For Future Defense Technology
-TRDI OVERVIEW-

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Technical Research and Development Institute
Ministry of Defense, Japan

For Pacific Operational Science and Technology Conference, July 2008
OUTLINE

- TRDI Strategies for Future Defense Technologies
- TRDI Organization and Features
- TRDI Current Major R&D activities
- TRDI International Cooperation Activities
TRDI STRATEGIES FOR FUTURE DEFENSE TECHNOLOGIES
- Medium-to-long term defense technology outlook -

Derivation of Capabilities Needed

Changes in the Security Environment
- Response to Diverse Contingencies
- International Peace Cooperation
- Tight Defense Budget

Changes in the Operational Environment
- Joint Operation
- Information Superiority

Trends in Science & Technology
- Progress of COTS Technology
- Emerging Technology

Capabilities Needed

Derivation of priority in defense technology

Detailed Functions

Core Equipment

Future Weapon System Technologies
- Technical Areas
- Direction of Efforts

Potential Technologies
Trends in Science & Technology

Advance technologies to contribute defense capabilities

- Software Radio
- ASIMO
- Fullerene
- Nanotechnology/Biotechnology
- Robot/Unmanned Technology
- QDIP
- Sensor/Device Technology
- Information Technology

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Derivation of Capabilities Needed

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Detailed Functions

Core Equipment

Future Weapon System Technologies
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Potential Technologies
MEDIUM-TO-LONG TERM DEFENSE TECHNOLOGY OUTLOOK
-Key Points in the Capability Derivation (Examples)-

Changes in Security Environment

Response to new threads and diverse contingencies

Terrorism

Ballistic Missile

Bacillus Anthrax

Cyber Attack

International Peace Cooperation

Armed special operation vessel
Changes in the Security Environment
- Response to Diverse Contingencies
- International Peace Cooperation
- Tight Defense Budget

Trends in Science & Technology
- Progress of COTS Technology
- Emerging Technology

Changes in the Operational Environment
- Joint Operation
- Information Superiority

Derivation of Capabilities Needed

Derivation of priority in defense technology

Detailed Functions
- Core Equipment

Future Weapon System Technologies
- Technical Areas
- Direction of Efforts

Potential Technologies
MEDIUM-TO-LONG TERM DEFENSE TECHNOLOGY OUTLOOK
-Key Points in the Capability Derivation (Examples)-

Changes in Operational Environment

Network-Centric Warfare

Joint Operation
The helicopter of JGSDF taking off from DD of JMSDF

Intelligence/Information Sharing
# MEDIUM-TO-LONG TERM DEFENSE TECHNOLOGY OUTLOOK
## -Capabilities Needed in the Future-

<table>
<thead>
<tr>
<th>Category</th>
<th>Capability Needed</th>
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</thead>
<tbody>
<tr>
<td><strong>Response to New Threats and Diverse Contingencies</strong></td>
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<tr>
<td>Defense against Ballistic and Cruise Missiles</td>
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<tr>
<td>Defense Against Guerrillas and Special Operation Forces</td>
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<tr>
<td><strong>Counter-terrorism</strong></td>
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<tr>
<td>Defense against Cyber Attacks</td>
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<tr>
<td>Counters to Armed special operation Vessels</td>
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<tr>
<td>Defense against aggression on Offshore Island</td>
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<tr>
<td>International Peace Cooperation</td>
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<tr>
<td><strong>Network-Centric Warfare</strong></td>
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<tr>
<td>Command &amp; Control</td>
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<tr>
<td>Intelligence</td>
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<tr>
<td>Information Sharing</td>
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<tr>
<td><strong>Others</strong></td>
<td></td>
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<tr>
<td>Improved Efficiency of R&amp;D activities</td>
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</tbody>
</table>
Counter-terrorism

Characteristics
- Mobility
- Surprise attack
- Simultaneous multiple attacks
- Difficulty in sign recognition
- Importance of early warning
- Wide area and multiple fronts surveillance
- Damage assessment
- Communication
- Information sharing
- NBC attack

Functions
- Ground mobility
- Intelligence
- Information sharing
- Counter NBC

Core Equipment
- Platform
- Intelligence /Sensors
- Unmanned Systems
- C3I
- NBC Counter measures
<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unmanned System</strong></td>
<td>Formatively operational multiple Robots system</td>
</tr>
<tr>
<td>Technology Area</td>
<td>1. UGV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unmanned System</strong></td>
<td>High altitude and long endurance; Autonomy in flight/Combat; Portability</td>
</tr>
<tr>
<td>Technology Area</td>
<td>2. UAV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unmanned System</strong></td>
<td>UUV: Underwater autonomy; Networking with platforms for situation awareness, target detection, judgment, communication and attack USV: Remote control; Autonomous navigation; Mobility; Seaworthiness</td>
</tr>
<tr>
<td>Technology Area</td>
<td>3. UUV/USV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soldier System</strong></td>
<td>Physical protection from diverse threats; Intelligent munitions; Battle-space situation awareness</td>
</tr>
<tr>
<td>Technology Area</td>
<td>4. Soldier System</td>
</tr>
<tr>
<td>Technology Area</td>
<td>Core Equipment</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>5. NBC protection/detection/decontamination</td>
<td>NBC Counter measure</td>
</tr>
<tr>
<td>6. Vessel</td>
<td>Platform</td>
</tr>
<tr>
<td>7. Fighter Aircraft</td>
<td>Platform</td>
</tr>
<tr>
<td>8. Sensor</td>
<td>Intelligence/Sensor</td>
</tr>
</tbody>
</table>

**MEDIUM-TO-LONG TERM DEFENSE TECHNOLOGY OUTLOOK -Future Weapon System Technologies 2/4-**

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<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Future Weapon System Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technology Area</td>
</tr>
<tr>
<td></td>
<td>Direction of Efforts</td>
</tr>
<tr>
<td>Precision Guided Weapon</td>
<td></td>
</tr>
<tr>
<td>9 System</td>
<td>Interception of small and high speed targets with short to long range</td>
</tr>
<tr>
<td>10 Components</td>
<td>High miniaturization; Terrain data-position data-matching; Micro optical seeker; Semi-active millimeter wave seeker; Passive radio seeker; High performance propulsion system; Safe propellant</td>
</tr>
<tr>
<td>11 Ammunition</td>
<td>Multifunction and precision guidance; Terminal guidance; Insensitiveness and safety</td>
</tr>
<tr>
<td>12 Directed Energy Weapon technology</td>
<td>Lethal or non-lethal destruction by the irradiation of high-power laser or microwave</td>
</tr>
<tr>
<td>M&amp;S/ System Integration</td>
<td></td>
</tr>
<tr>
<td>13 Integrated Simulation</td>
<td>Integrated simulation creating battlefield with various types of equipment systems and enabling simulated battles in virtual reality</td>
</tr>
<tr>
<td>14 Aircraft System Integration</td>
<td>Sustainment and improvement of technology base for the system integration of small, high-performance aircraft; In-flight demonstrations of advanced technologies</td>
</tr>
</tbody>
</table>
### Future Weapon System Technologies - Platform

<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Technology Area</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform</td>
<td>Ground Vehicle</td>
<td>Remote control; Following drive; Lightweight armor; Stealth; Electrical drive; Generator; Electromagnetic suspension; Long cruising range</td>
</tr>
<tr>
<td></td>
<td>Helicopter</td>
<td>Load handling capacity; Crashworthiness; All-weather operation; High performance and efficiency</td>
</tr>
</tbody>
</table>

### Future Weapon System Technologies - Intelligence / Sensor

<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Technology Area</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>Sonar</td>
<td>Sonar for shallow waters</td>
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</tbody>
</table>

### Future Weapon System Technologies - Counter Electronic Attack

<table>
<thead>
<tr>
<th>Core Equipment</th>
<th>Technology Area</th>
<th>Direction of Efforts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter</td>
<td>Information Electronic</td>
<td>Highly secure and encrypted command and communication system; Information EW system for protecting communications</td>
</tr>
<tr>
<td>Electronic</td>
<td>Warfare</td>
<td></td>
</tr>
<tr>
<td>Attack</td>
<td>Counter Electromagnetic</td>
<td>Countermeasures against electromagnetic attacks</td>
</tr>
<tr>
<td>Attack</td>
<td>Network</td>
<td>Software radio; Wideband and high-power device; Robust and large capacity field digital communication network system</td>
</tr>
</tbody>
</table>

**MEDIUM-TO-LONG TERM DEFENSE TECHNOLOGY OUTLOOK**

**Future Weapon System Technologies 4/4**
MEDIUM-TO-LONG TERM DEFENSE TECHNOLOGY OUTLOOK
- Potential Technologies and Applications 1/2 -

**Potential Technologies**

- **Power Storage**
  - Small lightweight power source for the extension of operational endurance and range

- **CNT Device**
  - Small lightweight power source for the extension of operational endurance and range

- **Human Power Amplifier**
  - Information and communication device embedded in lightweight soldier suits
  - Portable power source for human loads reduction and long operations

- **Power MEMS**
  - Assistance of elaborate works and high mobility for quick operations, long operations and the increase of firearms and armors

- **Terahertz Application**
  - Quick detection of B and C agents in wide areas; Remote sensing for personnel protections

- **Bio-Sensor**
  - Improvement of B agent detections for quick intelligence and analysis; Small detector
  - Small lightweight guidance and control unit for the extension of the missile range

**Expected Capabilities**

- **Electronic parts for micro and high performance UAVs**

- **Unmanned System**
  - NBC Countermeasure
  - Soldier System
  - Precision Guided Weapon (1/2)

**Core Equipment**

CNT: Carbon Nano-Tube
Potential Technologies

- Nano-Composite Material
- Superconductive Electromagnetic Propulsion
- Functional Composite
- Image Sonar
- Photonic Crystal
- Digital Watermarking
- Quantum Cryptography

Expected Capabilities

- Lightweight missile body for the improvement of agility and the extension of range
- Lightweight aircraft body for the improvement of agility and the extension of range
- Submarine powerplant for the improvement of mobility and the reduction of detectability
- Heat-resistant material for lightweight and long-life engine parts
- Efficient small lightweight image sonar for the improvement of target classifications and identifications
- High performance computing for quick and accurate intelligence
- Long, low-noise and robust optical communication for efficient joint operations and quick and accurate intelligence
- Highly secured network system
- Highly secured network system

Core Equipment

- Precision Guided Weapon(2/2)
- Platform
- Intelligence/Sensor
- C3I
TRDI ORGANIZATION AND FEATURES
-Organization of OD-

Since September 1, 2007

Cabinet
Prime Minister

Minister of Defense

Internal Bureau

Joint Staff Office
- Ground Self Defense Force
- Maritime Self Defense Force
- Air Self Defense Force
- Defense Intelligence HQ
- Equipment Procurement & Construction Office

Technical Research and Development Institute (TRDI)

Local Bureaus
- The Inspector General’s Office of Legal Compliance
- National Institute for Defense Studies
- National Defense Academy
- National Defense Medical College
TRDI ORGANIZATION AND FEATURES
-TRDI Organization-

Managerial Departments

- Administration Div.
  - Finance Div.
  - Technical Policy & External Affairs Div.
  - Technical Information Div.
  - Programs Management Div.
  - Programs Development Div.
- Plans Dep.
- Programs Dep.

Research Centers

- Air Systems
  - Niijima Branch
- Ground Systems
- Naval Systems
  - Kawasaki Branch
- Electronics Systems
  - Iioka Branch
- Advanced Defense Tech. Center

Test Centers

- Sapporo
- Shimokita
- Tsuchiura
- Gifu

Minister of Defense
TRDI Director
General
Deputy Director
General
Technical Advisers

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For Pacific Operational Science and Technology Conference, July 2008
Established as sole organization for R&D for Japan Self Defense Forces

Developments conducted based on requirements from each services

No Production Capability
TRDI ORGANIZATION AND FEATURES
-Authorized strength and Budget Classification (JFY08)-

Total: 1,126 (JFY2008)

- Administrative Officials (civilians) 1% (8)
- Research Engineers 47% 533
- Maritime SDF 8% (90)
- Ground SDF 11 (127)
- Air SDF 6% (64)

Civilian 75%
Uniform 25%

Total Budget: ¥183 Billions

- Engineering Model Demonstration and Prototyping: 68%
- In-house Research and Test & Evaluation: 24%
- Personnel & Misc.: 7%
- Test Equipment & Facilities: 1%

Approximately $1,620 Million and 3.9% of Defense Budget
TRDI CURRENT MAJOR R&D ACTIVITIES

-New Tank-

Successor to the current MBT

Features:

- Improved firepower, protection and mobility
- Advanced C4I system
- Light weight
Next-Generation Patrol Aircraft (XP-1)
Used for persistent broad area maritime surveillance and patrol as the replacement of the P-3C.

Next-Generation Cargo Aircraft (C-X)
Used for domestic and international airlift as the replacement of the C-1.

Commonality
To reduce life-cycle cost by using common structures and subsystems
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TRDI CURRENT MAJOR R&D ACTIVITIES
-Concept of BMD Deployment and Operation (image diagram)-

Mid-course phase
In this phase, the rocket engine has completed burning and the missile is flying in space (exoatmosphere) with inertia

Boost phase
In this phase, the rocket engine is burning and accelerating the missile just after the launch

Detection / tracking by a variety of sensors (ground-based radars / Aegis)

Upper-tier (exoatmospheric) interception by Aegis BMD

Lower-tier interception (after atmospheric re-entry) by the Patriot PAC-3

Terminal phase
This phase covers the part from atmospheric re-entry to the impact.

Ballistic missile

ASDF anti-aircraft units

Protection zone

ASDF Japan Aerospace Defense
Ground Environment

Aegis BMD Protection zone

BMD task force commander

Protection zone

Patriot PAC-3 (improvement to existing systems + acquisition of missiles)

Ground-based radars
Existing radars (improved)
New-type radars

MSDF component units

Aegis vessels
(Improvement to existing systems + acquisition of missiles)

ASDF’s air warning and control unit

BMD task force commander

Aegis vessels

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23
JFTM-1 (the KONGO firing test) Overview
- Video -
UNCLASSIFIED

TRDI CURRENT MAJOR R&D ACTIVITIES
- BMD Related Project Activities -

<table>
<thead>
<tr>
<th>JFY</th>
<th>1999</th>
<th>2000</th>
<th>01</th>
<th>02</th>
<th>03</th>
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<th>06</th>
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<th>09</th>
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<tbody>
<tr>
<td>Bilateral Study</td>
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JAPAN/U.S. Cooperative BMD Research Project

SM-3 Cooperative Development Project

JAPAN/U.S. Radar Research Project

BMD Open Architecture Research Project

Nosecone  IR Seeker  Divert and Attitude Control System  2nd Stage Rocket Motor

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## TRDI INTERNATIONAL COOPERATION ACTIVITIES

**-Transition of US-JP Technology Cooperation-**

<table>
<thead>
<tr>
<th>Year Range</th>
<th>1950s</th>
<th>1960s</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
<th>2000s</th>
<th>2010s</th>
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<tr>
<td></td>
<td>Data Exchange Agreement (DEA) (1962)</td>
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<td>Three Principles of Arms Export 1967</td>
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<td></td>
<td>Exemption of Cooperative BMD Development and Production (2004Dec10)</td>
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<td>Systems &amp; Technology Forum (S&amp;TF) 1980</td>
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<td>E/N Concerning the Transfer of Military Technologies</td>
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### Technology Transfer

**ONE Way Flow from US to JP**
- MAP
- FMS
- License Production

**Two Way Flow**
- FS-X
- Cooperative R&D
- ESEP
TRDI INTERNATIONAL COOPERATION ACTIVITIES
-Advanced Technologies adapted in F2 Cooperative Development-

**Wing**
- Co-cured composite materials

**Body / Tail**
- Advanced materials

**Windshield**
- Reinforced windshield

**Advanced avionics**
- Phased array radar
- Fly-by-wire system
- Integrated EW system
<table>
<thead>
<tr>
<th>1990’</th>
<th>2000’</th>
<th>2010’</th>
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<tbody>
<tr>
<td></td>
<td>Ducted Rocket Engine (92-99)</td>
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<td>Advanced Steel Technology (95-02)</td>
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<td>Fighting Vehicle Propulsion Using Ceramic Materials (95-02)</td>
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<td>Eye Safe Laser Radar (96-01)</td>
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<td>Advanced Hybrid Propulsion Technology (98-05)</td>
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<td>Sallow Water Acoustic Technology (99-03)</td>
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<td>BMD Technology (99-08)</td>
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<td>Low Vulnerability Ammunition for Artillery (00-04)</td>
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<td>Software Radio (02-07)</td>
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<td>Avionics Abroad the Follow-on Aircraft to the P3-C (02-06)</td>
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<td>Advanced Hull Material/ Structural Technology (05-)</td>
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<td>Japan-US Radar Research (06-)</td>
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<td>BMD Open Architecture Research (06-)</td>
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<td>SM-3 Cooperative Development (06-)</td>
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<td></td>
<td>Palm-sized Automated Chemical Agent Detector (08-)</td>
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</tbody>
</table>
TRDI INTERNATIONAL COOPERATION ACTIVITIES

-Software Radio-

Research on the Software Radio which change optimum communication mode easily by software downloadable function.

Project conducted from 2002 to 2007

US: Joint Tactical Radio System (JTRS) JPO, DoD
JA: 2nd RC (current Electronic Systems Research Center), TRDI

Features:
- Software Communication Architecture
- Wideband Antenna & RF module
- Ensure interoperability and invulnerability
TRDI INTERNATIONAL COOPERATION ACTIVITIES
-Palm-sized Automated Chemical Agent Detector (PACAD)-

Research on Palm-sized/All-in-one automated chemical agent gas detector based on the chemistry of the M256A1 chemical agent detector.

**Features:**
- High sensitivity and low false detection by the chemistry of M256A1
- Automated Detection by using EO device
- Small and lightweight
- One-man Operation
- Enable Day/Night Operation

Project Status: The MOU was signed in March, 2008

**US: ECBC, RDECOM**
**JA: Advanced Defense Technology Center (ADTC), TRDI**
TRDI INTERNATIONAL COOPERATION ACTIVITIES
-Engineers and Scientists Exchange Programs (ESEP)-

Research Organization Under DoD

Mutual Receipt of Engineers/Scientist to their Research Organizations

2000'

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
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<tbody>
<tr>
<td>2000'</td>
<td>ESEP MOU Signed (03)</td>
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<tr>
<td>2003</td>
<td>TRDI to CERDEC (03-04)</td>
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<tr>
<td>2004</td>
<td>TRDI to ARDEC (05-06)</td>
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<tr>
<td>2005</td>
<td>TRDI to NSWC (06-07)</td>
</tr>
<tr>
<td>2006</td>
<td>ARDEC to TRDI (07)</td>
</tr>
<tr>
<td>2007</td>
<td>TRDI to NUWC (07-)</td>
</tr>
<tr>
<td>2007</td>
<td>AFRL to TRDI (Expected)</td>
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<tr>
<td>2007</td>
<td>Natick Soldier Center to TRDI (Expected)</td>
</tr>
</tbody>
</table>
## TRDI INTERNATIONAL COOPERATION ACTIVITIES
### Promotion of International Technology Cooperation

<table>
<thead>
<tr>
<th>Country</th>
<th>Organization</th>
<th>Technical cooperation status</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>DGA</td>
<td>▪ Unclassified Technical Information Exchange</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Conducting Mutually Hosting Technical Seminar</td>
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<td></td>
<td></td>
<td>▪ Research Cooperation</td>
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<tr>
<td></td>
<td></td>
<td>- Comparative Testing of Large Cavitation Channels</td>
</tr>
<tr>
<td>Sweden</td>
<td>FOI</td>
<td>▪ Unclassified Technical Information Exchange</td>
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<tr>
<td></td>
<td></td>
<td>▪ Research Cooperation</td>
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<tr>
<td></td>
<td></td>
<td>- Attachment of Post Doc Researcher</td>
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<tr>
<td>UK</td>
<td>DSTL</td>
<td>▪ Unclassified Technical Information Exchange</td>
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<tr>
<td></td>
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<td>▪ Reciprocal Visit</td>
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<tr>
<td>South Korea</td>
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<td>▪ Unclassified Technical Information Exchange</td>
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<tr>
<td></td>
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<td>▪ Reciprocal Visit</td>
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<tr>
<td>Germany, Australia</td>
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<td>▪ Unclassified Technical Information Exchange</td>
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<tr>
<td>Canada</td>
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