Improvement of Air-gun system for Multi-channel Seismic Survey

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Nippon Marine Enterprises Ltd.
Multi-Channel-Seismic Survey

buoy

streamer cable
Kairei: 5,600 m
Kaiyo: 500 m

100 m

110 m

4 knot

Umbilical cable

air-gun arrays

reflected wave

seismic wave

gun shootings
MCS systems of JAMSTEC

- R/V KAIYO
- R/V KAIREI

MCS system installed in 2000

Multi purpose vessel with limited space for gun array.
**Air-gun** (seismic source generator)

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>type</strong></td>
<td>1500LL (Bolt technology corp.)</td>
</tr>
<tr>
<td><strong>chamber volume</strong></td>
<td>1,500 cu.in (0.025 m³: / gun)</td>
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<tr>
<td></td>
<td>12,000 cu.in (0.20 m³: 8 guns total)</td>
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<tr>
<td><strong>Sound Peak Level</strong></td>
<td>261 dB (8 guns total)</td>
</tr>
<tr>
<td><strong>weight</strong></td>
<td>216 kg (in air: / gun)</td>
</tr>
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</table>
Air-gun array (KAIREI)

- 2nd unit
- 1st unit
- 20 m
- 10 m
- Umbilical cable
- Lifting chains
- Dumper ropes
- Float
- Davit
- Towing frame
Operations on KAIREI

All guns was pressurized at once.
Worked near the air compressed guns.
Air-gun shooting movie
Problems of previous system

1. **Towing frame**
   - cracked in 2004
   - not easy maintenance
   - towing position
   - dumper rope damage

2. **Dangerous operation**
   - worked near the air pressurized guns

3. **Not efficient**
   - no backup of air leakage
Changed towing frame

- Stainless steel pipe
- Stainless steel H shaped beam
- Section modulus was 57% up (vertical)
- Easy maintenance

Cracked in 2004
Changed tow point positions

Previous
1. bending moment was large
2. tension of ropes was not equal

New
changed points near the gravity center of guns

bending-moment was 45% reduced
Damage of ropes

lifting chains

crossing
dumper ropes

cross point

No cross point
Changed air line

Air was supplied all guns at once

Control air independently
New system operation

valve 2nd open
1st open
More efficient

Air leakage

had to recover the array

ship time loss

(KAIREI: over 8 hours)
because of long streamer (5,600m)

Installed valves in all gun lines

remote control valve
Summary

1. **Stronger**
   - designed new towing frame
   - change towing point
   - change layout of dumper ropes and chains

2. **Safer**
   - separated air line and added valves

3. **More efficient**
   - installed remote control valves in all gun air lines
Thank you!

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### Specification of the MCS system

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td><strong>air-gun</strong></td>
<td>type: 1500 LL (Bolt technology corp.)&lt;br&gt;volume: 1,500 cu.in (0.025 m³) × 8&lt;br&gt;=12,000 cu.in (0.2 m³)&lt;br&gt;pressure: 2,000 psi (13.8 MPa)&lt;br&gt;depth: 10 m&lt;br&gt;frequency: 50 Hz</td>
</tr>
<tr>
<td><strong>streamer cable</strong></td>
<td>length: 4,200 m @ 75 m × 56&lt;br&gt;channel number: 168 ch&lt;br&gt;depth: 15 m&lt;br&gt;(attached 16 depth controllers)</td>
</tr>
<tr>
<td><strong>recording</strong></td>
<td>sampling rate: 4 ms&lt;br&gt;recording length: 13.5 sec</td>
</tr>
</tbody>
</table>
Air-gun
seismic wave generator

type: Bolt technology corp. 1500LL
volume: 1,500 cu.in (0.025m³)
pressure: 2000 psi (13.8MPa)
deepth: 10m

Air is charged in fire chamber

Air is passing another pass

Shuttle is moved

Air is rapidly emitted from port