

www.isopec.org; www.isopec2011.org

June 19–24, Maui, Hawaii, USA

The Twenty-first (2011) International Offshore (Ocean) and Polar Engineering Conference

Including ISOPE symposia:

- 1st Arctic Science & Technology
- 1st Arctic Materials
- 2nd Renewable Energy & Environment
- 3rd Sloshing Dynamics & Design
- 3rd Nanomaterials for Clean Energy
- 3rd Frontier & Clean Energy Tech
- 9th High-Performance Materials
- 5th Strain-Based Design
- 9th (Deep) Ocean Mining (& Gas Hydrates)

ISOPE-2011

Hyatt Regency Maui, Hawaii, USA, June 19–24

Technical Program

Refereed papers from **51** countries in **149** technical general
and keynote presentations
General Information, Reservations, Publications and Program
Updates on www.isopec.org www.isopec2011.org
Forms for Advance Registration and Venue Hotel:
Inside this program and on www.isopec.org

Organized by:

Technical Program Committee, ISOPE

Sponsored by:

International Society of Offshore and Polar Engineers
(ISOPE)

with cooperating organizations (listed inside)



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Jin S Chung Award (H Saeki, Hokkaido Univ) and ISOPE Award (X Jiang, CNOOC-COEC)



Teak Break and Banquet



20th ISOPE Conference Anniversary and COOEC & ISOPE Staff



Conference Opening Session

Maui photos on www.isope.org and www.isope2011.org

20th ISOPE Conference, Beijing, June 20-26, 2010

Welcome to ISOPE-2011 Conference

We greatly appreciate the excellent responses with **1350** abstracts and help we have received from colleagues around the world in the successful organization of the 21st International Offshore and Polar Engineering Conference (ISOPE-2011), Maui, Hawaii, June 19–24, 2011. The Conference features **149** sessions of *peer-reviewed* papers and **8** keynote presentations from more than **51 countries**, including the ISOPE specialty symposia as a part of the ISOPE-2011 Conference.

The conference program is issued in 2 versions: Printed and internet (www.isopec.org and www.isopec2011.org). To meet the page limit, only the first author data are listed in the printed version, and the internet version lists all authors.

The purposes of the ISOPE conference are to:

- * Promote technological progress and activities, international technological transfer and cooperation, and opportunities for engineers to maintain and improve technical competence; and
- * Provide a timely international forum for technical activities, cooperation, opportunity and fellowship among researchers and engineers by developing focused session topics with high quality papers (in both originality and significance) accepted through rigorous review, establishing high international standards for publication and worldwide distribution and promoting interdisciplinary interaction between academia and industry.

The International Society of Offshore and Polar Engineers (ISOPE) has already held **47 successful international meetings** with peer-reviewed papers:

- 1st (1990) European Offshore Mechanics Symposium (**EUROMS-90**) Trondheim; EUROMS-99 Moscow;
- 1st (1990) Pacific/Asia Offshore Mechanics Symposium (ISOPE **PACOMS-90**) Seoul; PACOMS-94 Beijing; 1996 Pusan, 2002 Daejeon, 2004 Vladivostok, 2006 Dalian, 2008 Bangkok, 2010 Busan;
- Annual **ISOPE** conferences, starting in Edinburgh, 1991 were held in San Francisco, Singapore, Osaka, The Hague, Los Angeles, Honolulu, Montréal, Brest, Seattle, Stavanger, Kitakyushu, Honolulu, Toulon, Seoul, San Francisco, Lisbon, Vancouver, Osaka and Beijing. Since 1992, the annual ISOPE conference program has been the world's largest of its kind;
- 1st (1995) ISOPE Ocean Mining Symposium (**OMS-95**), Tsukuba, 1995, Seoul 1997, Goa 1999, Szczecin 2001, Tsukuba 2003, Changsha 2005, Lisbon 2007; Chennai 2009;
- 1st (1996) International Deep-Ocean Technology (**IDOT-96**) Symposium and Workshop, Los Angeles; 2001 Stavanger and 2009 Beijing;
- ISOPE **HPM** Symposium: Honolulu 2003, Toulon 2004, Seoul 2005, San Francisco 2006, Lisbon 2007, Vancouver 2008; Osaka 2009 and Beijing 2010 ;
- ISOPE **ANGT** Symposium: Seoul 2005;
- 1st ISOPE **SBD** Symposium: Lisbon 2007, Vancouver 2008, Osaka 2009, Beijing 2010.
- ISOPE HPM : 1st **NANOS** Symposium: Lisbon 2007, Beijing 2010.

On behalf of the Technical Program Committee, it is our pleasure to welcome participants from all over the world to the ISOPE-2011 Conference in Maui, Hawaii.

Jin S Chung, USA	Ronald H Knapp USA	Xizhao Jiang China
Shigeru Naito Japan	Michael Isaacson Canada	A JNA Sarmiento Portugal

Co-chairmen of the ISOPE-2011 Conference

SUNDAY JUNE 19

09:00 ISOPE Board of Directors Meeting Regency Board
10:30 ISOPE-2010 Executive Committee Meeting Regency Board
EUROMS and PACOMS Executive Committees
15:00-18:00
CONFERENCE REGISTRATION Grand Promenade
17:00-18:00
WELCOME RECEPTION Napili Garden
Tour Information Visit tour desk in ISOPE registration area: www.isope.org
Spouse Program Join Tour program: see www.isope.org

MONDAY June 20

07:30 On-Site Registration starts at 07:30 Grand Promenade
07:30 Session Chair/Co-chair Briefing Grand Promenade

08:30 Conference Opening Monarchy Ballroom
08:30

1. OFFSHORE & ARCTIC REVIEW (V. 1) Monarchy Ballroom

10:30

2. LNG SLOSHING I: Numerical Modeling (V. 3) Room 1
3. HYDRODYNAMICS I: MetOcean 1 (V. 3) Room 2
4. RENEWABLE ENERGY I: Offshore Wind Stru 1 (V. 1) Room 3
5. ADV SHIP TECH I: New Design and ... (V. 4) Room 4
6. HPM I: Shipbuilding Steels (V. 4) Room 5
7. NANOMATERIALS I (V. 4) Room 6
8. VORTEX-INDUCED VIBRATIONS I (V. 3) Room 7
9. SUBSEA & INSTALLATION (V. 2) Room 8
10. FRONTIER ENERGY I: Clean Energy (V. 1) Room 9
11. UNDERWATER I: Communication & Navigat. (V. 2) Room 10

14:00

12. LNG SLOSHING II: Sloshing Loads (V. 3) Room 1
13. HYDRODYNAMICS II: MetOcean 2 (V. 3) Room 2
14. RENEWABLE ENERGY II: Offshore Wind Str 2 (V1) Room 3
15. ADV SHIP TECH II: Ultimate Strength ... (V. 4) Room 4
16. HPM II: Non-Destructive Testing (V. 4) Room 5
17. NANOMATERIALS II (V. 4) Room 6
18. VORTEX-INDUCED VIBRATIONS II (V. 3) Room 7
9. SUBSEA & INSTALLATION (V. 2) Room 8
19. FRONTIER ENERGY II: Clean Coal (V. 1) Room 9
20. UNDERWATER II: AUV and Robotics 1 (V. 2) Room 10

16:20

21. LNG SLOSHING III: Sloshing Physics (V. 3) Room 1
22. HYDRODYNAMICS III: MetOcean 3 (V. 3) Room 2
23. RENEWABLE ENERGY III: Offshore Wind Loads 1 Room 3
24. ADVANCED SHIP TECH III: Optimum Design (V. 4) Room 4
25. HPM III: Adv. Materials & Offshore Struct 1 (V. 4) Room 5
26. NANOMATERIALS III (V. 4) Room 6
27. VORTEX-INDUCED VIBRATIONS III (V. 3) Room 7
28. DEEPWATER SYSTEMS & INSTALLATION (V. 1) Room 8
29. RENEWABLE ENERGY XVI: Tidal & Current 2 Room 9
30. UNDERWATER III: Aquabiomechanics (V. 2) Room 10

18:30 ISOPE Technical Committee Meetings Find from the bulletin board

Tuesday June 21

07:30 Session Chair/Co-chair Briefing Grand Promenade

08:00

31. LNG SLOSHING IV: Sloshel (V. 3)	Room 1
32. HYDRODYNAMICS IV: MetOcean 4 (V. 3)	Room 2
33. RENEWABLE ENERGY IV: Offshore Wind Float 1 (V. 1)	Room 3
34. ADVANCED SHIP TECH IV: Impact & Earthqke (V. 4)	Room 4
35. HPM IV: Advanced Materials & Offshore Struct 2 (V. 4)	Room 5
36. NANOMATERIALS IV: (V. 4)	Room 6
37. SBD I: Materials for SBD (V. 4)	Room 7
28. DEEPWATER SYSTEMS & INSTALLATION (V. 1)	Room 8
38. RENEWABLE ENERGY XVII: Energy & Resource (V. 1)	Room 9
39. UNDERWATER IV: AUV and Robotics 2 (V. 2)	Room 10

10:30

40. LNG SLOSHING V: Strength Assessment (V. 3)	Room 1
41. HYDRODYNAMICS V: Tsunami (V. 3)	Room 2
42. RENEWABLE ENERGY V: Offshore Wind Float 2 (V. 1)	Room 3
43. ADVANCED SHIP TECH V: Propulsion & Cavitatn (V. 4)	Room 4
35. HPM IV: Advanced Materials & Offshore Structures 2	Room 5
44. COASTAL I: Coastal Waves 1 (V. 3)	Room 6
45. SBD II: Modeling in SBD (V. 4)	Room 7
46. GEOTECH I: Mechanics of Soils (V. 1)	Room 8
47. FRONTIER ENERGY III: Matls for Clean Energy 1 (V. 1)	Room 9
48. ARCTIC MATERIALS I: Materials & Develop... (V. 2)	Room 10

13:00

Keynote Presentation: Tsunami Room 2

14:00

49. LNG SLOSHING VI: Panel 1 (V. 3)	Room 1
50. HYDRODYNAMICS VI: Roll/Stability (V. 3)	Room 2
51. RENEWABLE ENERGY VI: Offshore Wind Reliab (V. 1)	Room 3
52. ADVANCED SHIP TECH VI: Seakeeping (V. 4)	Room 4
53. HPM V: Fatigue & Fracture I (V. 4)	Room 5
54. COASTAL II: Coastal Waves 2 (V. 3)	Room 6
55. SBD III: Full Scale Testing in SBD (V. 4)	Room 7
56. GEOTECH II: Soil Properties & Test (V. 1)	Room 8
57. FRONTIER ENERGY IV: Matls for Clean Energy 2	Room 9
58. ARCTIC MATERIALS II: Steel & Weldments (V. 2)	Room 10

16:20

59. LNG SLOSHING VII: Panel 2 (V. 3)	Room 1
60. HYDRODYNAMICS VII: Springing/Whipping (V. 3)	Room 2
61. RENEWABLE ENERGY VII: Offshore Wind Farm	Room 3
62. ADVANCED SHIP TECH VII: Fatigue Strength (V. 4)	Room 4
63. HPM VI: Fatigue & Fracture II (V. 4)	Room 5
64. COASTAL III: Tsunami & Storm Surge (V. 3)	Room 6
65. SBD IV: Fracture Mechanics in SBD (V. 4)	Room 7
66. GEOTECH III: Soil Dynamics & Liquefaction (V. 1)	Room 8
67. OCEAN MINING I: Gas Hydrates – Modeling (V. 1)	Room 9
68. ARCTIC MATERIALS III: Weldment & Coatin (V. 2)	Room 10

15:30 Awards Committee Meeting Regency Board

16:30 Board of Editors Meeting Regency Board

18:00 Student Forum (advance reservation to isope-2@isope-org)

WEDNESDAY JUNE 22

07:30 Session Chair/Co-chair Briefing Grand Promenade

08:00

69. RISK & RELIABILITY I (V. 4)	Room 1
70. HYDRODYNAMICS VIII: Dynamics 1 (V. 3)	Room 2
71. RENEWABLE ENERGY VIII: Wave Energy 1 (V. 1)	Room 3
72. LNG FPSO/FSRU & TOPSIDE (V. 1)	Room 4
73. HPM VII: Corrosion (V. 4)	Room 5
74. COASTAL IV: Current & Waves (V. 3)	Room 6
75. PIPELINES & RISERS I: Riser Integrity (V. 2)	Room 7
76. GEOTECH IV: Foundations & Anchors (V. 1)	Room 8
77. OCEAN MINING II: Gas Hydrates-Geotech (V. 1)	Room 9
78. ARCTIC I: Ice Observation & Model (V. 2)	Room 10

10:30

79. RISK & RELIABILITY II (V. 4)	Room 1
80. HYDRODYNAMICS IX: Dynamics 2 (V. 3)	Room 2
81. RENEWABLE ENERGY IX: Wave Energy 2 (V. 1)	Room 3
72. LNG FPSO/FSRU & TOPSIDE (V. 1)	Room 4
82. HPM VIII: Advances in Welding Technology 1 (V. 4)	Room 5
83. COASTAL V: Monitoring & Simulation (V. 3)	Room 6
84. PIPELINES & RISERS II: Steel Catenary Risers (V. 2)	Room 7
85. GEOTECH V: Piles (V. 1)	Room 8
86. OCEAN MINING III: Gas Hydrates – Assessme (V. 1)	Room 9
87. ARCTIC II: Ice and Ocean Environments (V. 2)	Room 10

12:00 ISOPE Board of Directors Meeting Regency Board

13:15 Keynote Presentation: Pipeline Design Room 1

14:00

88. ENVIRONMENT I: Triple-I (V. 1)	Room 1
89. HYDRODYNAMICS X: CFD Impact (V. 3)	Room 2
90. RENEWABLE ENERGY X: Wave Energy 3 (V. 1)	Room 3
91. FLOATING STRUCT & FPSO/SPAR/TLP I (V. 1)	Room 4
92. HPM IX: Advances in Welding Technology 2 (V. 4)	Room 5
93. COASTAL VI: Seabed & Sediment Transport 1 (V. 3)	Room 6
94. PIPELINES & RISERS III: Mooring (V. 2)	Room 7
95. GEOTECH VI: Soil Improvement (V. 1)	Room 8
96. OCEAN MINING IV: Systems & Tech 1 (V. 1)	Room 9
97. ARCTIC III: Ice-Structure Interactions 1 (V. 2)	Room 10

16:20

98. ENVIRONMENT II: Oil Pollution & Water Quality 1	Room 1
99. HYDRODYNAMICS XI: CFD/NWT Waves (V. 3)	Room 2
100. RENEWABLE ENERGY XI: Wave Energy 4 (V. 1)	Room 3
101. FLOATING STRUCT & FPSO/SPAR/TLP II (V. 1)	Room 4
102. HPM X: Composites (V. 4)	Room 5
103. COASTAL VII: Seabed & Sediment Transpor 2 (V. 3)	Room 6
104. PIPELINES & RISERS IV: Riser Design (V. 2)	Room 7
105. GEOTECH VII: Modeling & Simulation (V. 1)	Room 8
106. OCEAN MINING V: Systems & Tech 2 (V. 1)	Room 9
107. ARCTIC IV: Ice-Structure Interactions 2 (V. 2)	Room 10

19:00

Grand Ballroom

Annual Conference Banquet

21st ISOPE Anniversary, Cultural Event, Best Paper, Best Student Paper, Outstanding Students and Awards

Don't forget the banquet ticket.

THURSDAY JUNE 23

07:30 Session Chair/Co-chair Briefing Grand Promenade

08:00

- 108. ENVIRONMENT III: Oil Pollution & Water 2 (V. 1) Room 1
- 109. HYDRODYNAMICS XII: CFD Cylinders& Flo (V. 3) Room 2
- 110. RENEWABLE ENERGY XII: Wave Energy 5 (V. 1) Room 3
- 111. FLOATING STRUCT & FPSO/SPAR/TLP III (V. 1) Room 4
- 112. FSW I: Process Application (V. 4) Room 5
- 113. COASTAL VIII: Coastal Structures 1 (V. 3) Room 6
- 114. PIPELINES & RISERS V: Pipeline Flow (V. 2) Room 7
- 115. GEOTECH VIII: Slope Stability (V. 1) Room 8
- 116. OCEAN MINING VI: Deep-Ocean Minerals 1 (V. 1) Room 9
- 117. ARCTIC V: Ice-Ocean-Ship Interaction & Perfor (V. 2) Room 10

10:30

- 118. ENVIRONMENT IV: Monitoring (V. 1) Room 1
- 119. HYDRODYNAMICS XIII: CFD Floating Body (V. 3) Room 2
- 120. RENEWABLE ENERGY XIII: Wave Energy 6 (V. 1) Room 3
- 121. FLOATING STRUCT & FPSO/SPAR/TLP IV (V. 1) Room 4
- 122. FSW II: Microstructure & Properties: Ferrous (V. 4) Room 5
- 123. COASTAL IX: Coastal Structures 2 (V. 3) Room 6
- 124. PIPELINES & RISERS VI: Pipe-Soil Interactio (V. 2) Room 7
- 125. GEOTECH IX: Geoenvironment (V. 1) Room 8
- 126. OCEAN MINING VII: Deep-Ocean Minerals 2 (V. 1) Room 9
- 127. ARCTIC VI: Navigation and Ice Mangement (V. 2) Room 10

12:00 ISOPE Ocean Mining Executive Committee Regency Board

14:00

- 128. ENVIRONMENT V: Sediment & Debris (V. 1) Room 1
- 129. HYDRODYNAMICS XIV: CFD Flows (V. 3) Room 2
- 130. RENEWABLE ENERGY XIV: Wave Energy R(V. 1) Room 3
- 131. Jacket & Jackup (V. 1) Room 4
- 132. FSW III: FSW of Stainless & Dissimilar Metals (V. 4) Room 5
- 133. COASTAL X: Tide & Estuary 1 (V. 3) Room 6
- 134. PIPELINES & RISERS VII: Pipeline Integrity (V. 2) Room 7
- 135. GEOTECH X: Marine Geotechnology (V. 1) Room 8
- 136. OCEAN MINING VIII: Environment (V. 1) Room 9
- 137. ARCTIC VII: Exploration and New Instrumentati (V. 2) Room 10

16:20

- 138. ENVIRONMENT VI: Modeling & Restoration(V. 1) Room 1
- 139. RENEWABLE ENERGY XV: Tidal & Current 1 Room 3
- 140. FSW IV: FSW Stainless & Non-Ferrous Alloys (V. 4) Room 5
- 141. COASTAL XI: Tide & Estuary 2 (V. 3) Room 6
- 142. PIPELINES & RISERS VIII: Pipeline Design (V. 2) Room 7
- 143. OCEAN MINING IX: Mineral Processing (V. 1) Room 9
- 144. ARCTIC VIII: Ship Design and Navigation Req V. 2) Room 10

Sunday - Thursday	
Author Practice	Individual session rooms
On-site Registration	Grand Promenade
ISOPE Headquarters	Palace Suite
Proceedings Pickup	Registration Desk, Grand Promenade
Committee Meetings	Regency Board

FRIDAY June 24

Find Updates in Program on www.isope.org and www.isope2011.org

Tours: Click on www.isope2011.org or www.isope.org > General Information

ISOPE-2011 Maui Conference

This 21st annual conference features **149** technical and opening general sessions, and **8** keynote presentations with top experts from industry, academia and government. After peer review of the manuscripts selected from **1,350** abstracts Some **750** papers will be presented and discussed by researchers, engineers and managers from more than **51** countries.

The conference proceedings of peer-reviewed papers in PDF files will be available in a set of 4 volumes on CD-ROM (**4,200** pp. est.) — paginated within each volume — during the conference and later for worldwide post-conference mail order from ISOPE: **ISBN 978-1-880653-96-8**; **ISSN 1098-6189** and separately (deep) ocean mining symposium proceedings **ISBN 978-1-880653-95-1**; **ISSN 1946-0066**.

All indexed by Engineering Index (EI).

SESSION LIST BY TOPICS

OFFSHORE & ARCTIC INDUSTRY REVIEW

1. OFFSHORE & ARCTIC REVIEW (V. 1) Monarchy Ballroom

ISOPE FRONTIER AND CLEAN ENERGY SYMPOSIUM

10. FRONTIER ENERGY I: Clean Energy (V. 1) Room 9
19. FRONTIER ENERGY II: Clean Coal (V. 1) Room 9
47. FRONTIER ENERGY III: Mats for Clean Energy 1 (V. 1) Room 9
57. FRONTIER ENERGY IV: Mats for Clean Energy 2 Room 9

ISOPE (DEEP) OCEAN MINING (& GAS HYDRATES) SYMPOSIUM

67. OCEAN MINING I: Gas Hydrates – Modeling (V. 1) Room 9
77. OCEAN MINING II: Gas Hydrates-Geotech (V. 1) Room 9
86. OCEAN MINING III: Gas Hydrates – Assessme (V. 1) Room 9
96. OCEAN MINING IV: Systems & Tech 1 (V. 1) Room 9
106. OCEAN MINING V: Systems & Tech 2 (V. 1) Room 9
116. OCEAN MINING VI: Deep-Ocean Minerals 1 (V. 1) Room 9
126. OCEAN MINING VII: Deep-Ocean Minerals 2 (V. 1) Room 9
136. OCEAN MINING VIII: Environment (V. 1) Room 9
143. OCEAN MINING IX: Mineral Processing (V. 1) Room 9

OFFSHORE MECHANICS AND HYDRODYNAMICS

28. DEEPWATER SYSTEMS & INSTALLATION (V. 1) Room 8
91. FLOATING STRUCT & FPSO/SPAR/TLP I (V. 1) Room 4
101. FLOATING STRUCT & FPSO/SPAR/TLP II (V. 1) Room 4
111. FLOATING STRUCT & FPSO/SPAR/TLP III (V. 1) Room 4
121. FLOATING STRUCT & FPSO/SPAR/TLP IV (V. 1) Room 4
131. Jacket & Jackup (V. 1) Room 4

ISOPE RENEWABLE ENERGY & ENVIRONMENT SYMPOSIUM

4. RENEWABLE ENERGY I: Offshore Wind Stru 1 (V. 1) Room 3
14. RENEWABLE ENERGY II: Offshore Wind Str 2 (V1) Room 3
23. RENEWABLE ENERGY III: Offshore Wind Loads 1 Room 3
29. RENEWABLE ENERGY XVI: Tidal & Current 2 Room 9
33. RENEWABLE ENERGY IV: Offshore Wind Float 1 (V. 1) Room 3
38. RENEWABLE ENERGY XVII: Energy & Resource (V. 1) Room 9
42. RENEWABLE ENERGY V: Offshore Wind Float 2 (V. 1) Room 3
51. RENEWABLE ENERGY VI: Offshore Wind Reli (V. 1) Room 3
61. RENEWABLE ENERGY VII: Offshore Wind ... Farm Room 3
71. RENEWABLE ENERGY VIII: Wave Energy 1 (V. 1) Room 3
81. RENEWABLE ENERGY IX: Wave Energy 2 (V. 1) Room 3
90. RENEWABLE ENERGY X: Wave Energy 3 (V. 1) Room 3
100. RENEWABLE ENERGY XI: Wave Energy 4 (V. 1) Room 3
110. RENEWABLE ENERGY XII: Wave Energy 5 (V. 1) Room 3
120. RENEWABLE ENERGY XIII: Wave Energy 6 (V. 1) Room 3
130. RENEWABLE ENERGY XIV: Wave Energy R(V. 1) Room 3
139. RENEWABLE ENERGY XV: Tidal & Current 1 Room 3

88. ENVIRONMENT I: Triple-I (V. 1)	Room 1
98. ENVIRONMENT II: Oil Pollution, Water Quality 1	Room 1
108. ENVIRONMENT III: Oil Pollution & Water 2 (V. 1)	Room 1
118. ENVIRONMENT IV: Monitoring (V. 1)	Room 1
128. ENVIRONMENT V: Sediment & Debris (V. 1)	Room 1
138. ENVIRONMENT VI: Modeling & Restoration(V. 1)	Room 1

GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING

9. SUBSEA & INSTALLATION (V. 2)	Room 8
46. GEOTECH I: Mechanics of Soils (V. 1)	Room 8
56. GEOTECH II: Soil Properties & Test (V. 1)	Room 8
66. GEOTECH III: Soil Dynamics & Liquefaction (V. 1)	Room 8
76. GEOTECH IV: Foundations & Anchors (V. 1)	Room 8
85. GEOTECH V: Piles (V. 1)	Room 8
95. GEOTECH VI: Soil Improvement (V. 1)	Room 8
105. GEOTECH VII: Modeling & Simulation (V. 1)	Room 8
115. GEOTECH VIII: Slope Stability (V. 1)	Room 8
125. GEOTECH IX: Geoenvironment (V. 1)	Room 8
135. GEOTECH X: Marine Geotechnology (V. 1)	Room 8

OFFSHORE AND ARCTIC PIPELINES, RISERS AND MOORING

75. PIPELINES & RISERS I: Riser Integrity (V. 2)	Room 7
84. PIPELINES & RISERS II: Steel Catenary Risers (V. 2)	Room 7
94. PIPELINES & RISERS III: Mooring (V. 2)	Room 7
104. PIPELINES & RISERS IV: Riser Design (V. 2)	Room 7
114. PIPELINES & RISERS V: Pipeline Flow (V. 2)	Room 7
124. PIPELINES & RISERS VI: Pipe-Soil Interactio (V. 2)	Room 7
134. PIPELINES & RISERS VII: Pipeline Integrity (V. 2)	Room 7
142. PIPELINES & RISERS VIII: Pipeline Design (V. 2)	Room 7

AQUAMECHANICS, ROV, AUV, ROBOTICS AND COMMUNICATION

11. UNDERWATER I: Communication & Navigat. (V. 2)	Room 10
20. UNDERWATER II: AUV and Robotics 1 (V. 2)	Room 10
30. UNDERWATER III: Aquabiomechanics (V. 2)	Room 10
39. UNDERWATER IV: AUV and Robotics 2 (V. 2)	Room 10

ISOPE ARCTIC SCIENCE & TECHNOLOGY SYMPOSIUM

78. ARCTIC I: Ice Observation & Model (V. 2)	Room 10
87. ARCTIC II: Ice and Ocean Environments (V. 2)	Room 10
97. ARCTIC III: Ice-Structure Interactions 1 (V. 2)	Room 10
107. ARCTIC IV: Ice-Structure Interactions 2 (V. 2)	Room 10
117. ARCTIC V: Ice-Ocean-Ship Interaction & Perfor (V. 2)	Room 10
127. ARCTIC VI: Navigation and Ice Mangement (V. 2)	Room 10
137. ARCTIC VII: Exploration and New Instrumentati (V. 2)	Room 10
144. ARCTIC VIII: Ship Design and Navigation Req V. 2)	Room 10

ISOPE ARCTIC MATERIALS SYMPOSIUM

48. ARCTIC MATERIALS I: Materials & Develop... (V. 2)	Room 10
58. ARCTIC MATERIALS II: Steel & Weldments (V. 2)	Room 10
68. ARCTIC MATERIALS III: Weldment & Coatin (V. 2)	Room 10

ISOPE SLOSHING DYNAMICS SYMPOSIUM

2. LNG SLOSHING I: Numerical Modeling (V. 3)	Room 1
12. LNG SLOSHING II: Sloshing Loads (V. 3)	Room 1
21. LNG SLOSHING III: Sloshing Physics (V. 3)	Room 1
31. LNG SLOSHING IV: Sloshel (V. 3)	Room 1
40. LNG SLOSHING V: Strength Assessment (V. 3)	Room 1
49. LNG SLOSHING VI: Panel 1 (V. 3)	Room 1
59. LNG SLOSHING VII: Panel 2 (V. 3)	Room 1

HYDRODYNAMICS

3. HYDRODYNAMICS I: MetOcean 1 (V. 3)	Room 2
13. HYDRODYNAMICS II: MetOcean 2 (V. 3)	Room 2
22. HYDRODYNAMICS III: MetOcean 3 (V. 3)	Room 2
32. HYDRODYNAMICS IV: MetOcean 4 (V. 3)	Room 2
41. HYDRODYNAMICS V: Tsunami (V. 3)	Room 2
50. HYDRODYNAMICS VI: Roll/Stability (V. 3)	Room 2
60. HYDRODYNAMICS VII: Springing/Whipping (V. 3)	Room 2
70. HYDRODYNAMICS VIII: Dynamics 1 (V. 3)	Room 2
80. HYDRODYNAMICS IX: Dynamics 2 (V. 3)	Room 2
89. HYDRODYNAMICS X: CFD Impact (V. 3)	Room 2
99. HYDRODYNAMICS XI: CFD/NWT Waves (V. 3)	Room 2
109. HYDRODYNAMICS XII: CFD Cylinders& Flo (V. 3)	Room 2
119. HYDRODYNAMICS XIII: CFD Floating Body (V. 3)	Room 2
129. HYDRODYNAMICS XIV: CFD Flows (V. 3)	Room 2

COASTAL ENGINEERING

44. COASTAL I: Coastal Waves 1 (V. 3)	Room 6
54. COASTAL II: Coastal Waves 2 (V. 3)	Room 6
64. COASTAL III: Tsunami & Storm Surge (V. 3)	Room 6
74. COASTAL IV: Current & Waves (V. 3)	Room 6
83. COASTAL V: Monitoring & Simulation (V. 3)	Room 6
93. COASTAL VI: Seabed & Sediment Transport 1 (V. 3)	Room 6
103. COASTAL VII: Seabed & Sediment Transport 2 (V. 3)	Room 6
113. COASTAL VIII: Coastal Structures 1 (V. 3)	Room 6
123. COASTAL IX: Coastal Structures 2 (V. 3)	Room 6
133. COASTAL X: Tide & Estuary 1 (V. 3)	Room 6
141. COASTAL XI: Tide & Estuary 2 (V. 3)	Room 6

FLOW-INDUCED VIBRATIONS

8. VORTEX-INDUCED VIBRATIONS I (V. 3)	Room 7
18. VORTEX-INDUCED VIBRATIONS II (V. 3)	Room 7
27. VORTEX-INDUCED VIBRATIONS III (V. 3)	Room 7

ISOPE HIGH-PERFORMANCE MATERIALS SYMPOSIUM— HPM

6. HPM I: Shipbuilding Steels (V. 4)	Room 5
16. HPM II: Non-Destructive Testing (V. 4)	Room 5
25. HPM III: Adv. Materials & Offshore Structure 1 (V. 4)	Room 5
35. HPM IV: Advanced Materials & Offshore Structures 2	Room 5
53. HPM V: Fatigue & Fracture I (V. 4)	Room 5
63. HPM VI: Fatigue & Fracture II (V. 4)	Room 5
73. HPM VII: Corrosion (V. 4)	Room 5
82. HPM VIII: Advances in Welding Technology 1 (V. 4)	Room 5
92. HPM IX: Advances in Welding Technology 2 (V. 4)	Room 5
102. HPM X: Composites (V. 4)	Room 5

ISOPE FRICTION STIR WELDING SYMPOSIUM

112. FSW I: Process Application (V. 4)	Room 5
122. FSW II: Microstructure & Properties: Ferrous (V. 4)	Room 5
132. FSW III: FSW of Stainless & Dissimilar Metals (V. 4)	Room 5
140. FSW IV: FSW Stainless & Non-Ferrous Alloys (V. 4)	Room 5

ISOPE STRAIN-BASED DESIGN SYMPOSIUM

37. SBD I: Materials for SBD (V. 4)	Room 7
45. SBD II: Modeling in SBD (V. 4)	Room 7
55. SBD III: Full Scale Testing in SBD (V. 4)	Room 7
65. SBD IV: Fracture Mechanics in SBD (V. 4)	Room 7

ISOPE NANOTECHNOLOGY SYMPOSIUM

7. NANOMATERIALS I (V. 4)	Room 6
17. NANOMATERIALS II (V. 4)	Room 6
26. NANOMATERIALS III (V. 4)	Room 6

36. NANOMATERIALS IV: (V. 4) Room 6

RISK, SAFETY & RELIABILITY

69. RISK & RELIABILITY I (V. 4) Room 1

79. RISK & RELIABILITY II (V. 4) Room 1

ADVANCED SHIP TECHNOLOGY

5. ADV SHIP TECH I: New Design and ... (V. 4) Room 4

15. ADV SHIP TECH II: Ultimate Strength ... (V. 4) Room 4

24. ADVANCED SHIP TECH III: Optimum Design (V. 4) Room 4

34. ADVANCED SHIP TECH IV: Impact & Earthquake (V. 4) Room 4

43. ADVANCED SHIP TECH V: Propulsion & Cavitation (V. 4) Room 4

52. ADVANCED SHIP TECH VI: Seakeeping (V. 4) Room 4

62. ADVANCED SHIP TECH VII: Fatigue Strength (V. 4) Room 4

Conference Reception

17:00 Sunday June 19 Napili Garden

Conference Opening Address

08:30 Monday June 20 Monarchy Ballroom

19:00 Grand Ballroom

**Annual Conference Banquet
Cultural Event, Best Paper, Awards**

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