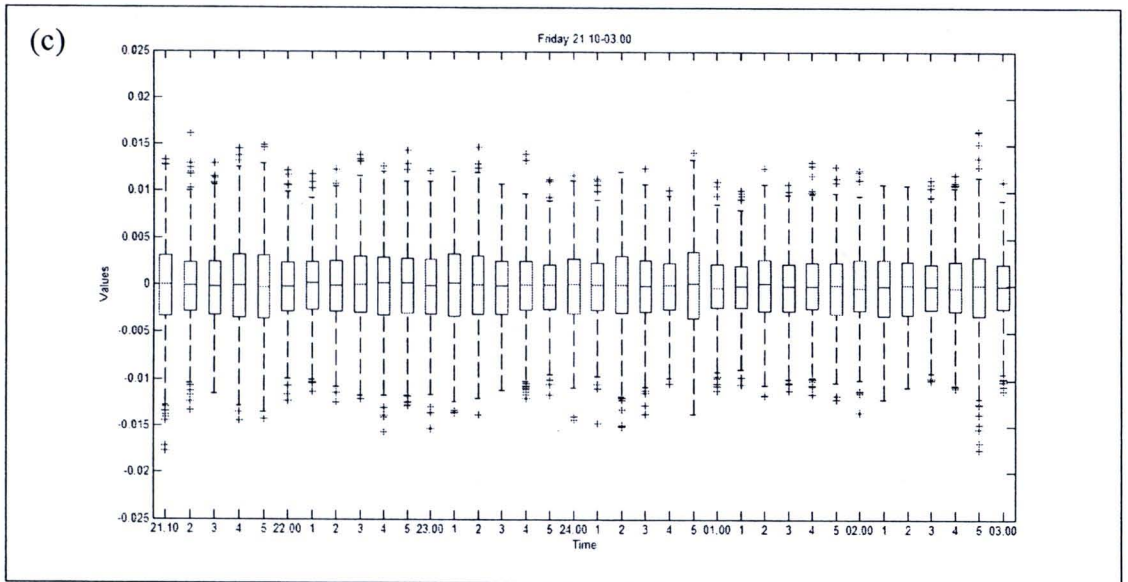
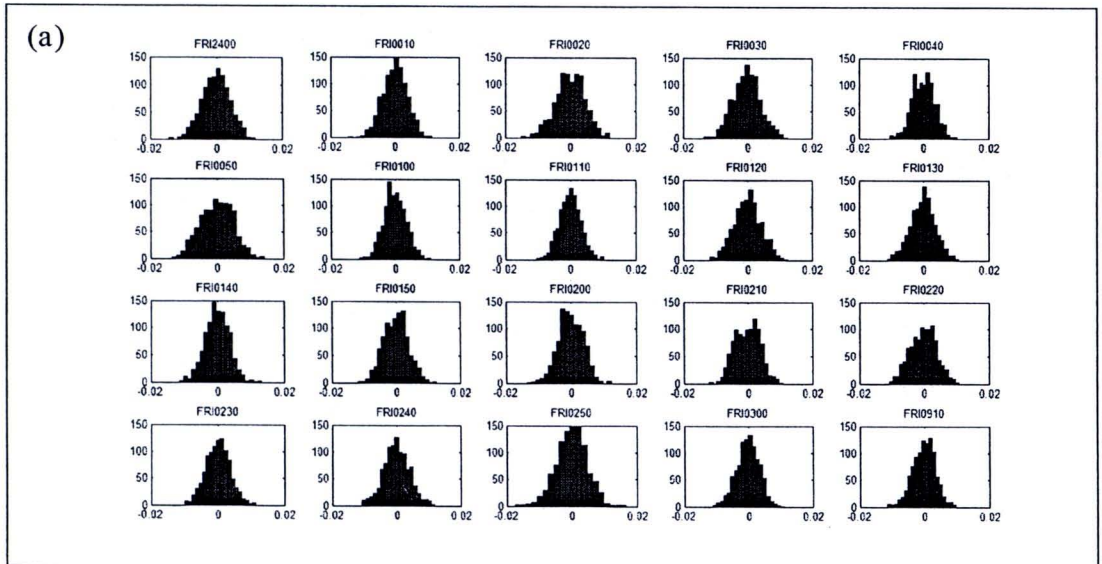
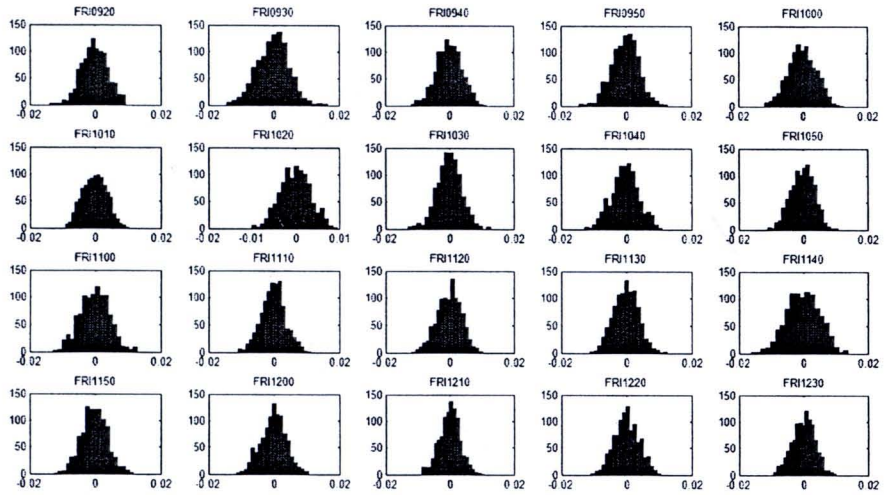


Figure B.1 The box plot of AE signal during time of (a) 09.10 A.M. – 03.00 P.M., (b) 03.10 P.M. – 09.00 P.M., and (c) 09.10 P.M. – 03.00 A.M.

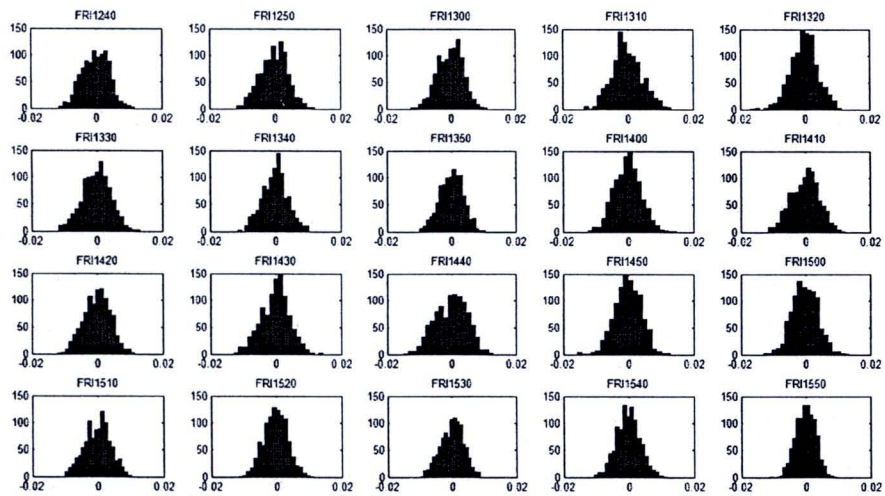
B.2 Histogram Plot



(b)



(c)



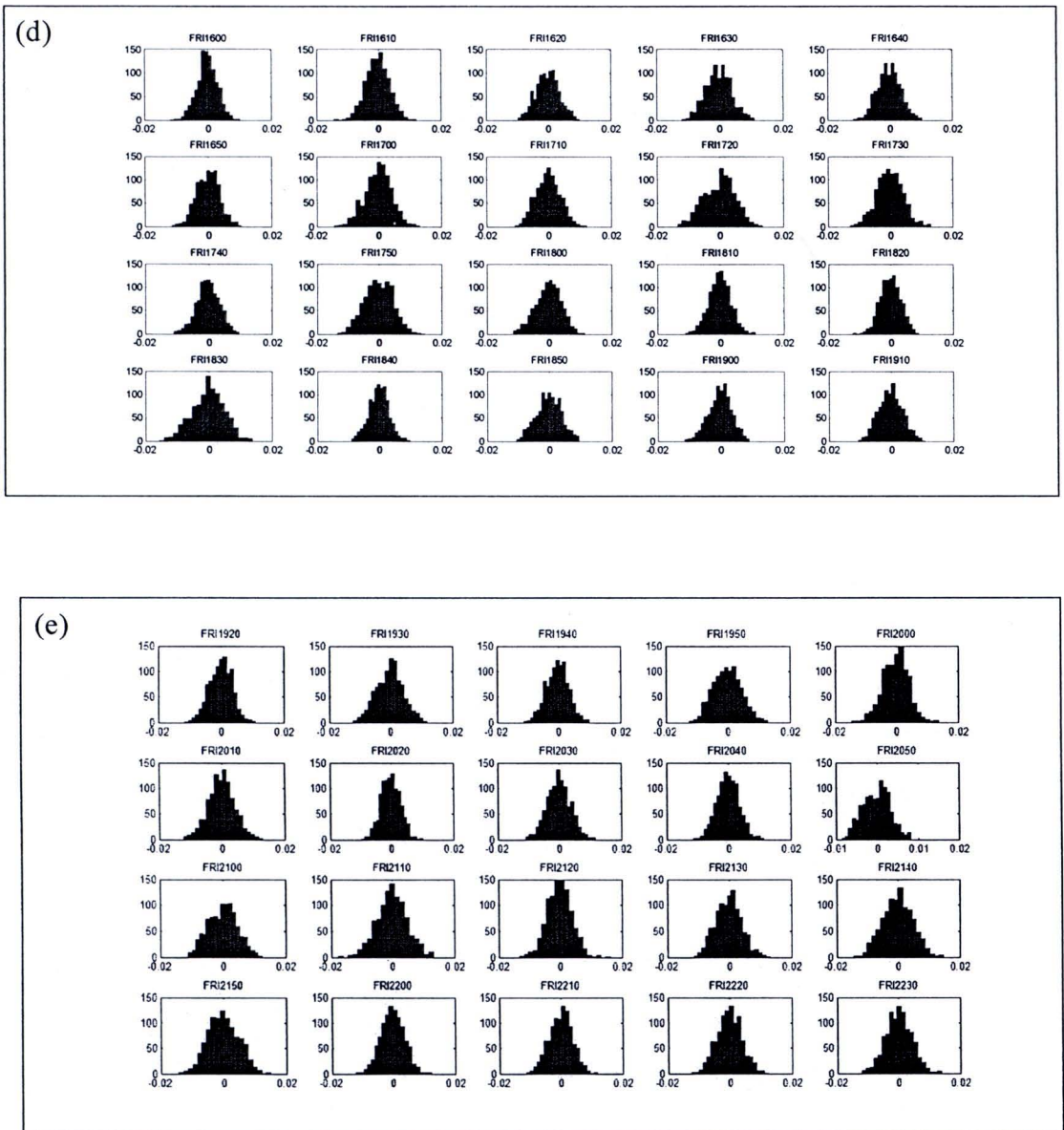
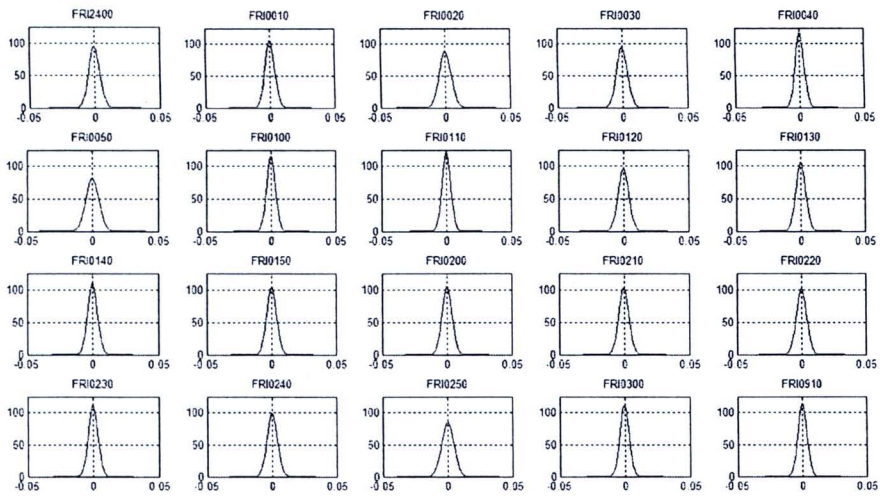


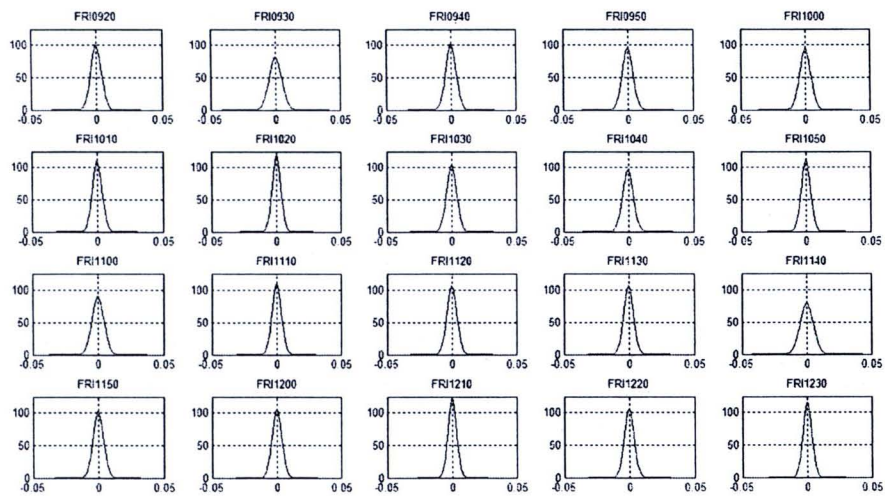
Figure B.2 The histogram of AE signal during time of (a) 00.00 A.M. – 03.00 P.M., (b) 09.10 A.M. – 12.30 P.M., (c) 12.40 P.M. – 03.50 A.M., (d) 04.00 P.M. – 07.10 P.M., and (e) 07.20 P.M. – 10.30 P.M.

B.3 Probability Density Function

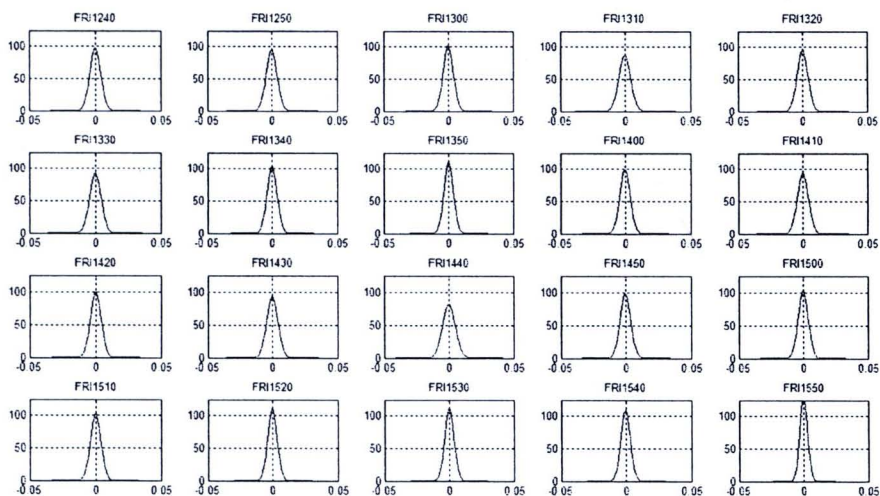
(a)



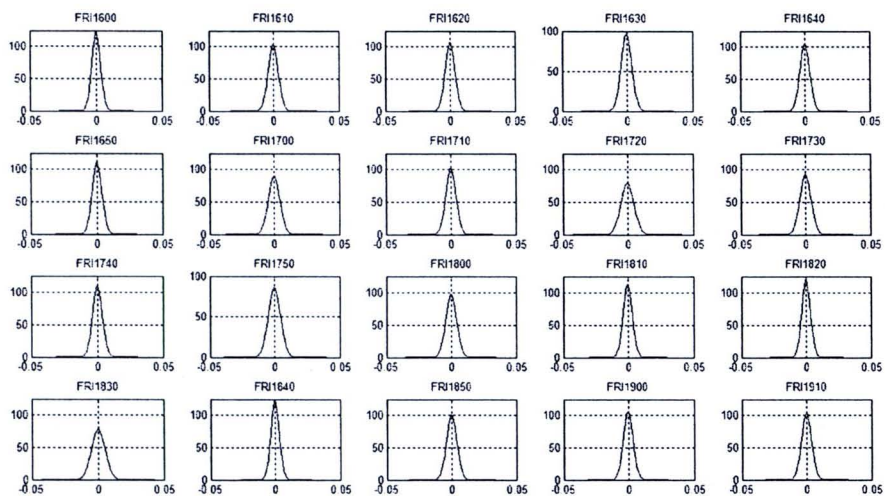
(b)



(c)



(d)



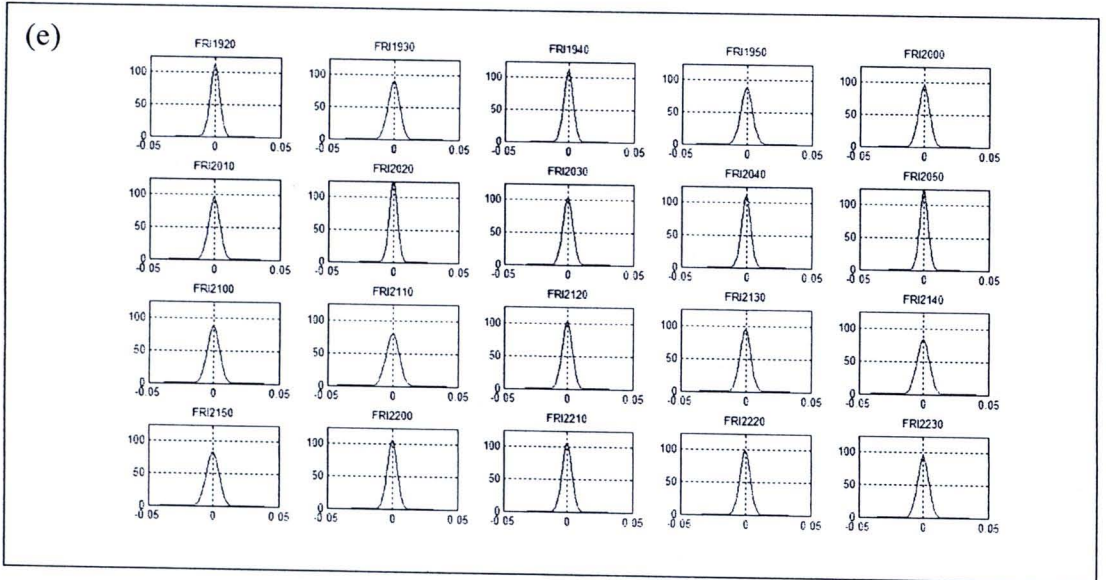


Figure B.3 The PDF of AE signal during time of (a) 00.00 A.M. – 03.00 P.M., (b) 09.10 A.M. – 12.30 P.M., (c) 12.40 P.M. – 03.50 A.M., (d) 04.00 P.M. – 07.10 P.M., and (e) 07.20 P.M. – 10.30 P.M.

Appendix C
Experimental Data

Table C.1 The experimental data at various conditions

Number	Variables			
	Valve size (D) (mm)	Leakage rate (Q) (l/min)	Inlet pressure level (P_1) (kPa)	AE_{RMS} (mV)
1	25.4	1.2	300	574.8
2	50.8	4.2	500	797.6
3	25.4	6.0	100	521.9
4	25.4	1.2	100	283.2
5	50.8	2.4	100	567.2
6	50.8	6.0	300	755.1
7	50.8	2.4	100	525.3
8	76.2	6.0	300	422.1
9	25.4	1.2	500	685.3
10	50.8	6.0	500	789.9
11	50.8	6.0	300	763.3
12	50.8	1.2	500	572.4
13	76.2	1.2	100	46.5
14	76.2	4.2	500	339.4
15	25.4	6.0	100	409.1
16	76.2	4.2	500	309.3
17	25.4	6.0	300	863.8
18	50.8	1.2	300	326.1
19	50.8	6.0	100	764.6
20	25.4	2.4	100	278.9
21	25.4	2.4	300	673.1
22	76.2	6.0	100	405.0
23	50.8	2.4	500	706.0
24	25.4	6.0	500	923.3
25	50.8	4.2	500	778.9
26	25.4	1.2	100	255.8
27	76.2	1.2	100	43.0
28	76.2	2.4	500	160.4

Number	Variables			
	Valve size (D) (mm)	Leakage rate (Q) (l/min)	Inlet pressure level (P_1) (kPa)	AE_{RMS} (mV)
29	76.2	2.4	500	159.4
30	50.8	1.2	300	377.9
31	25.4	4.2	300	812.1
32	25.4	2.4	500	875.6
33	76.2	4.2	100	164.6
34	25.4	2.4	100	232.5
35	50.8	6.0	500	778.1
36	76.2	2.4	100	55.7
37	25.4	4.2	100	398.2
38	25.4	2.4	300	706.6
39	50.8	2.4	300	641.4
40	25.4	6.0	300	872.0
41	25.4	2.4	500	845.4
42	76.2	2.4	100	55.2
43	25.4	4.2	500	932.3
44	25.4	1.2	500	704.8
45	76.2	6.0	500	463.6
46	50.8	4.2	100	667.5
47	25.4	1.2	300	607.2
48	76.2	20	500	107.5
49	25.4	4.2	500	925.8
50	50.8	4.2	300	706.7
51	50.8	2.4	500	670.0
52	76.2	1.2	500	83.6
53	76.2	4.2	300	270.2
54	25.4	4.2	300	842.8
55	50.8	6.0	100	408.2
56	50.8	4.2	300	699.7
57	76.2	4.2	100	153.7
58	76.2	6.0	300	401.5

Number	Variables			
	Valve size (D) (mm)	Leakage rate (Q) (l/min)	Inlet pressure level (P_1) (kPa)	AE_{RMS} (mV)
59	50.8	6.0	100	766.9
60	76.2	1.2	300	86.0
61	25.4	6.0	500	934.7
62	50.8	4.2	100	668.0
63	50.8	1.2	500	589.9
64	76.2	4.2	300	307.7
65	50.8	1.2	100	215.5
66	76.2	2.4	300	121.8
67	76.2	6.0	500	555.5
68	76.2	1.2	300	56.6
69	25.4	4.2	100	353.7
70	76.2	2.4	300	119.4
71	50.8	1.2	100	243.3
72	50.8	2.4	300	588.2

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Kaewwaewnoi, W., Prateepasen, A. and Kaewtrakulpong, P., 2007, "A Study on Correlation of AE Signal from Different AE Sensor in Valve Leakage Rate Detection", **ECTI-ECC**

Transactions on Electrical Eng., Electronics, and Communication, Vol. 5, No. 1 pp. 113–117.

Kaewwaewnoi, W., Prateepasen, A. and Kaewtrakulpong, P., 2010, “Investigation of the Relationship between Internal Fluid Leakage through a Valve and the Acoustic Emission generated from the Leakage”, **Measurement: Journal of the International Measurement Confederation**, Vol. 43, No. 2, pp.274-282.

Prateepasen, A., Kaewwaewnoi, W., and Kaewtrakulpong, P., 2011, “Smart Portable Noninvasive Instrument for Detection of Internal Air Leakage of a Valve Using Acoustic Emission Signals”, **Measurement: Journal of the International Measurement Confederation**, Vol. 44, No. 2, pp. 378-384.

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