PROJECT FOR RESEARCH AND DEVELOPMENT OF DEMINING RELATED EQUIPMENT IN CAMBODIA

No. 5

TRANSPORTATION

SWING TYPE MACHINE
15. TRANSPORTATION OF THE MACHINE DURING TEST

With lack of CMAC transport vehicle big enough to move demining machine from port to the test field and via versa, Transido which is a private transportation company, had been hired to provide this services under close cooperation with CMAC. During transportation, transido took care of transport, safety and insurance while CMAC would conduct the offload and reload the machine/to/from truck trailer or to/from ship at international Sihanouk ville port. Road assessment and route selection prior to transportation will be done by CMAC and transido.

Transport company address:

TRANNSINDO JAPAN CAMBODIA CO., LTD.
#29, MAO TSE TOU NG STREET, PHNOM PENH, CAMBODIA
TEL: +855.23.217061 FAX: +855.23.216524

The selection of the transport route is primary related to total gross weight of the machine (in combination with truck trailer) and the condition of road particularly the condition of the bridge. To open access road to the test site at Siem Reap, a poor, weak wooden bridge was dismantle and a new concrete bridge strong enough to support the gross weight of the demining machines was constructed. In other area, steel plates had been temporary laid on top of the existing pipe culvert to strengthen the structure and potholes had been refilled by earth/rock or leveled by CMAC bulldozer.

15.1. TRANSPORT FROM SIHANOUKVILLE TO DAM DEK TESTING SITE IN SIEM REAP

- Transport Origin: Sihanouk ville (Cambodia main sea port)
- Transport destination: Dam Dek (Performance test site in Siem Reap)
- Transport Route: Sihanouk ville (sea port) --> Phnom Penh --> Siem Reap (test site)
- Road condition:
  a. Sihanouk ville to Phnom Penh: National Road No. 4 – Asphalt – approx. 200km
  b. Phnom Penh to Siem Reap: National Road No. 6 – Asphalt (DBST) – approx. 300km
  c. At Siem Reap: From national road 6 to test site: cross country drive – laterite – approx. 20km

- SHIPMENT (4 ITEMS)

Client: Yamanashi Hitachi Construction machinery Co., Ltd.

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-FV25 main body</td>
<td>Low-bed trailer</td>
</tr>
<tr>
<td>BM307-V33 main body</td>
<td>Low-bed trailer</td>
</tr>
<tr>
<td>Frail Assembly in Wooden Crate</td>
<td>10 wheel truck</td>
</tr>
<tr>
<td>Rotor cutter in Wooden Crate</td>
<td>12 wheel truck</td>
</tr>
</tbody>
</table>

Schedule:

July 17 05:00 BM307-FV25 main body, BM307-V33 main body, Frail Assembly Rotor cutter left Sihanouv iille 17:20 All machineries arrived at Phnom Penh

July 18 05:00 all machineries left Phnom Penh 15:10 we arrived Dam Dek in Siem Reap and BM307-FV25 main body, BM 307-V33 rolled off on main road and self-drive 18:00 BM 307-V33 and BM 307-V25 arrived the testing site by self-drive
15.2. TRANSPORT FROM THE MINE TESTING SITE IN SIEM REAP TO BATTAMBANG WORKSHOP

- Transport Origin: Dam Dek (Performance test site in Siem Reap)
- Transport destination: CMAC workshop at Battambang
- Transport Route: Siem Reap --> Phnom Penh --> Battambang (CMAC workshop). Shortcut road from Siem Reap to Battambang by Banteay Meanchey could not be used due to poor condition of road and bridges.
- Road condition:
  a. From Siem Reap to Phnom Penh: National Road No. 6 – Asphalt – approx. 300km
  b. Phnom Penh to Battambang: National Road No. 5 – Asphalt (DBST) – approx. 300km

Client: Yamanashi Hitachi Construction machinery Co., Ltd.
Cargo:

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
<th>Transport</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-FV25 main body</td>
<td>Low-bed trailer</td>
<td>Mine Testing Site to BTB W/S</td>
<td></td>
</tr>
<tr>
<td>Frail Assembly, Bucket &amp; Rotor cutter (3 tons)</td>
<td>2x 2m truck</td>
<td>Mine Testing Site to BTB W/S</td>
<td></td>
</tr>
<tr>
<td>Mobile Work Shop</td>
<td>6m truck</td>
<td>Mine Testing Site to BTB W/S</td>
<td></td>
</tr>
</tbody>
</table>

Schedule:
- September 11, 2006
  08:00  Loading Frail Assembly, Bucket & Rotor Cutter to 2x12m truck
  08:45  Self-Driving Mobile Workshop to 6m truck
- September 14, 2006
  06:00  Self-driving 1 unit of BM307-FV25 Demining Machine from Mine Testing Site to asphalt road and roll on Low-bed-trailer
  20:50  Arrived Phnom Penh.
- September 15, 2006
  06:00  Leaving Phnom Penh for BTB W/S
  16:45  Arrived BTB W/S and delivered.

Client: Yamanashi Hitachi Construction Machinery Co., Ltd.
Cargo:

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
<th>Transport</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-V33 main body</td>
<td>Low-bed trailer</td>
<td>Mine Testing Site to BTB W/S</td>
<td></td>
</tr>
</tbody>
</table>

Schedule:
- September 17, 2006
  06:00  Self-driving 1 unit of BM307-V33 Demining Machine from Mine Testing Site to asphalt road and roll on Low-bed-trailer
  21:50  Arrived Phnom Penh.
- September 18, 2006
  06:00  Leaving Phnom Penh for BTB W/S
  17:00  Arrived BTB W/S and delivered.
15.3. TRANSPORT FROM CMAC WORKSHOP TO THE MINE FIELD

- Transport Origin: CMAC workshop at Battambang
- Transport destination: O dounpov acceptance test site
- Transport Route: Battambang --> Kbal Kmaoch --> Kamping puoy --> O dounpov. We do not use another route (through Bovel district) due to poor condition of the bridge at one place.
- Road condition:
  a. Battambang to Kbal Kmaoch: National road No. 5 - Asphalt (DBST) – approx. 20km
  b. Kbal Kmaoch to Kamping puoy: Old DBST road (rocky) with many holes – approx. 20km
  c. Kamping puoy to O dounpov: Laterite road (average condition) – approx. 15 km

ROAD SURVEY AND PREPARATION WORKS:

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 03</td>
<td>road survey from Battambang workshop to the mine field at O doun Pov village</td>
</tr>
<tr>
<td>October 05</td>
<td>We bought and paved 2 trucks of stones (18m³ per truck) on the road in Ta-ngeen village</td>
</tr>
<tr>
<td>October 06</td>
<td>We bought and paved 2 trucks of stones (18m³ per truck) on the road in Ta-ngeen village. We removed the concrete poles by Unic crane truck</td>
</tr>
</tbody>
</table>

FIRST SHIPMENT (2 ITEMS)

Client: Yamanashi Hitachi Construction machinery Co., Ltd.
Cargo:
- BM307-FV25 main body loaded on a low-bed trailer
- A frail assembly loaded on a 10 wheel truck
Schedule:

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 07</td>
<td>Loading at CMAC Workshop from 2PM</td>
</tr>
<tr>
<td>October 08</td>
<td>05AM The convoy left CMAC workshop.</td>
</tr>
<tr>
<td></td>
<td>10AM Low-bed trailer with the main body arrived to Kamping Puoy</td>
</tr>
<tr>
<td></td>
<td>11:40 The 10 wheel truck with a frail assembly arrived to “C0” Point.</td>
</tr>
<tr>
<td></td>
<td>12:20 The main body arrived to “C0” Point by self-driving.</td>
</tr>
<tr>
<td></td>
<td>12:30 – 13:40 Assembling the main body and the attachment.</td>
</tr>
<tr>
<td></td>
<td>13:40 BM 307-FV25 left “C0” demining machine moving by self-driving.</td>
</tr>
<tr>
<td></td>
<td>17:50 BM 307-FV25 machine got stuck in a big hole near the Mine field.</td>
</tr>
<tr>
<td>October 09</td>
<td>12:10 BM 307-FV25 was removed from a big holes</td>
</tr>
<tr>
<td></td>
<td>13:30 BM307-FV25 arrived to the mine field.</td>
</tr>
</tbody>
</table>

SECOND SHIPMENT (5 ITEMS)

Client: Yamanashi Hitachi Construction Machinery Co., Ltd.
Cargo:
- BM307-V33 main body loaded on a low-bed trailer
- BM307-ED40 loaded on a 9m truck
- Counter Weight (8.5 tons) loaded on a 9m truck
- Frail Assembly (4.5 tons) loaded on a 9m truck
- Bucket & Rotary Cutter (3 tons) loaded on a 9m truck
Schedule:

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 09</td>
<td>Loading at CMAC Workshop</td>
</tr>
<tr>
<td>October 10</td>
<td>05AM The convoy left CMAC Workshop</td>
</tr>
<tr>
<td></td>
<td>11:40 Low-bed trailer with main body arrived to Kamping Puoy</td>
</tr>
<tr>
<td></td>
<td>12:10 4 trucks arrived to “C0” point.</td>
</tr>
<tr>
<td></td>
<td>12:40 The mobile workshop was rolled off and was self-driven. An empty truck and 03 trucks left “C0”.</td>
</tr>
<tr>
<td></td>
<td>14:20 Mobile workshop was rolled on the truck again.</td>
</tr>
<tr>
<td></td>
<td>15:30 3 trucks arrived to the bridge at Oudoun Pov.</td>
</tr>
<tr>
<td></td>
<td>15:50 Off-loading the attachments from the three trucks was completed.</td>
</tr>
<tr>
<td></td>
<td>16:40 The truck with Mobile Workshop arrived to the bridge at Oudoun Pov.</td>
</tr>
<tr>
<td></td>
<td>17:20 The Mobile Workshop arrived at the Mine field by self-driven.</td>
</tr>
<tr>
<td></td>
<td>18:30 BM307-V33 main body arrived to the bridge near the mine field.</td>
</tr>
<tr>
<td></td>
<td>19:20 finished re-attaching the counter weights to BM307-V33 main body.</td>
</tr>
</tbody>
</table>
15.4. TRANSPORT FROM THE MINE FIELD TO BATTAMBANG WORKSHOP

- Transport Origin: O dounpov acceptance test site
- Transport destination: CMAC workshop at Battambang
- Transport Route: O dounpov --> Kamping puoy --> Kbal Kmaoch --> Battambang. We do not use another route (through Bovel district) due to poor condition of the bridge at one place.
- Road condition:
  a. O dounpov to Kamping puoy: Laterite road (average condition) – approx. 15 km
  b. Kamping puoy to Kbal Kmaoch: Old DBST road (rocky) with many holes – approx. 20 km
  c. Kbal Kmaoch to Battambang: National road No. 5 - Asphalt (DBST) – approx. 20 km

- ROAD SURVEY AND PREPARATION WORKS

  November 13 road survey from Battambang workshop to the mine field at Oudoun Pov village
  November 14 We bought and paved 4 trucks of stones (18m³ per truck) on the road.
  November 15 We bought and paved 3 trucks of stones (18m³ per truck) on the road.
  November 16 We bought and paved 3 trucks of stones (18m³ per truck) on the road.

- FIRST SHIPMENT (2 ITEMS)

  Client: Yamanashi Hitachi Construction machinery Co., Ltd.
  Cargo:
<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
<th>Transport by truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-FV25 main body</td>
<td>Low-bed trailer</td>
<td>MNF2- BTB W/S</td>
</tr>
<tr>
<td>Frail Assembly</td>
<td>10 wheel truck</td>
<td>MNF2- BTB W/S</td>
</tr>
<tr>
<td>Bucket &amp; Rotor cutter (3 tons)</td>
<td>12 wheel truck</td>
<td>MNF2- BTB W/S</td>
</tr>
</tbody>
</table>

  Schedule:

  November 20 05:00 We left Battambang
  07:45 We arrived to the mine field.
  08:45 Complete loading and left the site
  09:50 BM307-FV25 main body arrived Co. and rolled off
  11:30 BM307-FV25 main body arrived at Komping Pouy and re-rolled on the trailer.
  11:50 The trailer with BM307-FV25 main body left Komping Pouy
  14:10 Frail Assembly, Bucket and Rotor cutter arrived BTB W/S.
  15:45 BM307-FV25 main body arrived to Battambang Workshop

  November 21 At Battambang Workshop
  07:20 Rolled off the BM307-FV25 main body
  07:40 Discharging the Bucket & Rotor cutter (3 tons)
  11:20 Discharging the Frail Assembly

- SECOND SHIPMENT (5 ITEMS)

  Client: Yamanashi Hitachi Construction Machinery Co., Ltd.
  Cargo:
<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
<th>Transport by truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-V33 main body</td>
<td>Low-bed trailer</td>
<td>MNF2-Co and KOMPING POUY – BTB W/S</td>
</tr>
<tr>
<td>BM307-ED 9m truck</td>
<td>9m truck</td>
<td>MNF2-BTB W/S</td>
</tr>
<tr>
<td>Counter Weight (8.5 tons)</td>
<td>9m truck</td>
<td>MNF2-BTB W/S</td>
</tr>
</tbody>
</table>

  Schedule:

  November 22 05:00 We left Battambang
07:00 We arrived to the mine field.
07:50 Complete loading and left the Mine Field
09:10 BM307-V33 main body arrived Co.
11:00 BM307-V33 main body arrived Komping Pouy by self-driving and re-rolled on the trailer
11:20 BM307-V33 main body left Komping Pouy to Battambang W/S
14:20 BM307-ED Mobile workshop and Counter Weight (8.5 tons) arrived at BTB W/S.
16:10 BM307-V33 main body arrived BTB W/S.

November 23
07:10 Rolled off the BM307-V33 main body
08:00 BM307-ED mobile work shop rolled off
09:10 Discharging and re-installing the counter weight onto main BM307-V33 Main body.

15.5. TRANSPORT FROM BATTAMBANG CMAC WORKSHOP TO SIEM REAP REGIONAL CENTER

- Transport Origin: CMAC workshop at Battambang
- Transport destination: CMAC Siem Reap Regional Centre
- Transport Route: Battambang --> Phnom Penh --> Siem Reap (CMAC regional center).
  Shortcut road from Battambang to Siem Reap by Banteay Meanchey could not be used due to poor condition of road and bridges.
- Road condition:
  a. Battambang to Phnom Penh: National Road No. 5 – Asphalt (DBST) – approx. 300km
  b. From Phnom Penh to Siem Reap: National Road No. 6 – Asphalt – approx. 300km

- SHIPMENT (4 ITEMS)

  Client: Yamanashi Hitachi Construction machinery Co., Ltd.

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-FV25 main body</td>
<td>Low-bed trailer</td>
</tr>
<tr>
<td>BM307-V33 main body</td>
<td>Low-bed trailer</td>
</tr>
<tr>
<td>Frail Assembly in Wooden Crate</td>
<td>10 wheel truck</td>
</tr>
<tr>
<td>Rotor cutter in Wooden Crate</td>
<td>12 wheel truck</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 28 14:00 Starting Loading at Battambang CMAC Workshop</td>
</tr>
<tr>
<td>16:50 Completed Loading</td>
</tr>
<tr>
<td>November 29 05:00 BM307-FV25 main body, BM307-V33 main body, Frail Assembly</td>
</tr>
<tr>
<td>Rotor cutter left Battambang</td>
</tr>
<tr>
<td>17:20 All machineries arrived at Phnom Penh</td>
</tr>
<tr>
<td>November 30 05:00 all machineries left Phnom Penh</td>
</tr>
<tr>
<td>15:10 we arrived Siem Reap and Off-loading at Siem Reap Regional Center</td>
</tr>
<tr>
<td>December 01 The empty trailers returns to Phnom Penh</td>
</tr>
</tbody>
</table>

Please note: December 01 2006: We moved the 2 pcs of attachments of Komatsu Demining Machines from Ex-testing site in Dam Dek to Regional Center.
15.6. TRANSPORT FROM THE CMAC REGIONAL CENTER IN SIEM REAP TO SIHANOUKVILLE

- Transport Origin: CMAC regional center at Siem Reap
- Transport destination: Sihanouk ville (Cambodia main sea port)
- Transport Route: Siem Reap (CMAC regional center) --> Phnom Penh --> Sihanouk ville (sea port)
- Road condition:
  a. Siem Reap to Phnom Penh: National Road No. 6 – Asphalt (DBST) – approx. 300km
  b. Phnom Penh to Sihanouk ville: National Road No. 4 – Asphalt – approx. 200km

Client: Yamanashi Hitachi Construction machinery Co., Ltd.

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
<th>Transport</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-FV25 main body</td>
<td>Low-bed trailer</td>
<td>CMAC Regional Center SRP-to Sihanoukville Port</td>
<td>Sihanoukville Port</td>
</tr>
<tr>
<td>Frail Assembly, Bucket &amp; Rotor cutter (3 tons)</td>
<td>2x2m truck</td>
<td>CMAC Regional Center SRP-to Sihanoukville Port</td>
<td>Sihanoukville Port</td>
</tr>
<tr>
<td>Mobile Work Shop</td>
<td>6m truck</td>
<td>CMAC Regional Center SRP-to Sihanoukville Port</td>
<td>Sihanoukville Port</td>
</tr>
</tbody>
</table>

Schedule:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 28, 2006</td>
<td>15:30</td>
<td>Rolled on 1 unit of BM307-FV25 Demining Machine to Low-bed-trailer in CMAC Regional Center 2, Siem Reap.</td>
</tr>
<tr>
<td>December 29, 2006</td>
<td>06:00</td>
<td>Leaving Siem Reap for Phnom Penh.</td>
</tr>
<tr>
<td></td>
<td>16:40</td>
<td>Arrived Phnom Penh.</td>
</tr>
<tr>
<td>December 30, 2006</td>
<td>06:30</td>
<td>Leaving Phnom Penh to Sihanoukville port.</td>
</tr>
<tr>
<td></td>
<td>16:00</td>
<td>Arrived Sihanoukville port and rolled off.</td>
</tr>
<tr>
<td>December 21, 2007</td>
<td>08:00</td>
<td>Loading Frail Assembly, Bucket &amp; Rotor 2x20CTR to 2x12m truck and rolled on Mobile Workshop to 6m truck. (Storage in Phnom Penh).</td>
</tr>
</tbody>
</table>

Client: Yamanashi Hitachi Construction Machinery Co., Ltd.

<table>
<thead>
<tr>
<th>Cargo</th>
<th>Means of transport</th>
<th>Transport</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM307-V33 main body</td>
<td>Low-bed trailer</td>
<td>CMAC Regional Center SRP-to Sihanoukville Port</td>
<td>Sihanoukville Port</td>
</tr>
</tbody>
</table>

Schedule:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 01, 2007</td>
<td>16:30</td>
<td>Rolled on 1 unit of BM307-V33 Demining Machine to Low-bed-trailer in CMAC Regional Center 2, Siem Reap.</td>
</tr>
<tr>
<td>January 02, 2007</td>
<td>06:30</td>
<td>Leaving Siem Reap for Phnom Penh.</td>
</tr>
<tr>
<td></td>
<td>16:40</td>
<td>Arrived Phnom Penh.</td>
</tr>
<tr>
<td>January 03, 2007</td>
<td>06:30</td>
<td>Leaving Phnom Penh to Sihanoukville port.</td>
</tr>
<tr>
<td></td>
<td>16:00</td>
<td>Arrived Sihanoukville port and rolled off.</td>
</tr>
</tbody>
</table>

Please noted that the M/V MIDORO arrived Sihanoukville port on January 08, 2007
16. GENERAL EVALUATION

This evaluation will take into account the performance of the machine for Anti-personnel mine clearance, the survivability of the machine under Anti-tank mine explosion, repair/maintenance and the transportation of the machine from one location to another.

16.1. POSITIVE VALUE OF DEMINING MACHINE SWING TYPE

- Yamanashi swing type shows good mine clearance result
- The swing has large track that enables it to work in both seasons in Cambodia in all kind of environment particularly in muddy and soft ground.
- Quick hitch: easy to change and fast to change its attachment which enables the operator to switch from rotary cutter to other buckets. The change is operated by hydraulic system.

- The swing has an arm and mechanism that enables it to conduct self-recovery during bogged down. This excellent capability enables planner and operator to trust the machine in mobility which in turn the machine could be deployed in various locations and all kind of terrain.
- The view from the cabin is excellent enable the machine to spot aboveground mines or other obstacle.
- Swing type could extend its arm up to 9m each side (total 18m), thus enable the machine to work at great area with less mobility which in turn save fuel consumption.
- Swing system has the capability to remove the tree in such a way that selected individual tree (if necessary) could be left intact without interference with its mine clearance work.
- The operator could easily spot whether the rotary is working or not, therefore, the operator could cease an operation with part of the flail system is not working up to the design standard.
- Demining swing machine could rotate 360 degree and its arm could circle around obstacle, thus enables the machine to clear 100% of target area.
- Swing type system has its automatic re-oil system which enable daily maintenance faster thus could spend long hour in minefield.
- Its attachment has the capability to push the tree down, hold and remove the obstacle.
- BM307-V33 could be used to support development and other purposes (to excavate in order to recover remnant of war or other explosive objects in the ground, dig canal for water sources...etc). or it could help carry heavy object in case of emergency (see figure below).
- The operator could survive from Anti-tank blast without sustaining any injury (explode under the attachment).
- The machine could be able to operate from the blast site enable the operator to direct machine to safe area for repair thus reduce the cost for recovery.
- The damage from Anti-tank blast is minor to the attachment. Ordinary CMAC mechanics could repair the machine on site thus maximizing the present of the machine in the field.
16.2. NEGATIVE VALUE OF DEMINING MACHINE SWING TYPE

- Holder, chain and hammers are prone to damage and required frequent maintenance, check and repair.
- Clearance productivity rate of this machine using flail system is lower than the requirement.
- With current weight of 37 tons, it is too heavy to transport across country where there are many poor bridges. Newly built bridge at country site could normally support only 25 tons in load.
- Counter balance is 8 tons and is built in one piece. It is difficult to assemble/disassemble and prevent the flexibility of using less counter weight.

![Counter balance built in one piece](image)

Figure 119: Counter balance is built in one piece

- If this type of machine is deployed to cleared residual minefield where land is considered safe for utilization, then the deployment of this machine could be done at free will. However, if this machine will be used for mine clearance and a second clearance is required after the machine, then the deployment of this machine must take into consideration the potential area to be polluted again by the machine. This is because of rotary rotates in one direction. In contrast, a deployment of the machine in opposite direction resulted to the re-contamination of former cleared area.

![Correct and Incorrect deployment of swing machine](image)

Figure 120: Correct and Incorrect deployment of swing machine
17. GENERAL CONCLUSIONS

After undergone numerous tests: performance, acceptance, survivability, transportation and repair/maintenance, for approximately six months in Cambodia, the result of the test could be summarized as follows:

17.1. CLEARANCE PRODUCTIVITY

<table>
<thead>
<tr>
<th>Description</th>
<th>Machine capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average productivity rate at performance test:</td>
<td>357 m²/h</td>
</tr>
<tr>
<td>Maximum productivity rate:</td>
<td>424.48 m²/hour</td>
</tr>
<tr>
<td>Average productivity rate:</td>
<td>303.4 m²/hour</td>
</tr>
<tr>
<td>True cleared area:</td>
<td>99.97%</td>
</tr>
<tr>
<td>Un-cleared area or area for additional clearance:</td>
<td>0.03%</td>
</tr>
<tr>
<td>True productivity rate is reduced by</td>
<td>15%</td>
</tr>
</tbody>
</table>

Clearance productivity rate of swing machine is limited. This machine need to upgrade or modified in order to achieve the productivity rate of 500m²/h. However, there is one good point about swing type machine is that it’s true cleared area is almost 100% which indicate that this machine could be able to clear all the location in the minefield regardless of tree stump or other obstacle. There is one more point should be put into consideration is that the performance of this machine is changing between clearing low vegetation area and high vegetation. It’s productivity rate is reduce by 15%.

17.2. MINE CLEARANCE QUALITY

<table>
<thead>
<tr>
<th>Description</th>
<th>Machine capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average mine clearance quality:</td>
<td>89%</td>
</tr>
<tr>
<td>Fragment in operation area:</td>
<td>21%</td>
</tr>
<tr>
<td>Fragment out of operation area:</td>
<td>79%</td>
</tr>
<tr>
<td>Maximum distant of flying fragment:</td>
<td>23.55 m</td>
</tr>
<tr>
<td>Average broken mine:</td>
<td>2.8 pieces/mine</td>
</tr>
</tbody>
</table>

Demining machine swing type could break mine into pieces and its clearance quality is considered high. According to the above figure, this machine strikes the ground and dispersed most object at great distant (around 20m forward). The potential to break mine apart is high.

17.3. FUEL CONSUMPTION

<table>
<thead>
<tr>
<th>Description</th>
<th>Machine capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average fuel consumption rate:</td>
<td>34.54 liters/hour</td>
</tr>
<tr>
<td>Average fuel consumption rate (Performance test):</td>
<td>36.1 liters/hour</td>
</tr>
<tr>
<td>Average fuel consumption rate (Acceptance test):</td>
<td>4%</td>
</tr>
<tr>
<td>Productivity - fuel ratio (performance test):</td>
<td>10.34 m²/l</td>
</tr>
<tr>
<td>Productivity – fuel ratio (acceptance test):</td>
<td>8 m²/liter</td>
</tr>
<tr>
<td>Productivity – fuel ratio is decreased by</td>
<td>33%</td>
</tr>
</tbody>
</table>

Fuel consumption of demining machine swing type is fluctuated around 35 liters/hour. It would consume less fuel if the clear area has less vegetation and does not have tree stumps. However, the productivity – fuel ratio is greatly changed.

17.4. MAINTENANCE/REPAIR

<table>
<thead>
<tr>
<th>Description</th>
<th>Machine capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average clearance duration:</td>
<td>3.8 hours/day</td>
</tr>
<tr>
<td>Maximum repair:</td>
<td>3 times/week</td>
</tr>
<tr>
<td>Maximum repair duration:</td>
<td>17 hours/week</td>
</tr>
<tr>
<td>Average repair duration:</td>
<td>3.7 hours/week</td>
</tr>
<tr>
<td>Average productivity/repair:</td>
<td>633 m²/repair hour</td>
</tr>
<tr>
<td>Average work/repair:</td>
<td>2.09 work hour /repair hour</td>
</tr>
</tbody>
</table>
According to the above table, demining machine swing type requires about 17 repair hours to clear one hectare of minefield. Each day it could clear only one morning and requires the whole afternoon for maintenance.

17.5. SURVIVABILITY OF THE MACHINE

The pressure sensor, which was placed in the flail cage of Machine #1 (YAMANASHI S), lost its connection to the measurement system as the anti-tank mine blast blew off the sensor signal wiring. When the sensor signal was lost, the data recorder logged the maximum input of 2.5 MPa as it was designed so. The explosives used were combination of C4 (TNT 2kg) and an Anti-tank mine (TNT 6kg). According to the measured blast pressure data, it seems that the C4 first detonated, and then the TNT 6kg mine blasted.

Section 11.2.5 figure “blast pressure at Yamanashi Hitachi swing type – Anti-personnel mine [2/2] depicts this time sequence. There was about 1ms time delay between the first and second explosions as seen in the time chart. In the time duration of 1ms, sound waves propagate about 0.34m at room temperature, and the travel distance is much smaller than the typical cabin geometry. As shown in section 11.2.1 figure “sound pressure in the yamanashi Hitachi swing type machine – Anti-Personnel mine [2/2]”, for example, the main frequency spectrum of the sound overpressure signal seems to locate in several 10 hertz, and the wavelength of the blast sound wave is estimated to be in the magnitude of several meters. Therefore, the above mentioned two successive blasts may be regarded as a single explosion in view of sound pressure analysis.

The measurement results in Section 11.2 and the analysis results in Section 12 are compared with the FMW Safety criteria in table below:

Table 61: Safety Evaluation on Machine #1 (YAMANASHI HITACHI SWING TYPE)

<table>
<thead>
<tr>
<th>Physical Effect</th>
<th>Body part</th>
<th>FMV Safety Criteria</th>
<th>Mine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Anti-Personnel</td>
<td>Anti-Tank</td>
</tr>
<tr>
<td>Pressure</td>
<td>Ear</td>
<td>No Protection if &lt;200 PA (140dB)</td>
<td>Max 140.81 dB (section 11.2.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check B-Duration</td>
<td>B-duration 89.65 ms (section 12.5.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refer to FMV/Fig.1</td>
<td>i.e., &lt;x-curve in FMV/Fig.1</td>
</tr>
<tr>
<td>Shock Acceleration</td>
<td>Foot/Ankle (on Floor)</td>
<td>Average Acceleration &lt;20G Max Velocity Change &lt; 3m/s</td>
<td>Max 13.82G (section 11.2.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Velocity &lt; 0.01m/s</td>
<td>Max 22.77G, Average 3.42 G (section 11.2.3)</td>
</tr>
<tr>
<td></td>
<td>Spine (on seat)</td>
<td>Average Acceleration &lt; 20G Max Velocity change &lt; 3m/s</td>
<td>Max 4.60G (section 11.2.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max Velocity &lt; 0.004m/s</td>
<td>Max -16.76G, Average -0.98G (section 11.2.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Section 12.5.3)</td>
<td>Velocity &lt; 0.1m/s (Section 12.5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DRI&lt;16 (Max Displacement &lt; 56mm)</td>
<td>Max Displacement &lt; 4mm (Section 12.5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max Displacement &lt; 10mm (Section 12.5.3)</td>
</tr>
</tbody>
</table>

n/a: Not available or applicable

17.5.1. EAR INJURY RISK

The sound pressure exceeded the absolute safety limit of 140dB by about 12.5dB when an anti-tank mine blasted. The sound-level and B-duration point of this sound overpressure falls between X- and W-curves (around the midpoint). (See Fig. 1 in the FMV report.)

17.5.2. FOOT/ANKLE INJURY RISK

No significant acceleration and velocity changes were observed.

17.5.3. SPINE INJURY RISK

No significant acceleration and velocity changes were observed. DRI met the safety requirement with a margin of about x5.
To examine the safety of demining machine operator, the sound pressure and vibration/acceleration in the machine cabin were measured when a mine blasted underneath the machine. The measured data were compared with the FMV safety criteria, and the demining machine tested was found to meet the FMV standard for the acceleration with a sufficient margin, that relates to foot, ankle, and spine injuries. The sound pressure surge in cabins at anti-personnel mine blast was suppressed fairly well and the machines met the FMV goal. Excess sound pressure that requires some protection for the machine operator was observed at anti-tank mine blast in the machine, however. The statements above are based on a single set of experimental data and can hardly be conclusive. It is recommended to conduct an intensive experimental study on the demining machine safety. For example, a slight change in explosive location can yield a very different measurement results.

17.6. TRANSPORTATION

- The machine is too heavy to transport as one piece. It requires disassemble into pieces and transport separately.
- CMAC does not have the capacity to transport the machine due to lack of transport truck bed (CMAC does have the transport truck). Drop-bed type truck is most suitable for this type of machine.
- The weight of the machine is a problem to transport at Cambodia countryside where many road and bridge are in poor condition.

18. RECOMMENDATION

- Demining machine swing type weight is too heavy to transport within Cambodia. Most bridge in Cambodia rural area is built to support equipment weight about 25 T. Therefore, it would be best if another model of light weight (Less than 30 T) is used.
- Current attachment is heavy; require frequent and long repair time. New light weight and less – duty repair time is required.
- New attachment must be capable of clearing mine at dry and wet condition faster than the previous attachment. According to our observation, rotary cutter system is recommended (see picture bellow). If this attachment is used the rotary system does not generate pile of earth after each clearance lane, therefore, the machine could be deployed to work in minefield in any pattern: from left to right or from right to left.

![Figure 121: ROTARY CUTTER attachment to be mounted on demining machine swing type](image)
• Equip swing type machine with strong communication system (between operator and deminer)

• Provide a place where operator could recharge his own communication equipment

• Provide a space where operator could keep demining equipment tool such as metal detector (there is a potential that in the future operator will have a multi-skill to operate the machine and to detect suspected object such as landmine, UXO or AT.

• Equip swing type machine with mechanism that could detonate AP mine during mine clearance operation.

• Equip swing type machine with mine counter equipment upon detonation (according to AP blast).

• Counterweight shall be built separately such as 1 ton or 2 tons each. Thus enable the assemble/disassemble work easier. On top of that it gives the flexibility of using less counter balance (if it is required).

• If attachment is changed, additional test shall be initiated to identify the following machine performance:
  o Performance test to identify the efficiency of the machine to clear different type of landmine at different depth, at different soil (soft ground and hard ground)
  o Performance test to identify the vegetation clearance capacity: dense vegetation and light vegetation.

• Additional test shall be initiated to identify the survivability of the machine and the operator by exploding AT mine under the tract.

• Create vibration system or other mechanism that could insert pressure to the ground to explode mines beyond clearing capacity by the rotary system.

• Additional test to identify the mine clearance pattern that could generate more productivity, save time and use less fuel consumption.

• Swing shall have the capability to be able to command by remote control at a distant of 1000m

• Equip digital camera on the machine and live picture could be displayed at remote control box so that operator who use remote control could detect obstacle before directing the machine running into it.

• Equip digital camera if possible so that in conjunction with remote control system the machine could be operated from a safe distant and could be used in an extreme dangerous location or complicated environment (dense vegetation).

• Modify mobile workshop to have the following function:
  o Powerful remote control that can operate demining machine from greater distant (at least 1000 m in bush area.
  o Powerful communication system that could contact the demining machine, call demining unit or contact other emergency or development agencies.
  o Provide support not only to the demining machine but also to deminer who is going to work alongside the machine: a built in water tank to keep clean water for deminer/operator (water is the most important factor for deminer health). Each deminer used lot of water cause of working in hot weather. Currently, they keep water in contaminated used oil container.
  o If space is not a matter, a place to keep demining equipments/tools is excellent.
  o Fragmentation proof so that could be deployed close to demining machine.
  o If possible, equipped with recharge battery tool for deminer’s walkie talkie.

• Build and test another vibration system (mounted on attachment) in the attachment so that it could insert pressure to the ground to explode mine.

• Equipped electric-powered magnetic device mounted behind the machine to collect fragments after demining machine.
• Produce and test another fragment-removal system mounted on a single vehicle (so that it could generate powerful absorption/collection of metal).

• The safety criteria used in this study were originally developed for military vehicles. Demining machines for humanitarian purpose and land development may need a different safety standard as they are rather akin to civilian applications such as road construction. The military standard can assume very abnormal situations and emergency cases, such as an emergency escape from a downed jet fighter. The dynamic human body model used in this study can be based not on Asian but Caucasian bodily statistics. The safety criteria may have to be updated for Asian use and non-military applications.

• Mine blast caused significant damages to the demining machines. Some machine parts came apart and flew away. In view of machine crew protection, the mechanical strength of the machine cabin seems critically important to ensure operator’s safety. Measurement on blast pressure and mechanical strength (i.e., stress and strain) of the demining machine should contribute to optimizing machine safety design, improving machine maintenance, and eventually operator’s safety.
ANNEX 1:
DEMINING MACHINE ACTIVITIES DURING TEST IN PICTURES

### WEATHER IN CAMBODIA DURING TEST

<table>
<thead>
<tr>
<th>Image 1</th>
<th>Image 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Weather Condition" /></td>
<td><img src="image2.jpg" alt="Weather Condition" /></td>
</tr>
</tbody>
</table>

Some of the weather conditions during the test in Siem Reap and Battambang provinces.

### GENERAL CONDITION OF THE TEST SITE

<table>
<thead>
<tr>
<th>Image 3</th>
<th>Image 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.jpg" alt="Test Site Condition" /></td>
<td><img src="image4.jpg" alt="Test Site Condition" /></td>
</tr>
</tbody>
</table>

To O doungov minefield test site

Deminer is building a temporary wooden bridge to O doungov minefield test site

Swing machine helps Komatsu machine out of trouble (stuck in the mud)

Swing type machine got stuck during test
TEST SITES

Demining machine swing in performance test
Demining machine swing in acceptance test site

VERIFICATION OF MINE STATUS AFTER PERFORMANCE TEST

Some mines are destroyed by the machine during test. Good shape mine will be neutralized and analyzed by CMAC expert to identify its status (damaged or still in danger)

SURVIVABILITY TEST

Before the test (just before explosion)  After explosion
**DAMAGED DONE BY THE EXPLOSION**

- Chain was blown away
- Rubber plate to protect dust was blown away
- Some chains are cracked/loose
- Status of the swing attachment after explosion

**REPAIR/MAINTENANCE**

- Most of the repair/maintenance are done on site by CMAC mechanics and Japanese manufacturers.
- Tools and equipments are kept in mobile workshop (Hitachi BM307-EG40)

**TRANSPORTATION TO/FROM TEST SITE**
### OTHER ACTIVITIES

<table>
<thead>
<tr>
<th>Trim tree branch to clear way for transport the machine</th>
<th>Time is well recorded by using double chronometers (just in case)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel quantity is well recorded</td>
<td>CMAC deminer are checking test lane after test by using metal detector Minelab</td>
</tr>
<tr>
<td>CMAC deminer are checking test lane after test by using deep search</td>
<td>Test lane is recorded and photographed</td>
</tr>
</tbody>
</table>
VISITORS
ANNEX 2:
THE BACKGROUND OF CAMBODIA

Figure 1: Cambodia locate in Southeast Asia

COUNTRY:

- Country name (conventional long form): Kingdom of Cambodia
- Country name (local long form): Preahreacheanachakr Kampuchea (phonetic pronunciation)
- Area: 181,035 sq.km
- Border boundary: Laos 541 km, Thailand 803 km, Vietnam 1,228 km; Total: 2,572 km
- Coast line: 443 km

GEOGRAPHY:

- Place in the world: Southeast Asia – Thailand to the west, Lao P.D.R to the north and Vietnam to the east and south.
- Geographic coordinate: 13 00 N, 105 00 E
- Climate: tropical; rainy, monsoon season (May to November); dry season (December to April); little seasonal temperature variation
- Terrain: mostly low, flat plains; mountains in southwest and north
- Government type: multiparty democracy under a constitutional monarchy
- Capital: Phnom Penh (33 N, 104 55 E)

POPULATION AND LANGUAGE:

- Official language: Khmer
- Spoken language: Khmer
- Total population: 14 million (2007 estimated)
- Capital: Phnom Penh (1.3 millions people)
- Ethnics: 90% Khmer, 10% Vietnamese, Chinese and others.
- Foreign Language: English, French (>60 yrs), Russian (40 yrs – 50 yrs) and Japanese
LANDSCAPE

- Flat and green. Only a few meters above sea level. Easy to get flooding
- Most of current flow to the Tonlesap great lake
- Not many mountains except along the border.

CUSTOM

- Many Cambodians do not use eye contact while speaking
- Human head is considered sacred, important and value. Do not touch. Touching head is an insult.
- Short hair is considered gentle and good people. In opposite long hair is considered rude and bad.
- To show respect, hat shall be removed while talking
- To talk to monk, hat must be removed
- Do not call people by their family name. Please call Cambodian by their name especially the last word. Mr. Srey Rithisak for example, people normally call him Mr. Sak or Rithisak in stead of Mr. Srey or Mr. Rithi
- Cambodian is not accustom to use the word “san”. Please do not feel irritate when being called by Cambodian without the word “san”.

CURRENCY

- Cambodian currency is Riel. The smallest note is 100 riels.
- Thai and American currency is widely used in the market.
- There is a possibility of fake money. Please check when get the change

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Tonlesap is the name of the great lake in Cambodia. It absorb large amount of water from the Mekong During the wet season and release it to sea during dry season. This is one of the greatest natural reservoirs in the world.
Bank is available at provincial town. Working hour for the bank is from 8:00 in the morning until 4:00PM. Banks usually close during weekend.

FOOD & WATER
- Unlike Thai food, Cambodian food is not spicy however you got to inform waiter/waitress in advance if you don’t like spicy (when you are traveling close to Thai border).
- Rice and bread are available at market.
- Pack food (obento) could be arranged at market or food store. It cost from 1500 riel ($0.4) to 4500 riels ($1.1) per pack.
- It is convenience to bring pack food to work at all three locations.
- Bottle water is drinkable water. However, ice is not always made from drinkable water.
- Take extra caution with your wallet when go shopping in the market. There is a possibility of pick-pocket.

RELIGION
- Buddhism: similar to the one practice in Thai, Lao and Burma.
- Do not wear hat upon entering the pagoda or monastery compound.
- Do not wear short trouser and entering the monastery compound.
- Do not sit cross leg in front of elderly or monk.
- Offering money, food and utensils to monk is a good ok but cigarette and alcohol items are prohibited.

TELECOMMUNICATION & POST
- Cambodia’s Country Code: 855 (Japan’s country code: 81)
- World time: UTC+7
- Telephone system: adequate landline and/or cellular service in Phnom Penh and other provincial cities; mobile phone coverage is rapidly expanding in rural areas.
- International: adequate but expensive landline and cellular service available to all countries from Phnom Penh and major provincial cities; satellite earth station - 1 Intersputnik (Indian Ocean region).
- Mobile: 1.062 million (2005). Many people use pre-paid mobile phone. Mobile phone and SIM card are available at almost every corner of the street. Pre-paid telephone card ($5, $10, $20, $50) are also available at every phone shop.
- To call abroad, it is cheap to go to any internet shop and make a call.
- Mobile phone could be use at CMAC regional center (about 20km from Siem Reap town) but could not be used at light bush (about 40km from Siem Reap town). You could use mobile phone in light bush if you climb on high ground and use the right direction. Mobile phone could not be used at live minefield in Battambang province.
- We use walkies talkies issued by CMAC for communication (range approximately 1.5km).
- To send package abroad, you could contact DHL or EMS office. This service is expensive.
- To send package locally, you could go to the post office. To be more convenience, you go approach bus office and ask for this service.
- If you want to use internet, you could go to any internet shop. In Siem Reap there are many internet shop. In Battambang, there are not many. Please contact CMAC staff for the address.
- Internet code: .kh; Internet host: 1,378 (2006), Internet user: 41,000 (2005)

ELECTRICITY
- Voltage: 220V
- Cord and Plug: Multi-standard
- Strong sunlight, high potential for generating electricity by sunray.

TRANSPORTATION & TRAVELLING
- Transportation: Keep right (opposite to Japan’s)
- Driving speed in town: between 20km – 30km/h
- Driving speed between town: maximum 80km/h
- Driving speed in the village: Slow
Local roads are mostly made from dirt or laterite. The road is usually narrow and bumping. Using this road must slow down in order:
- Not to generate dust (dry season)
- Not to spill water to nearby passenger (during wet season)
- Not to scare oxcart or local
- Do not go alone. If you have to, please inform somebody and please bring communication equipment (mobile or walkies talkies)
- There are many poor-condition bridges in Cambodia. Please take extra caution when using it. Good bridge could take 25T load. Many other local bridges are made from wood and do not have load limitation warning.
- There is an airport in Siem Reap still in use. There is out-of-business airport in Battambang. In case of accident by landmine, please contact CMAC staff to call medivac (helicopter).
- Fuel and gasoline price are expensive. It is not a good idea to use fuel and
- Merchant marine: total: 544 ships (1000 GRT or over) 1,777,907 GRT/2,529,708 DWT
- Merchant marine by type: bulk carrier 41, cargo 443, chemical tanker 11, container 10, livestock carrier 3, passenger/cargo 4, petroleum tanker 9, refrigerated cargo 19, roll on/roll off 2, specialized tanker 1, vehicle carrier 1
- Merchant marine by foreign-owned: 407 (Bulgaria 1, Canada 6, China 128, Cyprus 12, Egypt 8, Gabon 1, Greece 8, Hong Kong 15, Indonesia 1, Japan 4, South Korea 23, Latvia 2, Lebanon 6, Nigeria 2, Norway 1, Philippines 1, Russia 105, Singapore 4, Spain 1, Syria 20, Taiwan 2, Turkey 26, UAE 1, Ukraine 17, US 8, Yemen 3, unknown 1) (2006)
- Railway: total: 602 km
- Road way: total: 12,323 km
  - paved: 1,996 km
  - unpaved: 10,327 km (2000)
- Airport with pavement runway: total: 6
  - 2,438 to 3,047 m: 2
  - 1,524 to 2,437 m: 2
  - 914 to 1,523 m: 2 (2006)

**BUS AND TAXI**
- There are bus running between the capital and provincial town.
- Many local use motodup (motor-taxi). Please inform them where you want to go and how much does not cost in advice. Price could be negotiable.
- How to recognize motodup? They have no uniform and they use variety of motorcycles. They normally wear hat but you have to use your skill to differentiate. When you need motodup just raise your hand up. Look at the condition of the motorcycle and the driver because making the deal. There is no driving school for motorcycle driver in Cambodia. So do not expect them to know about the traffic rule.
- Helmet is rarely used. Many Cambodian use it to keep dust away.

**WEATHER**
- Weather: Two distinctive seasons: dry and wet seasons. Monsoon rain start from May until October. The peak period is in September (rain could last for the whole month!). This is the most difficult time for Cambodian to commute around. That is why Pchum Ben which is the ceremony to commemorate the death is held in this month. During rainy season, there is a window of dry period which generally start from mid July until mid August.
- Thunder is aggressive especially during raining. Every year at least 10 people lost their lives because of thunder. It is advice to use anti-thunder equipment for every electronic equipment.
- For safety reason, do not stay under the tree during raining.

**DISEASES:**
- Diseases: STD, HIV
- Malaria: Transmitted by mosquito. It is advice to use anti-malaria pill and/or mosquito-repel spray or cream.
- Diarrhea: Un-hygiene water is the main cause. Use bottle water for drinking. Take extra caution when using ice for drinking purpose (ice tea for example).
MINE/UXO PROBLEM:

- Many UXO in Eastern part of the country
- Many Landmine in Western part of the country
- Mine/UXO accident is more than 700 people dead/injured every year
- More than half a million tons of bomb had been dropped by USA in Cambodia, approximately ten percent of which became an Unexploded Ordnance (UXO). Many of the UXO, locate in the eastern part of Cambodia.
- At least 4 millions landmines being polluted over 4,400 km². Many of landmines were laid in western part of Cambodia (along the Thai border). Siem Reap and Battambang provinces are the most mine/UXO contaminated provinces in Cambodia.
ANNEX 3:  
THE HISTORY OF MINE/UXO CONTAMINATION IN CAMBODIA

Most Cambodians consider themselves to be Khmers, descendants of the Angkor Empire that extended over much of Southeast Asia and reached its zenith between the 10th and 13th centuries. Attacks by the Thai and Cham (from present-day Vietnam) weakened the empire ushering in a long period of decline. The king placed the country under French protection in 1863. Twenty years later in 1883, Cambodia became part of French colony. Following Japanese occupation in World War II, Cambodia gained full independence from France in 1953. In April 1975, after a five-year struggle, Communist Khmer Rouge forces captured Phnom Penh and evacuated all cities and towns. At least 1.5 million Cambodians died from execution, forced hardships, or starvation during the Khmer Rouge regime under POL POT. A December 1978 Vietnamese invasion drove the Khmer Rouge into the countryside, began a 10-year Vietnamese occupation, and touched off almost 19 years of civil war. The 1991 Paris Peace Accords mandated democratic elections and a ceasefire, which was not fully respected by the Khmer Rouge. UN-sponsored elections in 1993 helped restore some semblance of normalcy under a coalition government. Factional fighting in 1997 ended the first coalition government, but a second round of national elections in 1998 led to the formation of another coalition government and renewed political stability. The remaining elements of the Khmer Rouge surrendered in early 1999. Some of the remaining leaders are awaiting trial by a UN-sponsored tribunal for crimes against humanity. Elections in July 2003 were relatively peaceful, but it took one year of negotiations between contending political parties before a coalition government was formed. Because of its long and fluctuated history, today Cambodia is one of the most contaminated mine/UXO in the world. The origin of this contamination could be broken down as follows:

- **WORLD WAR II (1940 – 1945)**

  The world was at war between 1940 until 1945. Japanese troops occupied Cambodia then part of Indochina in the early year of the war and by the closing of the war allied planes (French, English and American) appeared over the sky and bombs key Japanese bases and military installations by high flying B-17. Some of which had remained intact until recently. There was no report of ground attack between the ally force and the Japanese in Cambodian territory except the border war between the Japanese backed Thai armed force and the Cambodian armed force in Western part of Cambodia (Battambang and Banteay Meanchey provinces).

  **Table 1: summary mine/UXO background 1940-45**

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1940 – 1945</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>Allies (French, USA, UK) and Japanese</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Large UXO (aircraft bomb)</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>Towns and City</td>
</tr>
</tbody>
</table>

- **STRUGGLE FOR INDEPENDENCE (1945 – 1953)**

  Cambodia had been colonized by French since 1863. After the end of world war two in 1945, the French return to Cambodia with a weak force (France had been hit hard by world war two), local peasants locally known as “ISSARAK” or “freedom fighter” took up arms and demanded for independent. Gun and explosive objects had been reportedly used by both sides but no concrete record had ever mentioned of the use of landmine. The potential location to be polluted by this conflict was in the southeast and western part of Cambodia.

  **Table 2: summary mine/UXO background 1945 - 53**

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1945 – 1953</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>French &amp; Issarak (freedom fighter)</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Small ammunition</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>Southwest and West</td>
</tr>
</tbody>
</table>

- **INDEPENDENT (1953 – 1970)**

  Cambodia gained independent from France in 1953 and the country was ruled by then Prince Norodom Sihanouk. Cambodia under prince Sihanouk’s rule was an island of peace. It had enjoyed progress and development while the surrounding countries (Vietnam and Lao) were in flame of war.
However, with the Cambodia involvement in the Vietnam war by allowing HO CHI MINH trail, where supply from the North to South Vietnam, run across eastern part of Cambodia, numerous raids and attempt had been waged by the south Vietnamese and the US troops to cut or temporary severed this supply road. Landmines became the perfect weapon chosen by the clandestine operation. It had been laid mainly by the American and south Vietnamese troops to damage the North Vietnamese logistics route. Because of the origin of this top secret or clandestine mission, no record on the use of landmine had been kept. Eventually, the clandestine confrontations escalated and lead to the “carpet bombing” (operation code name: “breakfast”, “lunch”, “dinner” and “supper”) of the Communist sanctuaries based along the border inside Cambodia.

Table 3: summary mine/UXO background 1953 – 70

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1953 - 1970</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>Then North and South Vietnam and American</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Landmine &amp; UXO</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>East and Northeast (see figure 1)</td>
</tr>
</tbody>
</table>


Instead of destroying the North Vietnamese camp along the Ho Chi Minh, the carpet bombing by notorious B-52 planes drove North Vietnamese deep into Cambodia. Unable to cope with the turmoil politics, Cambodia lost balance of maintaining the peace and threat, Cambodia entered a full scale civil war in 1970 when then-prince Norodom Sihanouk was deposed by coup d’e tat led by General Lon Nol. The bombing campaign by the United State continued to destroy the communist base in the countryside. The bombing was so intense that the Seventh Air Force was faced with serious logistical problems. At one stage B-52 sortie rates were as high as eighty-one per day. In Vietnam the maximum had been sixty per day. The Seventh Air Force history for the period notes that, with the Cambodian sky so crowded, the problems of air-traffic congestion were considerable, sorties were so frequent that it was impossible to give adequate “Air Strike Warnings” to other aircraft.

In June 1973, 5,064 tactical sorties were flown over Cambodia, in July this was raised to 5,818 and in the first half of August, 3,072 raids were flown. In those 45 days air campaign to crush the communist in the country side, the tactical bombing increased by 21 percent. The B-52 bombing also increased, though those planes were already almost fully committed. By August 15 1973, when the last American planes dropped their cargoes, the total tonnage dropped since operation breakfast was 539,129. Almost half of these bombs, 257,465 tons, had fallen in the last six months of 1973, more than the bombs dropped in Japan by allied during World War Two between 1940-45. On Air Force maps of Cambodia thousands of square miles of densely populated, fertile areas are marked red dot from the inundation. According to the International Committee of the Red Cross (ICRC), about ten percent of the mines in Cambodia were laid during this period—most in the central and southern provinces.

When Lon Nol, the American back government, was cut off all land route by the Khmer Rouge, the supply such as food and ammunition was brought in by air and water. Large quantity of weapons and

Figure 1: Ho Chi Minh supply route
ammunition brought in convoy of ships from then Saigon (the capital of South Vietnam) through the Mekong river to Phnom Penh. This convoy had been attacked along the way by the Khmer Rouge. At Neak Leang where there is a bottle neck that allow the convoy to be within range of the Khmer Rouge shoulder-fire rocket, many ammunition carried ferry/ships sunk.

Table 4: summary mine/UXO background 1970-75

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1970 – 1975</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>Then Khmer Rouge, then North Vietnam, Khmer Republic and American</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Landmine and UXO</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>Central and southern Cambodia (figure 2)</td>
</tr>
</tbody>
</table>

- **POL POT REGIME (1975 – 1979) OR KHMER ROUGE REGIME**

The first civil war between the communist Khmer Rouge and the American ended with the defeat of the central government in April 1975. After it came to power, the Khmer Rouge adopted violence policies both domestic (Auto-Genocide) and international (cross border conflict with Thai and Vietnam). A number of offensives had been fought between Khmer Rouge and the Vietnamese on the hundred kilometer border front in eastern and southern part of Cambodia in order to reclaim the lost Cambodia territory, known as Kampuchea Krom, which had been handed over to the Vietnamese by the French in May 1949.

The border dispute developed to the large scale offensive in 1977 and 1978. At that time, Khmer Rouge (the Cambodian communist) divisions came deep inside Kampuchea Krom to claim the lost territory by force. Unable to solve the problem by diplomatic means, by late 1978 and early 1979, 300,000 well equipped Vietnamese troops marched into Cambodia and installed the more cooperated communist regime in Phnom Penh. During this conflict, hundred of thousand of landmines had been laid along the Cambodia-Vietnamese border particularly at Svay Rieng province.

Table 5: summary mine/UXO background 1975 - 79

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1975 – 1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>Then Khmer Rouge and the Vietnamese</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Landmine and UXO</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>Landmine at Svay Rieng province and UXO all over the countries</td>
</tr>
</tbody>
</table>


After losing the power, the Khmer Rouge adopted the guerilla warfare by establishing its base along the Cambodia-Thai border. The second civil war started. Supported by western blocks and some of the communist pro-Chinese, Khmer Rouge launched its destructive campaign from their base some of which in Thai soil. Unable to ware a large scale offensive, the guerilla used “attack and run” tactics to bleed the government to dead. To be able to do so, railway, road and bridge were destroyed, fertile agriculture soil was denied by landmine. Not only the Khmer Rouge guerrilla but the government troop also used landmine to protect their installation and key infrastructure to buy the time for preparation just in case of surprise attack made by the enemy. Landmine, which is a cheap product, became “the
weapon of choice” and was used extensively by all conflict parties. It was estimated later that million of landmines had been used during this period.

![Figure 3: Mine pollution in western part of Cambodia](image)

**Table 6: summary mine/UXO background 1979 - 98**

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1979 - 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>Then Khmer Rouge and the Government</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Landmine and UXO</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>Western part of Cambodia (see figure 3)</td>
</tr>
</tbody>
</table>

- **INTERNAL CLASH BETWEEN THEN FIRST AND SECOND PRIME MINISTERS (1997)**

After the general election, the fragile coalition government was formed with two prime ministers. The warm friendship last until 1997. By mid 1997, tension between then first prime minister (Prince Norodom Ranarith) and then second Prime Minister (Samdech Hun Sen) rose to the point of armed clashes between supporters. Troops loyal to the-then second prime minister won the battle fields both at tactics and strategic levels whereas the opponents lose the ground and retreated to their border stronghold – O’ Smach. With the advantage of high ground, dense vegetation and excellent defensive, the outnumber opponent survived the numerous onslaught for months despite being bombed, shelled and major offensives.

**Table 7: summary mine/UXO background 1993 – 98**

<table>
<thead>
<tr>
<th>Year of pollution</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict parties</td>
<td>First and second prime ministers of the RGC</td>
</tr>
<tr>
<td>Pollution type</td>
<td>Landmine and UXO</td>
</tr>
<tr>
<td>Potential polluted location</td>
<td>Samraong – O’ Smach (see figure 4)</td>
</tr>
</tbody>
</table>

![Figure 4: Map of O’smach](image)
ANNEX 4:
GENERAL INFORMATION ABOUT MINE/UXO AND MINEFIELD IN CAMBODIA

1. WHAT IS A MINE?

"Mine" means a munitions placed under, on or near the ground surface area which is designed to be detonated or exploded by pressure, proximity or contact of a person or vehicle. Mines would mean any type of landmines both anti-personnel and anti-tank or booby traps".

2. THE HISTORY OF MINE

The word ‘Mine’ is derived from the Latin word mina which means ‘vein of ore’ and was originally applied to the excavation of minerals from the earth. The term was then borrowed by military engineers, whose job it was to dig landmines in the ground during sieges.

Non-explosive mine (2500 years ago)

Modern landmines are explosive traps, but they trace their lineage from non-explosive predecessors such as the spikes and stakes that were employed by ancient enemies. This concept could be traced back 2,500 years making it one of the oldest weapon systems in existence.

Explosive-filled-but-not-transportable mine (14th century)

By the 14th century gunpowder was in military use and had a profound effect on all future conflicts. By 1530 experiments had been conducted in the use of landmines in Sicily and southern Italy. These earliest landmines were known as fougasses and were essentially an underground cannon that showered rocks and debris over a wide area. Although it had the potential to stop a massed attack it was frequently unreliable and had its limitation.

Explosive-filled-transportable mine (19th century)

It was until the American civil war (1861-1865) that the first true blast mine—according to its definition—had been mass produced and used. It called “Land Torpedos” (see fig. 6 and fig. 7) and “infernal devices”. Other powerful countries at that time such United Kingdom had also employed landmine to win the battle during the colonial expeditions such as the Sudanese campaigns of 1884-88 and during the Boer War of 1899-1902.

Land Torpedos (Landmine used during American Civil War)
**Early explosive-filled-portable mine (early 20th century)**

In World War I, tank which immune to small gun fire, was first introduced into the battle by the ally (French and British). There was nothing could stop this modern-new-invented machine. Therefore, the German soldier in the frontline had improvised Anti-tank explosive by using artillery shell.

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**The modern mine**

Mine is composed of case, explosive and fuze. Upon contact fuze is actively activate and generate the first explosion that could trigger the main explosive. Due to fuze's intelligence and its reaction to a specific threat, mine could be classified into three main generations:

- First generation mines have simple mechanical devices, requiring the unsuspecting to physically activate them; for instance, a pressure mechanism would require pressure to be exerted on the top of the fuze. Due to its relatively cheap price, this generation is extensively used in Cambodia.
- Second generation mines have electronic fuze with an intelligence chip able to detect the target in some cases to work out speed and normally to select by a time delay the optimum time to fire the war head.
- Third generation mines are fitted with advanced fuze systems able to detect targets from a considerable distance, to work out speed, to differentiate between Friend and Foe, to communicate with other mines in the minefield, report to control centers and to be able to attack a target from several to over one hundred meters stand-off.

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**3. TYPES OF LANDMINE**

There are million of landmines available on earth but they fall only into two categories: Anti-Personnel and Anti-Tank landmines. There are two other categories of landmine but due to their low profile in Cambodia, they are not to be discussed in this papers (anti-ship or sea mine and anti-plane mines).

- **ANTI-PERSONNEL (AP) MINE**

Mine designed to kill or maim personnel on foot are known as anti-personnel mines. Anti-personnel landmines have become a widely used tool of war since 1940. According to the United Nations these weapons claims some 2,000 victims a month, and the International Committee of the Red Cross (ICRC) estimates that over the last 50 years these weapons have probably inflicted more death and injury than nuclear and chemical weapons. Although mines were originally designed to counter the use of tanks and other armored vehicles, in the second half of the twentieth century they have been increasingly used to target humans. Changing patterns of war resulted in an increasing use of anti-personnel landmines, which were easy to use and spread terror where they were used. According to the UN, each year 2-5 million new mines are put in the ground, adding to “one of the most widespread, lethal and long-lasting forms of pollution” the world has ever known.
Early precursors to the modern landmine were developed during World War I, when German soldiers used buried artillery shells with exposed fuses to block the advance of French and British tanks (see Fig. 9). The invention in the 1920s of easy-to-handle, powerful, and lightweight explosive trinitrotoluene (TNT) led to the development of the first reliable anti-tank pressure mines. During World War II, these flat steel cylinders, measuring about 30 centimeters in diameter and containing about 10 kilograms of TNT, were used extensively by all parties. According to the US Defense Intelligence Agency (DIA), more than 300 million anti-tank landmines were used during World War II, including 220 million deployed by the Soviet Union, 80 million by Germany and 17 million by the United States.

However, these anti-tank mines had one major weakness: they could easily be removed by enemy troops, who would replant them in their own minefields. To keep mine-clearing soldiers at bay, both German and Allied troops began seeding their anti-tank minefields with small metallic or glass containers holding a few pounds of explosive. These early anti-personnel mines were activated by the direct pressure of 15 to 40 pounds, or by a few pounds of pull on a tripwire. Soldiers also booby-trapped anti-tank mines to prevent removal. In the early stages of the war, most of these devices were improvised with hand grenades or simple electric fuses. Later, more complex machine-made fuses were rigged to explosive charges that would easily detonate when pressure was applied or when an electrical circuit was closed.

It was not long before improvised explosive devices and anti-personnel mines were being used as weapons in their own right, rather than merely to protect anti-tank mines. Even though anti-personnel mine come with many varieties but it fall into two categories: blast and fragmentation mines.

- **BLAST MINE**

  **Blast mine**

  Blast mines are designed to maim rather than kill, and rely for effect on a part of the human body making direct contact for initiation. The majority of these, including many remaining from the 1970-75 period, are constructed of plastic with minimal metallic content, thus making detection a difficult, slow and costly process.

- **FRAGMENTATION MINE**

  - **Fragmentation mine:** Fragmentation mines are designed to kill rather than maim and rely for their effect on projecting lethal fragmentation over a wide area from the point of detonation. It usually has a dual initiation system, one a system of prongs which function if trodden on and secondly, a tripwire arrangement. Due to the high metallic content, fragmentation mines are easily detected. Prior to sweeping with detectors, the trip wires must first be located and dealt with, which can be extremely difficult in areas where mines are overgrown by vegetation.

  - **Bounding fragmentation mine:** These usually consist of two portions, a base with propelling charge and a secondary container containing steel rod sections or ball bearings which is propelled by an explosive charge from the base at or just below ground level. This container is designed to detonate at waist/shoulder height to facilitate the most effective projection of fragments in a radial pattern.

- **ANTI-TANK (AT) MINE**

  Mines designed to destroy tanks, vehicles and construction plant are called anti-tank mines. These are less prevalent in Cambodia, but still exist in considerable numbers. Anti-tank mines usually have a
significant metallic content and are generally easy to detect and destroy. For this reason they are frequently laid together with anti-personnel mines to form a mixed minefield.

**MAIN POINTS**
- All mines are potentially dangerous.
- Mines and especially UXOs are very powerful and are capable of killing or wounding over great distances.
- There is a mine with a device inside that causes it to explode upon contact.
- Do not touch mines or UXOs, even if you think they are safe:-
  ~ they may not be safe.
  ~ this action may teach children to touch mines that could kill them.

4. **UNEXPLODED ORDINANCE (UXO)**

"UXO" means any type of unexploded ordnance, this may have various definitions, but for the purposes of this project the term applies to all munitions other than landmines, which represent significant risk to human life". Unexploded ordnance (UXO) are those munitions such as artillery shell, mortars, air-delivered cluster bomblets, aerial bombs, rockets, grenades ...etc. which fail to function as intended when used in battle. Many remain on the surface hidden by vegetation or covered by leaf litter. Many others remain below the surface lying principally in the top 1.5 meters if artillery shell, mortar bombs, rockets or cannon shell, etc. larger aerial bombs will remain buried, often just below the surface if delivered by interdiction strike aircraft, or up to 5-6 meters or more if delivered from high altitude strategic coming such as B-52s. Aerial bombs present an obvious hazard to geotechnical and foundation drilling, or major earthworks.

5. **BOOBY TRAPS**

A booby trap is a familiar object attached to a mine or explosive that is set off if the object is disturbed, sometimes even by movement close at hand. Everyday objects, such as a packet of cigarettes, a watch, or a toy, may serve as booby traps. Likewise, a weapon may be used as a booby trap by placing it on the edge of a path and attaching it to a tripwire connected to a concealed above-ground mine. People should remember never to touch anything unless they are completely certain that it is safe.

**BOOBY TRAPS**

**Main Curriculum Points**
- Almost anything can be made into a booby trap.
- Booby traps are lures to trick people into detonating an explosive.

6. **THE USE OF MINE AND ITS DEPLOYMENT**

Advances in mine technology, as in all areas of weaponry, accelerated in the decades following World War II, particularly in response to changing battlefield requirements and the development of new military technologies. In the early 1960s, the United States first introduced the use of a new and sophisticated class of contact anti-personnel mines, known as ‘scatterables’, to stop the flow of men and material from north to South Vietnam through Laos and Cambodia. American pilots dropped so many of these mines they referred to them as ‘garbage’. They were scattered from the air and landed...
on the ground without detonating. When stepped on, the device, which weighed only 20 grams, could tear off a foot.

For all these tactical advantages, scatterable mines had drawbacks. Because of the hit-and-run nature of the Vietnam War, American ground forces often found themselves retreating through areas that their own pilots had previously saturated with mines-sometimes only a few days or hours before. These areas were not ‘minefields’ in any traditional military sense; they were simply zones randomly scattered with surface mines. The boundaries of these areas were therefore, not precisely knowable. Vietnamese forces, which used several dozen types of improvised or simply manufactured mines, proved that advanced technology was not needed to deploy landmines with deadly effectiveness. In 1965, one year for which detailed statistics are available, 65-70 percent of US Marine Corps casualties were caused by mines and booby traps.

With the proliferation of low-intensity conflicts since the 1970s the landmine, like the automatic rifle, became a weapon of choice for many government and guerrilla armies around the world. They are not only durable and effective, but also readily available from governments as well as from the vast global network of private arms suppliers. Mines are also easy and relatively cheap to manufacture locally. As scientists invent new high technology devices, older but equally lethal models have been unloaded on the surplus arms market or supplied directly to armies or guerrilla groups, usually in developing countries such as Cambodia.

7. MINEFIELD

Once the area is polluted or thought to be polluted by mine, with or without accident, the area has been regarded as dangerous and labeled as minefield. Minefield is the area could be of any shape, size whose land use could be river bed, rice field, or infrastructure that had been contaminated by or suspected to be contaminated by landmine. Mine could be deployed below surface or above ground.

- EXISTING MINEFIELD RECORDING SYSTEM

After Paris-Peace accord in 1991, all conflicts parties in Cambodia were brought together to be disarmed and eventually the return of the refugee in Thailand. Minefield became the most single threat to the resettlement. Mine Clearance Training Unit (MCTU) was formed to remove the explosive and provide safe area for the returnee. Information about the contamination was collected and mine affected area was identified known as minefield. The record held by CMAC, which were handed over by UNTAC comprise:

- Reported minefield: These are based on reports received by UNTAC from the civil population/ police, etc. and have yet to be verified through formal investigative techniques by CMAC. Map markings for such reports are generally broad due to the imprecise nature of the information received;
- Verified minefield: These have been formally verified by field searching as containing at least one or more mines. An approximation of the likely boundaries are drawn on maps and warning signs emplaced. Such areas are determined conservatively ad are also broad in nature, but cover a much smaller area than the original reported field.
Verification requires disciplined exploratory Demining by small teams until mines are found and a rough idea can be arrived at as to the likely extent.

- Marked Mined field: These are previously verified fields that have been further defined by field searching and boundaries physically marked on the ground with precise positional information recorded. Marked areas generally are very much smaller, with the approximate boundaries of verified fields having been considerably contracted in the process. Marking minefields is resource intensive, time consuming and dangerous. On the other hand, resources spent in marking can result in proportionately larger savings during later clearance of the field. According to Cambodian standard, the speed to clear 10,000 m² of arable land, it could take 30 deminers within 2 weeks of working (working 7 hours per day and 5 days per week).

- Cleared Minefield: After the completion of the clearance and the area is considered “safe”, the former minefield is named “Cleared area”. This cleared area is ready to be handed over to local authority for future development.

- Suspended Minefield: When the clearance was interrupted by some valid reasons (In Cambodia, it is usually interrupted by weather), the clearance operation must cancel and the unfinished-clearance minefield is named suspended minefield. This minefield is in the pending list and in top priority for future clearance. Suspended minefield is still regarded as generous area and is off limit to any development.

- Handover minefield: After the clearance has been completed, minefield is subjected to handover to local authority for development. Demining agency, officially, would have no control over the development scheme of this former minefield.

**NEW MINEFIELD RECORDING SYSTEM (NATIONAL SURVEY LEVEL ONE, TWO AND THREE)**

To update the contamination information, a joint project of CMAC Cambodia and CIDA Canada was launched and completed by the end of 2001. This new recording system groups minefields into three major groups:

- National Survey Level One: Country-wide survey was conducted. According to this campaign additional minefield was found.

- National Survey Level Two: this is an area reduction process before the detection and disposal of the contamination could be taking place. Mine Detection Dog plays a major role in this process.

- National Survey Level Three: the final part of mine clearance is to mark and record the boundaries of the cleared areas.
ANNEX 5:  
GENERAL INFORMATION ABOUT TEST SITE AT BATTAMBANG

GEOGRAPHY

The ground is soft and flat and get flooded in wet season (temporary flood from rain water). It is reported that the water flow from Pailin area to Tonle Sap great lake across this test area. Trees are every where. Tree whose diameter is larger than 10cm is 1,200 tree per hectare (1200 three/10,000 m²). Some of these tree had been cut down by local village but the trunk remain which might post obstacle for demining machine. Most of the trees are red wood type which is strong and hard to destroy. In general, tree in the test site is approximately 20cm in diameter.

Beside tree, elephant grass is very well grown up to 1,5m in some places created major problem for visual contact. Any use of spotter by any test contestants shall consider this issue seriously.

CONSTRAINTS

SOFT SOIL, LARGE TREE, MANY TREES, HIGH GRASS!

TRANSPORT ROUTES

There are two alternative routes from Battambang to test site:

- **Route 1:** Battambang → Kbal Kmooch → Kamping Puy (Khmer Rouge-dig water reservoir) → Test site. This route is short but there is a problem of using trailer.

- **Route 2:** Battambang → Thmor Kol → Bovel → Test site. This route is little longer than the first route. The route is rocky, bumpy but there are no concrete poles in the middle of the road like the first route. With careful drive truck trailer could use this route. There is not much overhead tree
brunch or electric wire to worry about while transporting. To reach the test site, there are number of small wooden and concrete bridges to cross. A steel plate shall be used to distribute the load on the bridges.

For the last several kilometer into the forest-test site, it is likely that the demining machines might get out of trailer and make the journey by itself. The road is very sticky, muddy and slippery when raining.

**CONSTRAINT**

ROUTE IS ROCKY, BUMPY, BRIDGE IS UNMARKED LOAD LIMIT, SMALL & NARROW CORNER AT BRIDGE’S ABUTMENT (PROBLEM FOR TURNING). THE LAST JOURNEY, TRUCK TRAILER COULD NOT BE USED!

**REPORTED LANDMINE TYPE USED IN AND AROUND TEST SITE**

The area is the front line during the civil war between the government and the Khmer Rouge. Extensive use of landmines is reported but the exact location/spot is still remain unrecorded/unknown. It is reported that there are three type of landmines had been used by the Khmer Rouge: Chinese made type-72A (blast mine), type 69 (bounding fragmentation mine) and Anti-tank. T-72A and T-69 are mainly used in the dense forest where the government troops are like to use. Anti-tank is heavy used along the existing route net work. The government, on the other hand, had also used former USSR made blast mine PMN and PMN-2 to protect their base and strategic supply route.

![Diagram of landmine type and location](image.png)

The relationship between location and landmine type.
MINEFIELD

Minefield in Cambodia has the following characteristics:
- Un-orthodox pattern
- Use fragments to distract/delay detection
- Use of combination: depth + AP/AT + layer + pattern + wood
- Use of vegetation to cover up and protect landmine

Un-orthodox pattern

Some countries had kept good record of minefield and location which save them time and money to remove later. Their laying also in pattern so that their chance to hit and damage to the opponent is high. However, mine laying record in Cambodia is almost none existent. New landmine was laid on top of the existing minefields when there was new comer (during civil war). The pattern is un-orthodox. Some time dozen of landmine was laid in a very concentrated area.

![Well recorded and properly laid minefield vs Poorly recorded and multiple laid minefield](image)

Use of fragments to distract/delay detection

Magnetic objects such as piece of metal, nail or other fragments had been used by the Khmer Rouge to generate false alarm to mine detector (see figure 19).

![Fragment is used around mine location](image)

The combination: depth + AP/AT + layer + pattern + wood
• Depth: To reduce the magnetic field of the mine so that it increase the difficulty for mine detector, Khmer Rouge place mine quite deep underground some times deeper than 0.8m.
• Layer: sometimes three to four layer of AT mine pile up on top of another. This technique is used to increase the killing blast.
• Pattern: as shown in figure 21, this pattern is to trick the sapper that the road is safe after the removal of the first layer (in fact it is not!)
• Bamboo + red wood: To insert pressure from load above (such as truck load) to mine. The bamboo play as cylinder to protect earth from touching the red wood. Red wood which locate inside the bamboo has free movement and any pressure from the top would be apply directly to the deep bored AT mine. The combination of wood is used because it could stay many years under the ground and ready to function. The most important point is that metal detector could not pick it up therefore, it does not reveal the mine location away.
• AP underneath AT: To protect AT against removal by opponent (sapper/deminer).
• In some cases, special booby trap is used to protect the object from removal by deminer/sapper.

The use of vegetation for landmine protection and concealment

The use of vegetation for landmine protection and concealment
Bamboo is favorably used by the Khmer Rouge to conceal their mines and minefields. This method is used mostly to protect their base/stronghold. The combination of AP/AT and bamboo is the perfect barrier for tank and any vehicles. During civil war, to destroy the Khmer Rouge base, tank was needed. However, tank could not get through the bamboo belt. If the bamboo is removed by bulldozer for example, it will be destroyed by AT.

After the civil war, bamboo still post a major obstacle for demining. Some mechanical demining machines take large amount of time and resource to overcome the bamboo. To succeed it, significant damage had been inflicted on the demining machines by the bamboo.

<table>
<thead>
<tr>
<th>CONSTRAINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARD TO DETECT AP T-72A!</td>
</tr>
<tr>
<td>WALKING ABOUT IN BATTAMBANG TEST AREA OUT OF CLEARED AREA SHALL BE BE-CAREFUL. IT IS BETTER TO CONSIDERED UN-CLEARED AREAS ARE MINEFIELD!</td>
</tr>
</tbody>
</table>
ANNEX 6:
HOW TO WORK IN MINE/UXO CONTAMINATED AREA

Working in mine/UXO affected country like Cambodia requires strict mine/UXO safety regulation/principles so that the personnel involved in the project can reduce the risk of accidents resulting from the explosion of these dangerous items. When operating in live minefields, organizations as well as individuals should take the following recommendations into consideration.

SAFETY TIPS FOR MANUFACTURER/ORGANIZATIONS

It is essential for manufacturers/organizations operating in mine/UXO affected areas such as in live minefield test site to take the threat of mine/UXO into consideration in the planning of their project activities. This implies making sure that proper safety procedures are in place, proper training provided, and proper equipment and information available. Manufacturers/Organizations should:

- Establish mine/UXO safety procedures adapted to their area of test/trial.
- Through regular contact with CMAC, verify and update all medical facilities and emergency contacts on a regular basis.
- Collect relevant and detailed information on the mine/UXO threat in the project area and update this information regularly. Keep a visual brief available (a map locating dangerous areas).
- Provide appropriate mine/UXO related information to personnel, including information on safe routes and dangerous areas, and emergencies contact information.
- Ensure that all expatriate and local staff (including drivers and interpreters) receive proper mine/UXO awareness training and are familiar with mine/UXO safety procedures.
- Be aware that the levels of alertness to the mine/UXO threat will decrease over time; therefore, frequent retraining on mine/UXO safety will be required.
- Provide appropriate equipment to personnel operating in mine/UXO affected areas, including radios, global Positioning System (GPS), compasses, first aid kits, and maps. Ensure staff members know how to use them.

SAFETY TIPS FOR INDIVIDUALS

In the context of the procedures established by their respective organizations, individual staff members must adhere at all times to the highest safety standards and adopt a team approach: unsafe behavior on the part of one individual can endanger the lives of other team members.

- Ensure that you and your teammates have received appropriate mine/UXO awareness and first aid training, and are familiar with safety procedures.
- Read and re-read mine/UXO documents, their threat and safety procedure.
- Keep contact list, verify and update the contact list regularly
- Must know how to use a radio and must not travel without a radio. Inform project staff of all the alternative frequencies that you may require. The use of GPS is also strongly recommended.
- Carry a travel pack with a first-aid kit in your vehicle at all times. Regularly check the expiry date and serviceability of all items and know how to use them.
- Obtain relevant and detailed information on the mine/UXO situation prior to any movement into an area or region which may contain mine/UXO.
- Be aware that some of the people living near the project area are new comer hence their knowledge of mine/UXO threat is limited.
- If suspected, assume the worst-case scenario applies. Even if only one source indicates that an area is dangerous, do not go.
- Update your mine/UXO information on a regular basis.
- Carry a map marked with the best available information about routes known to be free of mines. Update this information by checking with CMAC staff, local populations as you travel and pay attention to their warnings.
- Pass new information to your head office, to CMAC, so that they can share it with other organizations and staff members.
- Inform your office of the dates, times and planned route of your journey. If you change your route/plan, inform your office.
TIPS WHILE TRAVELING

When travelling in live minefields (confirmed or suspected):

- Do not enter known or suspected risk areas, and use only cleared and approved routes.
- Maintain radio contact while travelling.
- Whenever, possible, travel with a companion, preferably one who knows the areas and the route you need to use.
- When starting a journey, allow sufficient time in the morning for local traffic to have travelled the roads before you.
- Do not travel at night. Plan your journey to end two hours before sunset. This allows you and your head office two hours of sunlight to react to an emergency. In addition, mine warning signs and clues cannot be seen at night.
- If travelling in a convoy, allow a space of 100m between vehicles whenever possible.
- Stick to well-travelled routes, and stay in the travelled zone of the road.
- Whenever possible, stay on hard-surfaced roads, even if the trip is longer. Paved roads are generally less likely to be mined than unpaved roads. However, potholes and the shoulders or verges of paved roads offer opportunities to conceal mines: avoid potholes and avoid driving off the road.
- On dirt roads, stay on the existing tracks.
- Anti-tank mines are often laid along roadsides.
- Never leave the road to allow a vehicle to pass, to overtake, pass an obstruction, or turn around. If necessary, reverse back until a safe area is available. Beware of pulling off the road into lay-bys as they may be mined.
- Never drive around road blocks of former military positions. Never drive over anything on the road. A paper bag, a piece of cloth, or a wooden board can all conceal mines.
- Do not leave the road for any reason, even to relieve yourself.
- Always be extremely careful driving during or after heavy rains. Mines may be moved or exposed by rain.
- When traveling on foot, allow a local guide to lead the way, and allow a distance of around 25 meters between members of the group.
- Never walk through overgrown areas. Instead, stick to sidewalks and well-used paths.
- Don’t take risk if you are in any doubt, turn back by following your foot print.
- Carry a radio and first aid kit at all times. These items should be carried by a person walking in the middle of the team or towards the back and not by the lead person.
- Do not move obstacles – they may be mined or booby-trapped.
- Do not enter abandoned building or visit deserted locations. Talk to the local population and observe local behavior to find out about safe areas in communities.
- Resist offers to be shown a mine, as this is probably still in a mined area and therefore an area of extreme danger.
- Do not touch objects in mine/UXO contaminated areas, especially unexploded ordnance.
- Do not collect war souvenirs, and do not approach abandoned military vehicles or facility
ANNEX 7: FREQUENTLY ASKED QUESTIONS

Q1. Where can we find Landmine or UXO?
Landmine can be found below ground or above ground:

MAIN POINTS BELOW GROUND MINES
- Usually buried mines are impossible to see
- Buried mines can be uncovered by weathering.
- Buried mines are usually set off by stepping or putting weight on the top.
- It can be triggered by pressure (step on it)

ABOVEGROUND MINES
- Surface laid mines are usually placed in long grass or behind trees.
- It could be detonated by trip wire.
- Surface laid mines are set off by pulling a loose wire or pulling/cutting a tight wire.
- If you see a tripwire do not touch it or try to step over the wire.

UNEXPLODED ORDNANCE (UXO)
- UXOs are more destructive than mines.
- A common mortar has a lethal range of 300 meters.
- The largest bomb has a lethal range of 1000 meters.
- Even if you find the UXOs in their packing cases, they are still dangerous and should not be touched.

If mines have been properly laid and camouflaged, it will be extremely difficult – if not impossible – to spot a mined area. It is therefore essential to collect information on mines/UXO in your area before initiating any activities. Ask the local population the following questions to find out about the local mine/UXO problem:

- Has there been any fighting in this area?
- Have there been any soldiers living/working/passing through this area?
- Have there been mine/UXO accidents in this area?
- If yes, what types of injuries have occurred?
- Which areas are suspected or known to be mine/UXO contaminated?
- Are there roads/tracks/crossings/fields/wells/houses that the local population do not use?
- Have there been detonations in the area? If yes, in which location?
- How does the local population mark mine/UXO contaminated areas?
- What are considered to be safe roads/routes/parths/areas by the local population?
- If it is not possible to obtain proper information, there are still things you can do not avoid entering a mine/UXO affected area.

REMARK

No accident by mine/UXO explosion does not mean the area is safe!
Q2. How do I recognize landmine or UXO?

Landmines come in many different shapes and sizes. They can be made of metal, wood or plastic. After a period of time some mines will fall apart and may become unrecognizable.

Similarly, UXO is made in different shape, size, color and contain different type of explosive. Even it failed to detonate at its first use but its fuse and explosive remain intact will strike any moment in the future. Therefore, Please remain to be vigilant.

Q3. If I cannot find the local to ask question, how do I know the presence of mine/UXO?

If you can not find the villager to ask question about the present of mine/UXO, Please take the following precautions:

- Be aware of warning sign
- Be aware of warning clue
- Avoid area likely to contain Mine/UXO

Be aware of warning Sign

Normally the person who lays a landmine does not leave a clear sign to indicate the presence of the mines, but someone else may leave a temporary sign as a warning to others of the danger. People should be aware of the most common types of warning signs used in the areas in which they live and work. It is important to note and to emphasis that the lack of clear warning signs does not mean that an area is safe. People sometimes remove minefield warning sign without considering the effect on others. A plastic sign may be useful in repairing a damaged roof; the wooden stakes of a mine warning sign may be ideal for starting a cooking fire; metal signs can be fashioned into buckets to carry water; and a skull and crossbones hanging before the front door may be believed to ward off evil spirits. Children and adults need to be told not to remove mine warning signs, and they need to be told why this is so important.

RECOGNIZE MINE WARNING SIGNS

Main Curriculum Points

- Be aware of the usual form of warning signs.
- If you see any warning signs, you must assume that the areas is mined. You must go back the way you came and find an alternative, safer route.
- Do not remove mine warning signs from the area
- If there is no warning sign, do not assume that the area is safe.
Be alert for warning signs, if traveling in potentially mined areas.

**MINE WARNING SIGNS**

**MAIN POINTS**
- The 3 recommended warnings signs are:-
  - Skull & Cross Bones Sign
  - Crossed Sticks
  - Knotted Grass

- There are some other warning sign that could be used by the local:
  - A piece of cloth tied to a fence or tree
  - A can on a post
  - Small piles or circles of rocks
  - Rock laid across a path
  - A clump of grass that has been tied in the middle
  - Signs which have been cut into the bark of a tree
  - A shorn off branch

- If there are no warning signs, do not presume the area is safe.

**Be aware of warning clue**

Usually mined areas do not seem particularly different from areas, which are free of mines. Mines are difficult to see. They may be buried, or they may be concealed behind trees or in tall grass. However, there may be clues indicating that there are landmines in an area. The clues may be quite obvious, such as a mine exposed by the weather, or the presence of the skeletons of humans or animals. The clues may also be subtle, like a slight change in the vegetation growth pattern, a small mound, or a slight settling of the earth. If one sees anything that might be a warning clue, one should assume that the area is mined, go back and find an alternative, safer route.

**Main Curriculum Points**
- Injured or dead animals
- A partly exposed mine; an intact or broken tripwire; a fuse sticking out of the ground or laying on the ground
- A mine packing box or mine wrapping paper; discarded mine safety pins or detonator keys
- An unusual change in the vegetation, and unusual mound, or a small hollow caused by shifting sand or settling soil.
- Signs of fighting, such as bomb craters, shrapnel, or bullet casings
- No sign of recent foot traffic
- If you do not see any warning clues, do not assume that the areas is safe
Do not presume an area is safe if you don’t see any warning clues.

**MINE WARNING CLUES**

**MAIN POINTS**
- Be alert for all warning clues.
- Changes and disturbances in nature can be warning clues.
- There are man-made warning clues, such as parts of mines.
- If you see a warning clue presume you are in a mined area.
- If there are no warning clues, do not presume the area is safe.

Avoid Area likely to contain Mine/UXO

Some areas are more likely to be mined than others. Avoid areas where fighting has taken place, and avoid strategic military locations, including areas fenced off by the military and areas around abandoned military camps.

**AVOID AREAS LIKELY TO CONTAIN MINES OR UXO**

<table>
<thead>
<tr>
<th>Main Curriculum Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be especially careful near these areas:</td>
</tr>
<tr>
<td>Slope or Right Of Way of the road</td>
</tr>
<tr>
<td>Around bridge and key infrastructure</td>
</tr>
<tr>
<td>Water source</td>
</tr>
<tr>
<td>Shady rest area</td>
</tr>
<tr>
<td>High ground (hill top where it post of use to military)</td>
</tr>
<tr>
<td>Abandon village, pagoda, trench</td>
</tr>
<tr>
<td>Abandoned military outposts, checkpoints, and trenches or ditches.</td>
</tr>
<tr>
<td>Areas containing significant physical infrastructure</td>
</tr>
<tr>
<td>Ruins or overgrown areas or places that show no signs of passer – by</td>
</tr>
<tr>
<td>Deserted villages</td>
</tr>
<tr>
<td>Military bases, high security locations, potential military targets</td>
</tr>
<tr>
<td>Warehouses</td>
</tr>
<tr>
<td>Cave entrances</td>
</tr>
<tr>
<td>Water sources, wells, riverbanks.</td>
</tr>
</tbody>
</table>

Q4. What should I do when traveling in remote area or unknown location?
If you see something that interests you at the side of the road, for example a wrecked vehicle, good fruit trees, house ruins, etc., you should think that this area is probably mined or booby trapped.

Do not leave the safe ground - even to go to the toilet!

**Main Curriculum Points**
- Ask the local people about the safest paths.
- Travel by day whenever possible.
- If you are unsure whether a road or path is safe, do not use it, but seek a safer route.

**Q5. What should I do if I find mine/UXO?**

**DO NOT TOUCH MINES!**
**DO NOT ENTER DANGEROUS AREAS!**
- Do not throw a mine or throw anything at a mine
- Do not kick or otherwise strike a mine/UXO
- Do not touch any object unless you are absolutely sure it is safe. It may be booby-trapped.
- Do not attempt to de-fuse a mine or demine an area
- Warn others not to touch mines
- Prevent others from entering mined areas.
- Do not throw a mine/UXO into water
- Do not burn a mine/UXO
- Do not go anywhere near a tripwire, as the surrounding area may also be mined
- Do not attempt to collect mines/UXO for scrap metal.

**Q6. I am going to work in mine/UXO affected area, what should I do?**

**Inquire about safe paths**
A safe path is one which is traveled frequently and which is known to be free of mines or UXO. When traveling far from home, one should regularly inquire about the location of mined areas, as these locations may change. Nearby residents usually know which routes are safe and which are not, though it may be necessary to ask several people to be sure. One should travel by day whenever possible because it is harder to see warning signs and clues at night. Moreover, mines are often laid at night. Although they are usually removed in the morning, soldiers may sometimes forget to do this.
INQUIRE ABOUT THE SAFE PATHS

Main Curriculum Points
- Ask the local people about the safest paths.
- Travel by day whenever possible.
- If you are unsure whether a road or path is safe, do not use it, but seek a safer route.

Stay on the safe path

When traveling in potentially mined areas, under no circumstances should one leave a safe path. Always look for clues of the presence of mines. Why, for example, is there still a lot of fruit on the nearby tree? Maybe this is because there are mines laid between the safe path and the fruit in the middle of the path and with at least a meter separating one person from the next, because mines are commonly laid on the side of the path.

STAY ON THE SAFE PATH

Main Curriculum Points
- Stay well within the safe path
- Do not walk along the edge or at the side of the path

Q7. I am accidentally come across a minefield, How to get out of minefield?

Stand still and wait

If an individual spots a warning clue (for example, an exposed mine or a hole where a mine has exploded), then the individual should assume he or she is in a minefield. The best solution is to stand still, call out for help, and wait until help arrives. It has been said that “It is better to spend two days in a minefield than a lifetime as an amputee.”

STAND STILL AND WAIT

Main Curriculum Points
- Anyone finding himself or herself in a minefield must:
  - Stop talking immediately
  - Warn others who may be at hand by shouting, “Stop walking! There are mines!”
  - Note the area. Identify other dangerous objects and evaluate the situation.
  - Stay calm.
  - Call out for help. Use radio communication
  - Do not move and wait for help.
  - Take no unnecessary risks.

Retrace one’s footsteps
To retrace one’s footsteps is generally not a safe option for getting out of a minefield as it is highly unlikely that the true outline of your footprint will be visible unless you are walking in mud or snow. Retracing one’s footsteps is not a safe option; it is an extremely dangerous method. Technical experts must be consulted, proper procedures must be taught through practical exercises and not simply through media techniques if the decision is taken to recommend retracing one’s footsteps.

RETRACING ONE’S FOOTSTEPS

**Main Curriculum Points**

- Stop walking
- Warn others nearby of the danger.
- If you cannot see the impressions of your footsteps, wait for help.

If the decision is taken to recommend retracing one’s footsteps, technical experts must be consulted, and proper procedures must be taught through practical exercises and not simply through media techniques.

- Retrace your footsteps only if you can see them clearly.
- If you retrace your footsteps, keep an eye out for exposed mines, natural disturbances or other warning clues.
- Retrace your footsteps all the way back to a sure, safe path.

**Prodding**

Prodding means to take an instrument (preferably a long blade knife) and probe the ground in front of you to check if there are any mines there. Once you have established there are no mines then you can step inside the prodded area. It is a complex technique so it must be learnt thoroughly as it can be potentially dangerous if done incorrectly.

Prodding should only be used if there are no other options available, for example:

- If you are in a mined area and cannot retrace your steps.
- If someone who does not know the proper procedures is in a minefield and cannot get to a safe path any other way.
- If an individual has been injured and cannot get out of a minefield.

The aim is to prod the ground for mines so as to avoid them and reach a safe path. If the procedure is being used to retrieve an injured person, it is recommended that the path be wide enough to allow the rescuer to carry the injured person out of the mined area. In this case, it is not recommended that only the impressions of footsteps be prodded.

**BE REMEMBER**
MINE/UXO CAN KILL AND INJURE!
ANNEX 8:
SOME USEFUL INFORMATION
ON-SITE RULES AND INSTRUCTIONS

SAFETY FIRST!

The Project of Test and Evaluation of Demining Machines and Mine Detectors is a very important project which must be managed and executed safely, effectively and efficiently. All persons involved in this project, both visitors and project personnel, are asked to strictly observe the following rules and instructions while on the test site. For safety and convenience, you:

1. Must wear the ID Pass provided to you at all times while on test site. No one will be allowed in the area without the Pass.
2. Must listen carefully to and follow all the safety instructions on site.
3. While machines are operating, must follow the safety distance indicated by the Project Manager.
4. Must avoid smoking in test area.
5. Must switch off your mobile phones where indicated so.
6. Must wear Personal Protective Equipment (PPE) where requested.
7. Must not enter area(s) suspected of being or marked as hazardous.
8. Must not touch any object (suspected of) containing explosives or other dangerous items.
9. Must bring along communication equipment all the time.
10. Should wear boot and apply anti-mosquito repellent cream or spray.
11. Should use bottle water for drinking.
12. Should not walk alone in unfamiliar areas.
13. Should take caution of poisonous insects (spiders, snakes, ants…)
14. Should wear long sleeves shirt and trousers.
15. Must direct your questions to the Project Manager in case you have any queries.
16. Contact telephones on site:
   a. Project Manager for Demining Machines:
      i. Name: Mr. Srey Rithisak
      ii. Telephone: 012 949 184
   b. Project Manager for Mine Detectors:
      i. Name: Mr. Mong Sokunthearoiit
      ii. Telephone: 012 893 233
   c. Site Medic:
      i. Name: Mr. Penh Savath
      ii. Telephone: 011 651 868
   d. National Consultant:
      i. Name: Mr. Roath Kanith
      ii. Telephone: 012 429 001
   e. JICS Consultant for Demining Machines
      i. Name: Mr. Takefumi Mayumi
      ii. Telephone: 012 1744 450
   f. JICS Consultant for Mine Detectors
      i. Name: Mr. Takeshi Ajioka
      ii. Telephone: 092 946 198
   g. Project Coordinator
      i. Name: Mr. Oum Phumro
      ii. Telephone: 012 507 778
   h. CMAC Deputy Director General
      i. Name: H.E Heng Ratana
      ii. Telephone: 012 800 169
ANNEX 9:
DEMINING MACHINE TEST AND EVALUATION PROCEDURES
(Valid for Performance test only)

During the test and evaluation of the demining machines in the dry, wet and light bush areas (simulated minefields), the following procedures will be applied:

1. PRE-TEST BRIEFING
   1.1. Presenter: Project Manager
   1.2. Time: 8:30 a.m
   1.3. Duration: 15 minutes
   1.4. Location: test area
   1.5. Purpose: to check attendance and equipments (including PPE and mine detectors) of the team members, provide information regarding the activities of the coming test, and confirm with the manufacturers of their readiness.
   1.6. Audience: participants and team members

2. SPOTTERS/NAVIGATORS:
   2.1. All manufacturers are allowed to use spotters/navigators for their machines during tests.
   2.2. The evaluation will take into account the use of the spotters/navigators
   2.3. Manufacturer(s) intending to use spotters/navigators must inform Project Manager in advance. Verbal notice is acceptable.
   2.4. Spotters/navigators must wear PPE at all times or stay behind a safety shield.
   2.5. The spotters/navigators must stay within the safe distance indicated by the Project Manager. The minimum safety distance for the spotters should be at least 50 meters from the running machines. However, the Project Manager will assess the risk and may request a greater safety distance if required.
   2.6. The spotters/navigators may use a binoculars or other distance measurement devices.
   2.7. The use of spotters/navigators is the manufacturers’ own risk and responsibility.

3. SAFE AREA
   3.1. Please refer to picture 1 for information regarding safe zones in the test areas.
   3.2. Personnel associated with the machines (manufacturers and team members) will only stay in the safe areas indicated by the Project Manager.
   3.3. Visitors must stay within the safe areas indicated by a safety sign.
   3.4. Special Personnel: consist of the Project Management Team, Consultants, and appointed photographers. These personnel are allowed to perform their duties with reasonable proximity to the machines during the test runs.

4. REMOTE CONTROL
   4.1. Remote control is not allowed during the test in the dry, wet and light bush areas.
   4.2. Remote control is necessary for the drum or flail operation of the machine(s) during survivability test.
   4.3. The use of Remote Control is acceptable at live minefield for the machine which had been specified at 4.2

5. STARTING AND ENDING TEST RUNS
   5.1. Before starting the test run, the operators must run the machines at idle speed.
   5.2. Recording time will be begun when the rotating drum touches the ground.
   5.3. Ending the test run: the machine must return to the starting line. The Project Manager will give a whistle as the signal of ending the test run. The ending time will be recorded at this moment.
   5.4. Regarding Starting and ending test runs of the survivability test, it will be advised.

6. TEST RUN PATTERN
   6.1. The test run pattern will be decided by the manufacturers (U-turn or reverse operations mode, or others)
   6.2. The manufacturers must inform the Project Manager which run pattern they will use before each test run.

7. TEST RUN SCHEDULE
   7.1. Each machine will run two lanes per test day.
7.2. The manufacturers must perform the test runs in order of lane number 1, 2, 3 and 4.
7.3. The first test run will start at 9:00 a.m.
7.4. Komatsu D-85EX machine will start Block A, lane number 1 at 9:00AM
7.5. Hitachi BM307-FV25 machine will start Block B, lane number 1 at 9:30AM
7.6. Hitachi BM307-V33 machine will start Block C, lane number 1 at 10:00AM
7.7. For test run schedule for lane number 2, please refer to the table below.
7.8. Lane number 3 and 4 will be tested in the next test day with the same schedule
7.9. Further schedule will be discussed after performance test.

Table 1: Performance test schedule

<table>
<thead>
<tr>
<th>Machines</th>
<th>9:00 AM</th>
<th>9:30 AM</th>
<th>10:00 AM</th>
<th>10:30 AM</th>
<th>11:00 AM</th>
<th>11:30 AM</th>
<th>12:00 PM</th>
<th>12:30 PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Komatsu D-85EX</td>
<td>Start</td>
<td>Test</td>
<td>Finish</td>
<td>Start</td>
<td>Test</td>
<td>Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lane 1</td>
<td>in</td>
<td>lane 1 &amp;</td>
<td>lane 2</td>
<td>in</td>
<td>lane 2 &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>progress</td>
<td>refuel</td>
<td></td>
<td>progress</td>
<td>refuel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi BM307-FV25</td>
<td>Start</td>
<td>Test</td>
<td>Finish</td>
<td>Start</td>
<td>Test</td>
<td>Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lane 1</td>
<td>in</td>
<td>lane 1 &amp;</td>
<td>lane 2</td>
<td>in</td>
<td>lane 2 &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>refuel</td>
<td></td>
<td>progress</td>
<td>refuel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hitachi BM307-V33</td>
<td>Start</td>
<td>Test</td>
<td>Finish</td>
<td>Start</td>
<td>Test</td>
<td>Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lane 1</td>
<td>in</td>
<td>lane 1 &amp;</td>
<td>lane 2</td>
<td>in</td>
<td>lane 2 &amp;</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td>refuel</td>
<td></td>
<td>progress</td>
<td>refuel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. REFUELING
8.1. The refueling must be done by individual manufacturer under the observation from CMAC/evaluator.
8.2. Each machine will refuel after the completion of each test lane.
8.3. The refueling will be recorded by CMAC. The amount of fuel used will be recorded for subsequent analysis.
8.4. For those responsible for refueling, see Point on Duty Personnel.
8.5. The fuel drums will be located at the test lanes for convenience.

9. POST-RUN CHECKS, RECORDS AND EVALUATION
9.1. Project Manager and the team members will re-create the test lanes with red sticks after all the test runs are complete base on the “5-step” procedures
9.2. The team members will check the processed lanes to verify the conditions and rate of destruction of the mines.
9.3. The Project Consultant (Local) with two Assistants will collect the data and record on the Evaluation Sheet.
9.4. The Project Manager will double-check the Evaluation Sheet to make sure it is completed properly.
9.5. The Project Manager will follow the maintenance of the machines after test and complete a Maintenance Evaluation Sheet.
9.6. The Project Consultant (Local) will collect and maintain all Evaluation Sheets for analysis.

10. MANUFACTURERS
10.1. Ensure that the machines are in good operating conditions prior test runs.
10.2. Ensure the servicing of the machines is conducted properly.
10.3. Provide the maintenance of the machines after test runs in case there are damages to the machines.
10.4. Strictly observe the safety requirements and test schedule.
10.5. May take photos of their test activities
10.6. Must follow the “written oath” rule

11. ANNOUNCEMENT
11.1. Prior to the survivability tests, the Project Manager will notify the local authorities and make safety announcement to the public.
11.2. The Project Manager will appoint deminers to make announcements to the public.

12. EXTERNAL OBSERVERS
12.1. CMAC can bring in external observers to observe the test and evaluation process and provide advise on the process.
12.2. If the manufacturers wish to bring visitors to observe the tests of their machines, they must inform the Project Manager in advance. These visitors will be under the guidance of the Project Manager.

13. SECURITY
13.1. The Project Manager and Project Assistant will make all necessary arrangements to ensure good security during the test days and security of all properties during the nighttimes, both at parking area and the test lane area.
13.2. In case there is a special requirement by the manufacturers to safeguard their properties, the concerned manufacturers must notify the Project Manager.

14. ACCIDENTS AND INCIDENTS
14.1. In case there is an accident, the field medic will provide emergency treatment.
14.2. The field medic will make the decision, depending on the seriousness of the injury, to keep the victim at CMAC accommodation, transport him/her to hospital, or call the helicopter to transport the victim to the Emergency hospital in Battambang.
14.3. If the victim is required to be taken to Emergency Hospital in Battambang, the Project Manager will contact the Helicopter company. Please refer to the list of contacts attached.
14.4. When there is an accident involving the area of test, the Project Manager will call off the test if necessary. The test will resume only when the Project Manager sees it fit.
14.5. Team members must have full PPE and mine detector prepared for any emergency situation during test.

15. WEATHER CONDITION
15.1. In case the weather is not favorable for the test, such as raining, lightning, flooding, etc. the Project Manager will discuss with the Consultants (Local and JICS) whether to conduct the test or suspend the test.
15.2. In case the test is in progress, it must continue till it completes the particular lane, regardless of any disruptions caused by the weather.

16. MEDICAL SERVICE
16.1. The field medic will ensure that sufficient medical equipment is in place to ensure a good medical response in case of need.
16.2. The ambulance must stand close to the test area in good working condition at all times during the test runs.

17. VISITORS
17.1. All visitors must be accompanied by the Project Manager or appointed Officer at all times.
17.2. During the test runs, the visitors will stay within the safe area indicated by the Project Manager.
17.3. The Project Manager or appointed Officer will provide safety briefing to the visitors prior to visiting the test areas.
17.4. The Visitors must wear the Visitor Pass at all times when on test site.

18. BREAKS
18.1. During the test days, lunch break for all team members will be allowed only after all the test runs are completed.
18.2. The duration of the lunch break is one hour. After the break, work will resume to conduct checks on the processed lane.

19. DAMAGES
19.1. If the test causes damages to the machine but the machines can still operate, the test will continue till the end of the test day.
19.2. If the machine cannot operate due to some serious damage or malfunctioning, the Project Manager will discuss with the Consultants what steps to be taken.

20. MACHINES OUT OF ORDER
20.1. If the machine cannot operate due to some serious damage or malfunctioning before the test begins, the Project Manager will discuss with the Consultants what steps to be taken.
21. BOGGED DOWN DURING TESTS
21.1. If a machine gets stuck in the test lane or outside the lane during the test run process, the operator could receive advice from manufacturer about what best to rescue the machine.
21.2. The operator with green light from manufacturer must make a sign or signal indicate “give up”. Ending time will record from this moment.
21.3. If the machine stuck in the mine area, the machine must remain as it is, if possible, oil will be checked and recorded or otherwise, genuine estimation will be used.
21.4. Machine will be removed from mine area only after the approval from project manager and consultants (after all required works are accomplished)
21.5. If the machine gets stuck before entering the test lane, help will be provided and another direction to complete the test lane is allowed.
21.6. CMAC will provide another opportunity to restart the test on another day if:
   21.6.1. The machine get stuck before the completion of 50% of the test lane
   21.6.2. The processed lane (already cleared area) is completely or partly destroyed due to the recovery of the stuck machine making it impossible for evaluation.

22. CHAIN OF COMMAND
22.1. The whole test process will be under the command of the Project Manager.
22.2. The team members will be under the command of the Project Manager.
22.3. All requests, concerns or questions must be directed to the Project Manager.
22.4. The manufacturers can communicate with the Project Manager through the JICS Consultant.

23. DUTY PERSONNEL
23.1. Time keeper: 1 for each machine to be appointed by Project Manager. Equipment: 1 stopwatch.
23.3. Ending signal: Given by the project manager. Equipment: 1 whistle.
23.5. Refueling assistants: 2 deminers and 1 mechanic.
23.6. Video Cameraman: 2
23.7. Fixed photo cameraman: 2
23.8. Security around the test area: security guards and 4 deminers
23.14. Request handling: Project Manager and JICS Consultant (Takefumi Mayumi)
23.15. Medical service: Dr. Penh Savath. Equipment: 1 ambulance.
23.17. Personnel or individual with no specific duty are not allowed in the test area.
23.18. Team members both Khmer and Foreigner are not allowed to venture for interest or observation of another manufacturer’s test area.

24. COMMUNICATION
24.1. Komatsu: Channel 3
24.2. Hitachi Push-Type: Channel 4
24.3. Hitachi Swing-Type: Channel 5
24.4. CMAC: Channel 7 (including Project Manager)
24.5. Consultants (Local & JICS): Channel 7
Table 2: Helicopter Emergency Contact List

<table>
<thead>
<tr>
<th>POSITION</th>
<th>LOCATION</th>
<th>PHONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAVE TAYLOR</td>
<td>SENIOR PILOT</td>
<td>SIEM REAP</td>
</tr>
<tr>
<td>GLEN WADSWORTH</td>
<td>PILOT</td>
<td>SIEM REAP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KEVIN TRELOR</td>
<td>GENERAL MANAGER</td>
<td>PHNOM PENH</td>
</tr>
<tr>
<td>MALEE CHAN (KHMER)</td>
<td>OFFICE MANAGER</td>
<td>PHNOM PENH</td>
</tr>
<tr>
<td>NEN NY (KHMER)</td>
<td>OFFICE STAFF</td>
<td>SIEM REAP</td>
</tr>
<tr>
<td>SOTHY CHHAY (KHMER)</td>
<td>OFFICE STAFF</td>
<td>SIEM REAP</td>
</tr>
<tr>
<td>KUNTHEA SIM (KHMER)</td>
<td>OFFICE STAFF</td>
<td>SIEM REAP</td>
</tr>
<tr>
<td>IRIDIUM PHNONE</td>
<td>SOMETIME CARRIED BY PILOT</td>
<td>001881 631 52 93 97</td>
</tr>
</tbody>
</table>

OFFICES

<table>
<thead>
<tr>
<th></th>
<th>PHONE</th>
<th>FAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHNOM PENH HEAD OFFICE</td>
<td>023 213 706</td>
<td>023 213 706</td>
</tr>
<tr>
<td>SIEM REAP OFFICE</td>
<td>012 814 500</td>
<td>063 963 316</td>
</tr>
</tbody>
</table>
ANNEX 10:

DEMINING MACHINE TEST AND EVALUATION PROCEDURES
(Valid for Survivability test only)

During the survivability test and evaluation of the demining machines, the following procedures will be applied:

1. GENERAL CONDITIONS
   1.1. The purpose of the survivability test is to check and study the durability of the machines and their attachments against anti-tank mines.
   1.2. "Safety First" is the key principle of conducting the survivability test.
   1.3. Good preparations must be made prior to the test to ensure maximum safety and smooth proceedings of the test.
   1.4. CMAC, JICS, Manufacturers and the Contractor must ensure that the test will be conducted in a transparent and effective manner and that all procedures described herein are strictly adhered to.
   1.5. The survivability test will be conducted in a condition as close to the real minefields as possible.

2. KEY PERSONNEL
   2.1. The Project Manager is responsible for overall management and proceedings of the test.
   2.2. The Project Assistant:
       • Provides general assistance to the Project Manager.
       • In charge of all logistics and supply issues.
       • Coordinates and manages the EOD team deployed during the test.
       • Ensures that all safety and administrative signs are in place and a flag is raised at the test spot.
   2.3. The Consultants (both JICS and local) are responsible for advising and assisting the test proceedings.
   2.4. The Manufacturers must ensure that the machines and attachments are in fit conditions for the test.
   2.5. The Contractor must ensure that all sensors are properly installed and working.
   2.6. The Operators must be ready to operate the machines during the test using the remote control or manual mode.
   2.7. The EOD team: will be deployed during the test to handle mines and explosives for the tests.
   2.8. The Emergency Team: consists of deminers and medic to provide emergency assistance during incident or accident.

3. PRE-TEST PREPARATIONS
   3.1. The Project Manager, Consultants and the Contractor must ensure that all sensors are properly installed.
   3.2. The Project Manager must check to make sure that the view area is safe and the test spot is easily visible.
   3.3. The Project Manager and the Consultants must ensure that cameras are in place to record the test proceedings.
   3.4. The Project Manager must give the briefing to the involved staff on their duties during the test.
   3.5. The Project Manager must ensure that the emergency team is ready for emergency tasks during the test.
   3.6. The Project Manager must make sure that fire extinguishers are available on the test site.
   3.7. The Project Manager must make sure that all visitors (if any) are fully briefed on the test proceedings and safety regulations.
   3.8. The Project Assistant and the EOD team must check the mines, explosives, location of the explosion spot, safety procedures and distance and other necessary EOD equipment and materials to make sure they are available and ready.
   3.9. The Project Assistant must check that all safety and administrative signs are in place.
   3.10. The Medic must ensure that all medical equipment and facilities are ready for emergency treatment and evacuation.
   3.11. The Manufacturers must check that their machine is in fit condition for test.
4. TEST LOCATIONS
4.1. The test will be conducted in the Siem Reap Rural Test Site.
4.2. The briefing area will be used as the view point during the test. Project Personnel and the visitors will be located in this area during the test.
4.3. The explosion test spot (the machine) will be located at a safe distance (300 m) from the view point (toward the north of the briefing view point). The exact location will be determined by the Project Manager and the Consultants, taking into consideration the visibility, safety, fragmentation, level of noise effect, etc.
4.4. The test spot must be easily visible from the view point. The explosion point must be marked by a red flag.

5. SAFETY AND EMERGENCY
5.1. Prior to the survivability tests, the Project Manager will notify the local authorities.
5.2. The project personnel, the manufacturers, visitors and the emergency team will be located at least 300 metres away from the explosion spot.
5.3. The Emergency Team will be fully equipped with PPE, mine detectors and other necessary equipment to provide emergency response in case of need.
5.4. The location and safety of the EOD team will be in accordance with the EOD SOP.
5.5. For safety reason, announcement will be made by the EOD team before the survivability test to prevent people from entering the test area. The Project Manager will also appoint guards and deminers to guard all the corners outside the danger zone during the test.
5.6. PPE will be reserved in case needed for safety reason. The Project Manager in consultation with the Project Consultants must work out how many sets of PPE are needed.
5.7. Photo and video cameras must be placed within a reasonable proximity to the test spot to prevent unnecessary damages.
5.8. The Medic and the ambulance must be stationed at the test site (within the safe distance) at all time during the test.
5.9. The Medic must establish a helicopter landing zone with an accurate GR for emergency landing of the rescue helicopter.

6. TEST MINES AND EXPLOSIVES
6.1. Two types of mines will be used during the test: the PMN or equivalent TNT of 115 g and TM46 with an addition of 1.5 kg of C4 on top.
6.2. One PMN mine or equivalent 115 g of explosive will be placed near the machine to test the performance of the sensors prior to the survivability test. This mine will be detonated by the detonator cord.
6.3. The anti-tank mine TM46 (6 kg of explosive) and 1.5 kg of C4 will be used to test the survivability of the machine (survivability test).
6.4. The TM46 with the C4 on top will be buried 10 cm deep (from top of C4 to the surface of the ground) underneath the rotating drum.
6.5. The TM46 and C4 will be detonated by the exploder operated by the EOD team.

7. TEST SENSORS
7.1. Sensors will be installed inside the cabin of each machine to test the pressure and ear drum pressure during the survivability test.
7.2. The sensors will be installed before the test day.
7.3. The sensors will be tested with a PMN mine before the survivability test.

8. THE EOD TEAM
8.1. An EOD team (consisting of 3 personnel) will be deployed during the survivability test to assist with the test proceedings.
8.2. The EOD team will be dispatched by CMAC to the test site at least 1 day before the test day.
8.3. The EOD team will be briefed by the Project Manager on the test schedule and procedures.
8.4. The Project Assistant will coordinate with the EOD team during the assignment at the test site.
8.5. The EOD team must have all necessary equipment ready for the exercise.
8.6. The EOD team will use EOD SOP during the performance of the survivability test.
8.7. The EOD team will:
8.7.1. Check the mines and all EOD equipment for safety and effectiveness of the operations.
8.7.2. Check the test spot for ERW before burying the mine for test.
8.7.3. Arrange all the safety matters related to the test.
8.7.4. Place/bury the mines according to the test procedures and detonate them using appropriate methods.
8.7.5. Make safety announcement prior to the test.
8.7.6. Check safety on the spot after explosion to confirm it is safe for others to enter the spot to make inspection.
8.7.7. Confirm whether the mine/explosive has fully exploded.
8.7.8. Advise on any other issues related to explosives and safety.

9. TEST PROCEEDINGS

9.1. Pre-test preparations: refer to "Pre-test Preparations" at section 3.
9.2. Test spot: refer to "Test Locations" at section 4.
9.3. Test Machines:
9.3.1. The machines for survivability test will be prepared by the manufacturer in a fit condition prior to the test. This must include full attachments.
9.3.2. The test machines will be parked on the test spot for sensor installations the day before the test.
9.3.3. Sandbags will be used to place in key locations around the machine for safety and fragmentation reason.
9.3.4. The sensors installed in the cabin will be tested (see also "Sensors Test") to make sure that they work properly before the survivability test.
9.3.5. The Operator will place the drum in an appropriate condition for test. The ends of the flail hammers or tiller teeth must be at a maximum 5 cm from the surface of the ground on the spot where the AT mine is buried. For Hitachi Swing Type, the arm must be extended 5 metres from the centre of the base machine.
9.3.6. No Operator is allowed inside the cabin of the machines during the test.
9.3.7. The test schedule will be strictly followed. If a machine on test schedule cannot operate due to some serious damage or malfunctioning before the test begins, the next test will be according to schedule.
9.3.8. How to operate the machines during the tests (sensors and survivability), refer to the section on "Sensors Test" and "Survivability Test" below.

9.4. Test Mines and Explosives:
9.4.1. Mines and explosives used for the tests (both sensor and survivability tests) will be handled by the EOD team in accordance with EOD SOP and placed in their target locations before the test.
   □ For sensor test, mine or explosive will be placed upon the confirmation from the Project Manager that the machine is ready for the test (sensors fully installed).
   □ For survivability test, mine and explosive (C4) will be buried after the confirmation from the Project Manager that the installed sensors work fine during the sensors test.
9.4.2. The mine and explosive will be weighed and photographed for records before placing them for the test.
9.4.3. The EOD will also check for ERW on the test spot before placing mines/explosives for the tests.
9.4.4. The mines/explosives will be exploded according to EOD SOP using appropriate methods for each test. The method of detonating each mine will be mentioned below.
9.4.5. For more information regarding the test mines, refer to "Test Mines" at section 6.

9.5. Safety Announcement:
9.5.1. The EOD team will make safety announcement through the megaphone to the public in the surrounding areas to prevent people from coming into the test area.

9.6. Emergency:
9.6.1. Assigned deminers and the medic will wait in the safe area assigned by the Project Manager with appropriate equipment for any emergency event.
9.6.2. CMAC's bulldozer and the Operator will be on standby for emergency assistance.
9.6.3. The Project Manager must make sure that fire extinguishers are available on the test site.

9.6.4. The emergency team will be under the command and control of the Project Manager.

9.7. Photo and Video Cameras:

9.7.1. Photo and video cameras (without a cameraman) can be placed within a close proximity to the explosion spot for better view. This is at the owner's risk.

9.7.2. The Project Manager and the Consultants may place photo towers in areas where deemed most safe and with good view.

9.8. Sensors Test:

9.8.1. The purpose of this test is to check the performance of the sensors installed in the cabin of the machines. This test is conducted before conducting the survivability test.

9.8.2. A PMN mine or equivalent 115 g of explosive will be placed within a close proximity to the machine in a location which can most impact the machine.

9.8.3. When the machine is ready with the sensors, the EOD team will place the mine securely in the selected location and attach a detonator cord and a fuse to the mine to detonate the mine.

9.8.4. Upon signal from the Project Manager, the EOD team will detonate the mine. After this, the EOD team will follow the EOD SOP to check and confirm that it is safe to enter the area.

9.8.5. Upon the confirmation by the EOD team, the Contractor will check the performance of the sensors inside the cabin.

9.8.6. If the sensors work properly, the preparations will start for the survivability test with the AT mine.

9.8.7. If the sensors fail to work, the Contractor must determine the cause and fix the problem. If it can be fixed on spot, the sensors will be tested again using the same procedures.

9.8.8. If the problem cannot be fixed, sensors will be replaced and they will be tested again using the same procedures.

9.8.9. The survivability test can start only upon confirmation by the Contractor that the sensors are working fine.

9.9. Survivability Test:

9.9.1. The purpose of this test is to check the survivability and durability of the machine against AT mines.

9.9.2. After the sensors test proves that all sensors work properly, preparations are made for the survivability test. When the machine is ready, the EOD team will bury the AT mine and explosive C4 in the selected spot.

9.9.3. The EOD team must prepare to detonate the mine and C4 using an exploder in accordance with the EOD SOP.

9.9.4. When all the preparations are ready (machine, sensors, mine and EOD team preparations), the Project Manager will signal the Operator to start the machine.

9.9.5. The Operator will use the remote control or manual mode to start the machine and rotate the drum to full speed.

9.9.6. When the machine and the drum are operating, the Operator will retrieve to the safety area.

9.9.7. When the drum is at full speed, the Operator will signal Project Manager and the EOD team to detonate the AT mine.

9.9.8. Upon receiving this signal, the EOD team will detonate the mine with the exploder.

9.9.9. After the mine has exploded, the machine Operator will switch off the engine of the machine. The Operator will inform the Project Manager when this is ready.

9.9.10. The Project Manager then signals the EOD team to inspect the explosion area in accordance with the EOD SOP to make sure it is safe to enter.

9.9.11. The following points should be taken into consideration during the survivability tests:

- If the mine does not explode, the EOD team will apply safety procedures to check the mine, retrieve it if possible, and re-place the mine with a new one or re-install the fuse. The test will resume when the mine and the EOD team are ready.

- In the worst case if the mine cannot be retrieved, it will be exploded on spot. In this case, the Operator will drive the machine away to the safety distance before exploding the mine.
If after the mine has exploded during the survivability test (attachment already damaged) but the sensors or one of the sensors fail to function, re-test at a later stage can be negotiated between CMAC and the manufacturer of the machine.

9.10. On-spot Damage Inspection
9.10.1. On-spot damage inspection can be done only after the EOD team confirms that the area is safe to enter.
9.10.2. On-spot damage inspection is the preliminary general inspection to determine the extent of the damage, the condition of the machine (whether it can still operate or not, both base machine and attachment) and how the machine can be retrieved from the explosion area.
9.10.3. Photographs of the damages will be taken for records by the Project Consultants.
9.10.4. Damaged parts will be detected and marked with sprays for evidence and subsequent analysis.
9.10.5. Damaged parts can be collected only with the authorization from the Project Manager and/or Consultants.

9.11. Retrieval of the Machine:
9.11.1. The manufacturer will determine how best to retrieve the machine from the test spot.
9.11.2. The machine can be retrieved from the test spot with the authorization from the Project Manager, after the on-spot damage inspection is complete.
9.11.3. CMAC will assist the retrieval of the machine if necessary.
9.11.4. The machine will be parked in the parking area for further detailed inspection and analysis.

9.12. Detailed Inspection and Damage Report
9.12.1. When the machine is parked in the parking area, the manufacturer in the presence of CMAC representative(s) will conduct detailed inspection of the damages caused by the detonation.
9.12.2. Detailed photographs must be taken of all the damages and parts for subsequent analysis.
9.12.3. Damages will be measured in quantity and size and damaged parts must be properly labeled for easy identification in the photographs.
9.12.4. The manufacturers will complete a damage report and submit to the Project Manager.
9.12.5. The Project Manager and the Consultants can join the detailed inspection at anytime.

9.13. Post-test Maintenance
9.13.1. The manufacturers are responsible for the post test repairs and maintenance of the machine.
9.13.2. All maintenance of the machine as a result of the test must be properly recorded and reported.

10. MANUFACTURERS
10.1. Ensure that the machines are in good operating conditions prior to the test.
10.2. Conduct the after-test machine retrieval.
10.3. Conduct on-spot and detailed damage inspection and prepare damage and maintenance reports.
10.4. Strictly observe the safety requirements and test schedule.
10.5. May take photos of their test activities.
10.6. Must follow the “written oath” rule.

11. EXTERNAL OBSERVERS
11.1. CMAC can bring in external observers to observe the test and evaluation process and provide advice on the process.
11.2. If the manufacturers wish to bring visitors to observe the tests of their machines, they must inform the Project Manager in advance. These visitors will be under the guidance of the Project Manager.

12. ACCIDENTS AND INCIDENTS
12.1. In case there is an accident, the field medic will provide emergency treatment.
12.2. The field medic will make the decision, depending on the seriousness of the injury, to keep the victim at CMAC accommodation, transport him/her to hospital, or call the helicopter to transport the victim to the Emergency hospital in Battambang.

12.3. If the victim is required to be taken to Emergency Hospital in Battambang, the Project Manager will contact the Helicopter company. Please refer to the list of contacts attached.

12.4. When there is an accident involving the area of test, the Project Manager will call off the test if necessary. The test will resume only when the Project Manager sees it fit.

12.5. Full PPE and mine detectors must be prepared for any emergency situations during the test.

13. WEATHER CONDITION

13.1. In case the weather is not favorable for the test, such as raining, lightning, flooding, etc., the Project Manager will discuss with the Consultants and EOD team whether to conduct or suspend the test.

14. MEDICAL SERVICE

14.1. The field medic will ensure that sufficient medical equipment is in place to ensure a good medical response in case of need.

14.2. The ambulance must stand close to the test area in good working condition at all times during the test runs.

15. VISITORS

15.1. All visitors must be accompanied by the Project Manager or appointed Officer at all times.

15.2. During the test, the visitors will stay within the safe area indicated by the Project Manager.

15.3. The Project Manager or appointed Officer will provide safety briefing to the visitors prior to visiting the test areas.

15.4. The Visitors must wear the Visitor Pass at all times when on test site.

15.5. The Project Assistant must ensure that some necessary personal gear is available for the visitors: boots, raincoats, PPE.

16. CHAIN OF COMMAND

16.1. The whole test process will be under the command of the Project Manager.

16.2. All requests, concerns or questions must be directed to the Project Manager.

16.3. The manufacturers can communicate with the Project Manager directly or through the JICS Consultant.

17. COMMUNICATION

17.1. Komatsu: Channel 3

17.2. Hitachi Push-Type: Channel 4

17.3. Hitachi Swing-Type: Channel 5

17.4. CMAC: Channel 7 (including Project Manager)

17.5. Consultants (Local & JICS): Channel 7
Table 1: Sensors and Survivability Test Process

1. Machine is installed with sensors and ready for test
2. Mine/explosive placed for sensor test
3. EOD team explodes the mine/explosive upon signal from Project Manager
4. EOD team confirms safety and Contractor checks the sensors
5a. Contractor confirms that the sensors work
5b. Sensors don’t work, go back to step 2
6. EOD team buries mine for survivability test
7. PM signals Operator to start the machine and rotate the attachment
8. At full speed, the Operator signals the EOD team to explode the mine
9a. Mine does not explode, follow EOD SOP to replace the mine and renew the test
9b. Mine explodes
10. EOD team confirms safety
11. On-spot Damage inspection
12. Retrieval of the machine
13. Detailed Damage Inspection
14. Post-test maintenance
1. SAFETY PROCEDURE
   - Non-CMAC personnel must stay in safe area (parking lot near the canal)
   - For safety reason, only CMAC personnel are allow to carry out trip in, out and within the live/suspected minefield.
   - Non-CMAC members are required permission from Project Manager Mr. Srey Rithisak before entering suspect/live minefield, but still without CMAC responsibility (if bad thing happened).
   - Trip into/out and within live/suspected minefield by non-CMAC personnel must be accompanied by assigned CMAC personnel guide at all time.
   - Please refer to part 4 (some tips for personnel safety and convenience) pages 19 and 20 mentioned in “Information booklet for participants” issued in July 2006.

2. ACCIDENT
CMAC as an organization or individual does not responsible:
   - In case of any accident resulted either from explosive or non-explosive cases
   - In case the accident will maim, kill, partial or whole damage of the non-CMAC personnel/property.

3. SICKNESS/DECEASE
All non-CMAC personnel shall take extreme precaution to take care oneself from any kind of sickness and decease. Please refer to CMAC booklet for additional information and please contact CMAC personnel for detail.

4. MACHINE BOGGED DOWN/RECOVER
In case of a machine bog down in the live/suspected minefield, it would be a joint rescue by CMAC and manufacturer to recover the machine. All related cost to recover the machine (exclude cost to cover accident) will be paid for by the project.

5. MAINTENANCE
Maintenance will be done by individual manufacturer supported by CMAC personnel

6. MACHINE OPERATION
CMAC will in charge all kind of operation of the machine either by remote control mode or manual operation mode.

7. TRAVELING (BY NON-CMAC PERSONNEL)
   - Must inform individual superior and CMAC
   - Traveling by foot shall be in pair and must bring communication equipments
   - If travel by car, it is best to travel in group of at least 2 cars.
   - Any suspected activity observed, if any, shall be reported to CMAC
ANNEX 12: Instructions for the Team Members (Leader, operators, mechanic, interpreter and deminers) Under the Project (Demining Machines)

CMAC’s staff who are appointed to be members under the Test and Evaluation project (Demining Machines), hereinafter referred to as Team Members, will observe the following special rules, apart from other policies, procedures and SOP's currently effective in CMAC.

1. Safety First: This is the most important key word to execute the Project.

2. Chain of Command: The Team Members will be commanded and managed by the Project Manager. However, the Team Members are under the direction of the manufacturer during training, repair and machine operation in the performance test.

3. Working hour: Working hours will be from 7:00 AM to 3:00 PM (lunch time: 12:00 noon to 1:00 PM) or 8:00 AM to 4:00 PM (lunch time: 12:00 noon to 1:00 PM) based on actual site schedule.

4. Overtime allowance: Team Members may be required to work overtime in some occasions, in which case they will not be compensated with overtime allowance.

5. Working period: Team Members will work in accordance with the actual on-site test schedule. Team Members may also be requested to work through the holiday if the circumstance requires. In such case, they will be compensated with equivalent number of days off after the project is completed.

6. Annual Leave: Annual leave cannot be taken during the project period, but will be accrued to the following year.

7. Sick leave: Is allowable with a valid medical certificate. However, medical service on site is available.

8. Special Leave (Congratulation or Condolence leave): Acceptable, but cannot exceed 3 working days during the project period.

9. Weather day off: If the condition of weather is not favorable for test operations, the Project Manager in consultation with the manufacturer has the right to decide weather off-day. Weather off-day substitutes day off.

10. Unfavorable day off: If the conditions of sites or roads are unfavorable, the Project Manager will consult with the manufacturer and decide whether they should operate or not. Unfavorable day off substitutes day off.

11. Accommodation and Food: CMAC will provide accommodation, but Team Members must provide their own food.

12. Professionalism: All staff appointed under the Test and Evaluation project are expected to deliver a high level of professionalism, including good disciplines, honesty, hard work and accountability.

13. Issues of Concerns: All issues of concerns, requests and questions must be directed to the Project Manager.
REFERENCES


APPENDIX
(FOR SURVIVABILITY TEST)

Numerical analysis of Equation (1): Iteration scheme with forward Euler Method

\[ x_1(0) = x_2(0) = 0 \]  \hspace{1cm} (A1)

\[ x_1(n+1) = x_1(n) + hx_2(n) \]  \hspace{1cm} (A2)

\[ x_2(n+1) = x_2(n) + h\left[ \omega_n^2 x_1(n) - 2\zeta \omega_n x_2(n) - a_o(n) \right] \]  \hspace{1cm} (A3)

Where
- \( x_1 \): Displacement
- \( x_2 \): Velocity
- \( n \): Number of Iteration Steps
- \( h \): Sampling Interval
- \( a_o \): Acceleration (measured)