



**SCIENTIFIC TECHNICAL EVALUATION OF EXPLOSIVE EFFECTS AND
CONSEQUENCES - SAFETY DISTANCES (QD) AND RISK ANALYSIS**



**EXPLOSIVE REMNANTS OF WAR DISPOSAL IN ITALY
RISK ANALYSIS AND EXECUTION OF A MISSION
CASE STUDY**

Rome, 22nd november 2016

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AGENDA



- 1. Reference documents**
- 2. Explosive Remnants of War Disposal**
- 3. Explosive Remnants of War Disposal: Threat
Vulnerability Risk Assessment**
- 4. Explosive Remnants of War Disposal: Case study (1)**
- 5. Explosive Remnants of War Disposal: Case study (2)**



REFERENCE DOCUMENTS

- **STANAG NATO 2369 / ALLIED EOD PUBLICATION 14**
NATO EOD Publications Set (NEPS)
IDENTIFICATION AND DISPOSAL OF SURFACE, AIR, AND UNDERWATER MUNITIONS
- **Technical Manual Explosive Ordnance Disposal Procedures A-1-1-4**
PROTECTION OF PERSONNEL AND PROPERTY
Published under the authority of the US Secretaries of the Army, Navy and Air Force
- **Italian Standard Operating Procedures (SOP)**
PROTEZIONE DI PERSONE, ATTIVITÀ E BENI IN CASO DI DETONAZIONE IN CAMPO APERTO DI ORDIGNI ESPLOSIVI ED ESPLOSIVI IN GENERE



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EXPLOSIVE REMNANTS OF WAR DISPOSAL



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Explosive Remnant of War (ERW):

Unexploded Ordnance (UXO) and/or Abandoned Explosive Ordnance (AXO) that remain after the end of an Armed Conflict.

International Ammunition Technical Guidelines ONU no. 1.40
Convention on Certain Conventional Weapons (10th October 1980)/
Protocol V on Explosive Remnants of War (28th November 2003).



Explosive Ordnance Disposal (EOD):

The detection, identification, onsite evaluation, rendering safe, recovery and final disposal of Unexploded Explosive Ordnance.

NATO Allied Administrative Publication no. 06



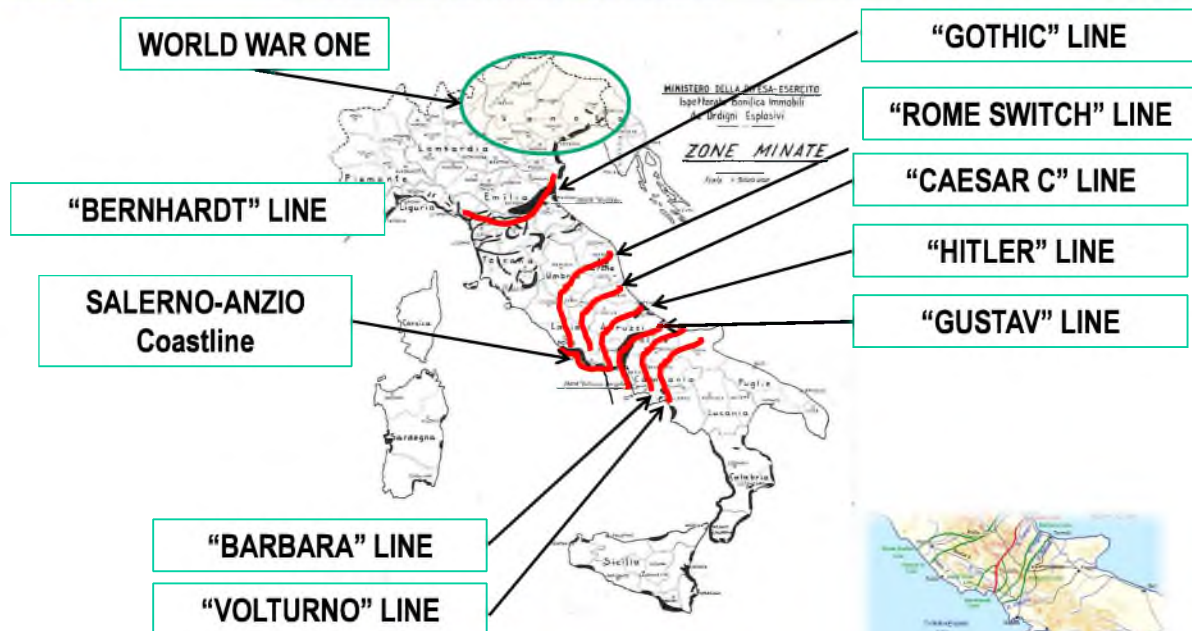
EXPLOSIVE REMNANTS OF WAR DISPOSAL



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CURRENT THREATS:

Unexploded Explosive Remnants of War
Depots of Abandoned Explosive Ordnances



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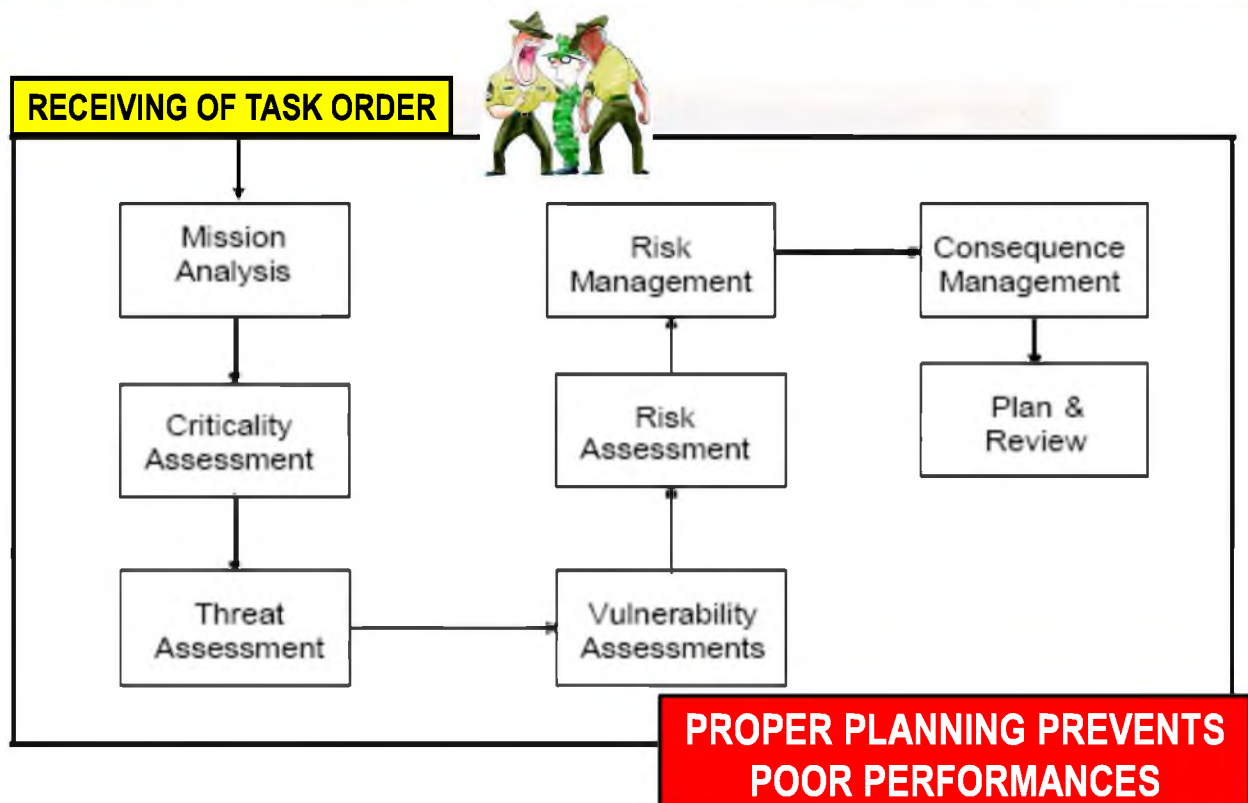
EXPLOSIVE REMNANTS OF WAR DISPOSAL IN ITALY THREAT VULNERABILITY RISK ASSESSMENT



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MISSION ANALYSIS

GOALS

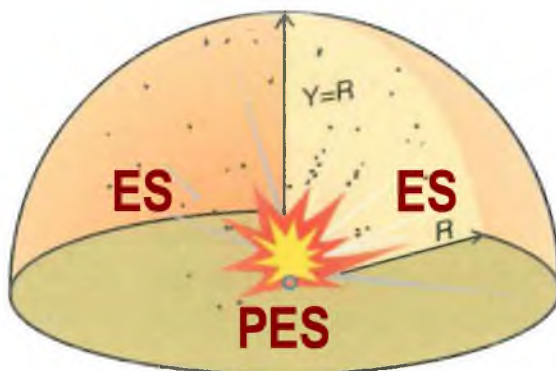
- Recommend minimal protection criteria to minimize serious injury, loss of life, and damage to property.
- Analyze field methodologies to manage risks associated with the explosion effects of Ammunition and Explosives.
- Implement protection of personnel and property.



MISSION ANALYSIS

CHEMICAL EXPLOSION

HEMISPHERICAL GEOMETRY



An Exposed Site (ES) is an area exposed to the potentially hazardous explosion effects from an explosion at a Potential Explosion Site (PES).

Protection of personnel and property can be achieved by:

- Minimal Separation distances for Ammunition hazards;
- Personnel protective measures;
- Ammunition explosion effects engineering controls.



MISSION ANALYSIS

SET OF HAZARD AREA

- Identify the threat (PAYLOAD + CASING) and the methods of activation (FUZES OR PISTOLS) of the Explosive Ordnance.
- Calculate the hazard area using tables of formulae.
- Assess the hazard of secondary threats (gas pipes, fuel tanks, power stations, water tanks, etc.).
- Assess the effect of natural protection on site.
- Assess the effectiveness of precautionary measures to be used.



QUANTITY DISTANCE (QD) PRINCIPLES

- Quantity distance is the **potential damage and/or injury** and the **minimum separation distance relationship** between the PES and the ES.
- Quantity distance is a function of the explosive charge (**Type and Weight**) and the Ammunition **fragment** category.
- There are three main categories based on charge/weight ratio: Extremely Heavy case, Robust and Non-robust.



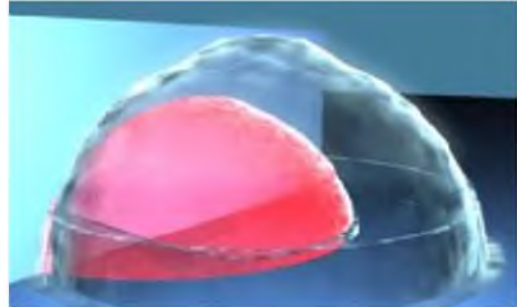


BLAST OVERPRESSURE DISTANCE - BOD -

BLAST WAVE SCALING / CUBE-ROOT-SCALING

$$D = K \times \sqrt[3]{C}$$

Equivalent Explosive Weight TNT in Kg



- BOD 1 Essential personnel (K19,84) 6,1kPa;
- BOD 2 Non Essential Personnel (K130,16) 0,46kPa.



FRAGMENTATION ORIGINATING FROM THE AMMUNITION CASING

$$D = 110 * C^{0,164}$$

Equivalent Explosive Weight TNT in Kg

HFD

Hazardous Fragmentation Distance

$$D = 976,4 + 172,5 * LN(C)$$

Equivalent Explosive Weight TNT in Kg

MFD – HORIZONTAL

Maximum Fragmentation Distance

$$MFD-V = 0,932 * MFD-H^{0,974}$$

MFD – VERTICAL

Maximum Fragmentation Distance



PARTICULAR HAZARDOUS SCENARIO

MFD-H * 1,33

- Intentional detonations of stacked Ammunition and Explosives.

MFD-H * 1,33

- Intentional detonations of Ammunition having preformed/scored fragmenting warheads.

MFD-H * 1,33

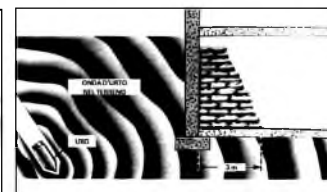
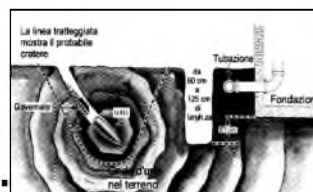
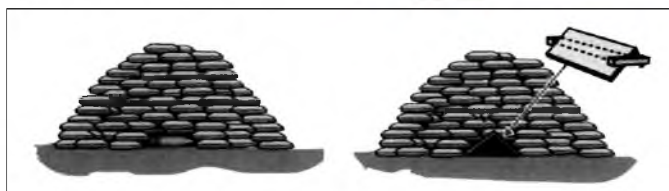
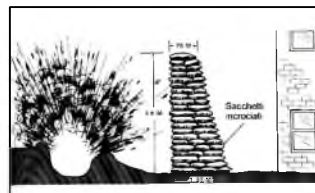
- Intentional detonations of Ammunition by other than the design mode-of-initiation.

Noses, nose plugs, suspension lugs, and baseplates, also known as "rogue" fragments can be projected to distances greater than 3,048 m.



Field Measures for Hazard Confinement have the purpose of preventing the damage due to explosion of Ammunition or Explosives.

- barricading;
- trenching;
- abutments;
- venting;
- covering;
- mounds;
- Tape on windows;
- Buried (tamped) detonations.





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EXPLOSIVE REMNANTS OF WAR DISPOSAL IN ITALY CASE STUDY



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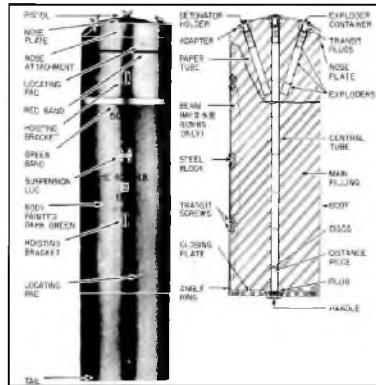
MISSION ANALYSIS CRITICALLY AND THREAT ASSESSMENT

WHAT?	Explosive Remnants of War found – British Air Bomb 4000 Lbs
WHO?	Civilian Technicians employed in an Unexploded Ordnance Detection Task
WHEN?	During detection of the ground for the realization of “PARCO DELLA PACE”
WHERE?	Former military and touristic airport “DAL MOLIN” Northern part of Vicenza (3 Municipalities: Vicenza, Caldogno, Costabissara)
WHY?	Precautionary Measures due to impact of World War 2 in Vicenza





MISSION ANALYSIS CRITICALLY AND THREAT ASSESSMENT



FUZING	3 Nose Pistols
COLOR MARKINGS	Dark green with red and light green bands from nose
BODY LENGTH	82 in.
BODY DIAMETER	30 in.
EXPLOSIVE WEIGHT	2954 lb. Amatol (60/40); 2960 lb. Amatol (80/20); 3070 lb. RDX/TNT (60/40); 3088 - 3242 lb. MINOL 2; 3294 lb. TORPEX 2
CHARGE/WEIGHT RATIO	75%



MISSION ANALYSIS CRITICALLY AND THREAT ASSESSMENT

BLAST OVERPRESSURE DISTANCE

- **NET EXPL. WEIGHT:**
3242 lb. MINOL 2 = 1472 kg
- **EQUIVALENT EXPL. WEIGHT TNT:**
1472 x 1,2 = 1766 kg
- **1583 meters**
IF HIGH EXPLOSIVE WITHOUT CASING





MISSION ANALYSIS CRITICALLY AND THREAT ASSESSMENT FRAGMENTATION ORIGINATING FROM THE AMMUNITION CASING

HFD

- 287 METERS

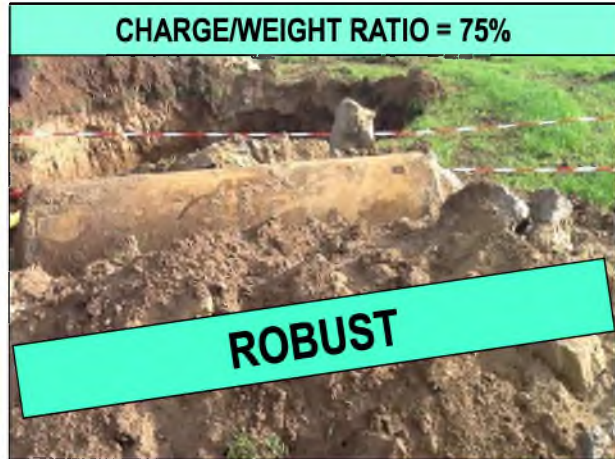
MFD – HORIZONTAL

- 1803 METERS

MFD – VERTICAL

- 1382 METERS

CHARGE/WEIGHT RATIO = 75%



MISSION ANALYSIS CRITICALLY AND THREAT ASSESSMENT PARTICULAR HAZARDOUS SCENARIO

STACKED MUNITIONS

- MFD – H x 1,33 =
1803 METERS X 1,33
2404 METERS



ROGUE FRAGMENTS

- DISTANCES GREATER
THAN 3048 METERS



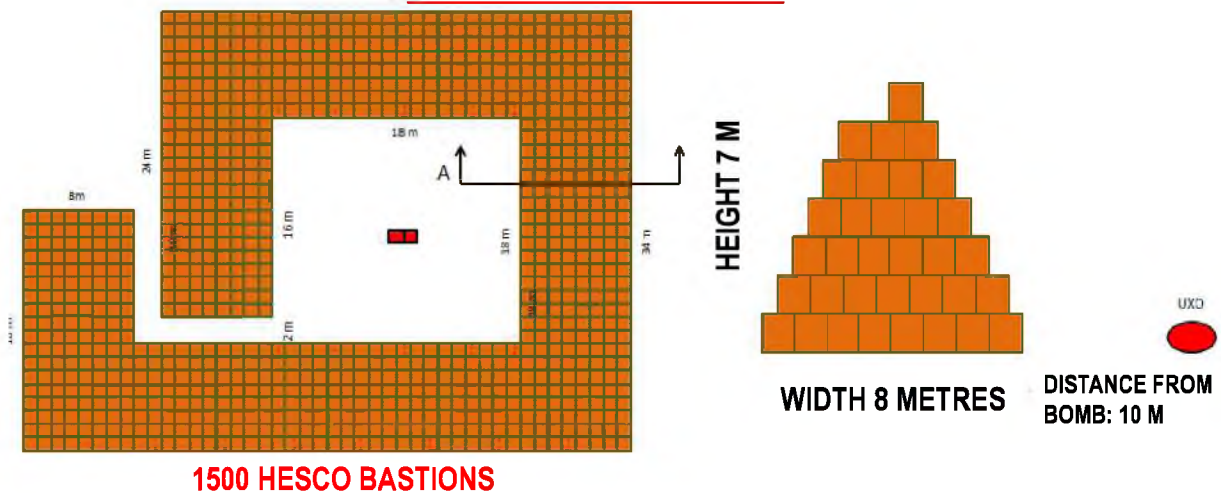


RISK MANAGEMENT

AMMUNITION AND EXPLOSIVES EXPLOSION EFFECTS FIELD ENGINEERING CONTROLS

FINAL DECISION BASED ON THE RISKS PERMITTED AND ASSUMED

FROM 3048 TO 2500 M



RISK MANAGEMENT

PROTECTION OF PERSONNEL

Involved Municipalities:

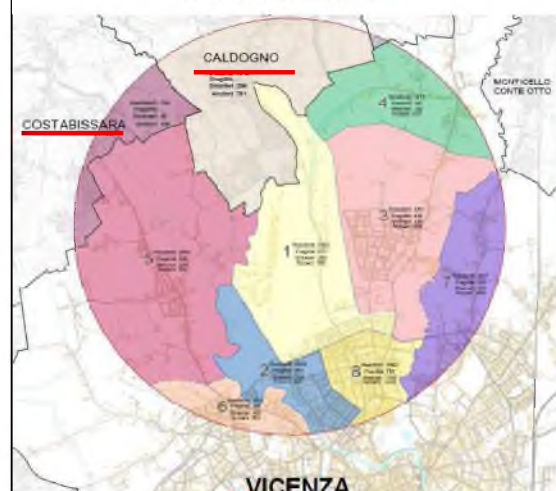
- VICENZA (27832 citizens)
- CALDOGNO (5438 citizens)
- COSTABISSARA (1735 citizens)
- Plus 5% of persons not registered

Provided specific medical assistance: 241 persons

No-Italian persons: 4000

- All communication in 7 different languages: Arabic, English, French, Romanian, Russian, Serbian and Spanish;
- Permanent coordination with the specific communities and religious Leaders.

EVACUATION OF 36750 PERSONS





RISK MANAGEMENT

PROTECTION OF PROPERTY

INFRASTRUCTURES IN DANGEROUS AREA

- Routes: 243
- Buildings: 3.702
- Schools: 27
- Shops: 294
- Religious Sites: 20
- Sport Facilities: 28
- Monuments: 7
- USA SETAF Barracks: 1
- National Barrack: 6
- Local Hospital at 2700 meters



RISK MANAGEMENT

CLEAR, CORDON AND CONTROL

**DISINNESCO BOMBA
EVACUAZIONE DELLA POPOLAZIONE
VENERDI' 25 APRILE 2014**

Il cerchio identifica l'area da evacuare con raggio di 2500 metri a partire dal punto in cui è situata la bomba.

È OBBLIGATORIO PER TUTTI ESSERE FUORI DALL'AREA DA EVACUARE ENTRO E NON OLTRE LE ORE 8.30 DEL MATTINO.

Per informazioni: www.comune.vicenza.it 800-127812

ComuneVi

Disinnesco di pericoloso ordigno bellico. Lasciare le abitazioni e liberare le strade entro le ore 8,30. Per informazioni www.comune.vicenza.it 800 127812

Sono iniziate le operazioni di disinnesco dell'ordigno. Per informazioni www.comune.vicenza.it 800 127812

Operazione di disinnesco terminata. F



COMUNE DI VICENZA

**DISINNESCO BOMBA
25 APRILE 2014**

**OBBLIGO
DI EVACUARE L'EDIFICIO
ENTRO LE ORE 8.30
DEL GIORNO 25 APRILE**

IL SINDACO

Per informazioni: www.comune.vicenza.it 800-127812

**BOMB DAY
EVACUATION FOR BOMB DISPOSAL
FRIDAY 25 APRIL 2014**

A World War II ordnance containing 1,800 kg of explosive has been found in the area of the former US Army Airfield in Vicenza. On Friday 25 April 2014, the Italian Army specialists will start disposal of the bomb at 8:00 am. All the buildings and houses within a radius of 2,500 metres from where the bomb has been found must be evacuated.

EVERYONE MUST BE EVACUATED FROM THE AREA IN QUESTION NO LATER THAN 8.30 ON THE MORNING OF 25 APRIL 2014.

Law enforcement officers will start checks at 8.30 am to ensure that there is nobody inside the



EXPLOSIVE REMNANTS OF WAR DISPOSAL IN ITALY CASE STUDY



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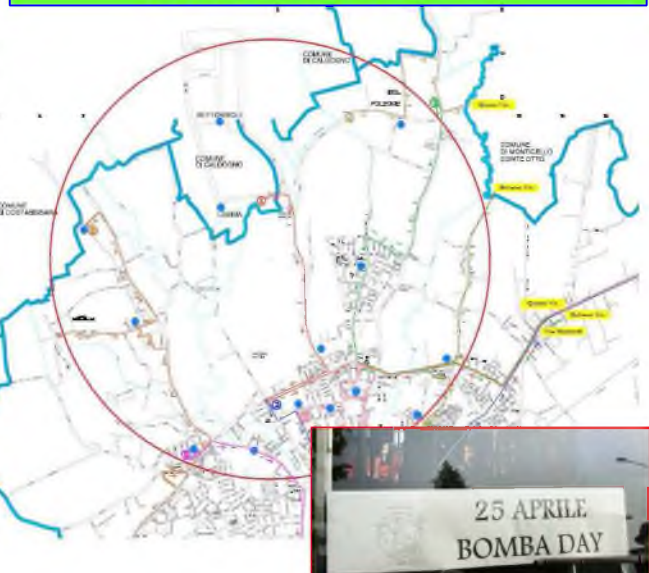
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RISK MANAGEMENT

CLEAR, CORDON AND CONTROL

45 CHECKPOINTS

8 ALL DAY FREE BUS



EXPLOSIVE REMNANTS OF WAR DISPOSAL IN ITALY CASE STUDY



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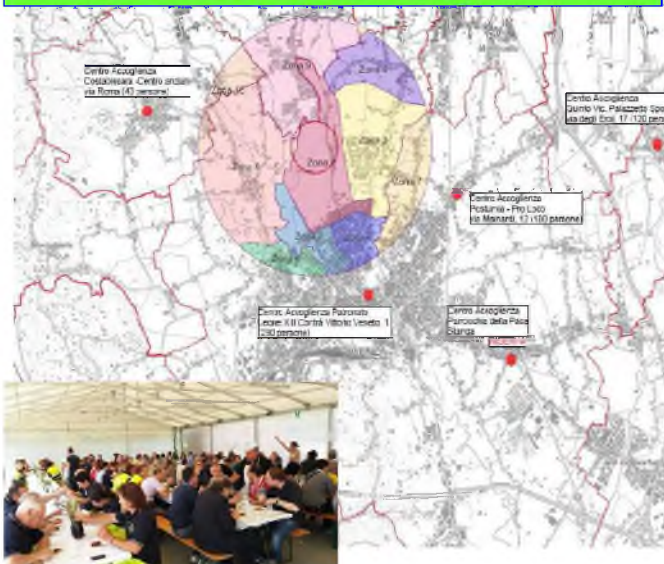
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RISK MANAGEMENT

CLEAR, CORDON AND CONTROL

7 DAYCARE POINTS

16 INFO POINTS





RISK MANAGEMENT

CLEAR, CORDON AND CONTROL



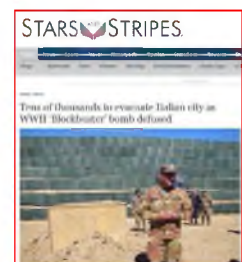
RISK MANAGEMENT

PERSONNEL EMPLOYED DURING THE TASK

- 32 OFFICIAL MEETINGS
- 25 LOCAL AUTHORITIES
- 60 ACCREDITED NEWSPAPER/TV & RADIO STATIONS
- 2 EOD STAFF OFFICERS (1 from C-IED CoE)
- 4 CMD TEAMS (1 from ...)

2000 PERSONS WORKED TOGETHER TO ACHIEVE THE SAME GOAL: PROTECTION OF PERSONNEL AND PROPERTY!

- 100 TRAFFIC OFFICERS
- 210 MUNICIPAL WORKERS
- 600 VOLUNTEERS OF NATIONAL CIVIL PROTECTION
- 60 TEAMS OF MEDICAL EMERGENCY SERVICE
- 100 TECHNICIANS OF SERVICES





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AMMUNITION AND EXPLOSIVES EXPLOSION EFFECTS ENGINEERING CONTROLS



Ground Shock has been registered up to 40 km from the Explosion Site .



MOUNDS

UDINE, April 2015
 British Air Bomb mod. GP MK I 1000 Lbs
 from 1800 m to 400 m
 185 HESCO BASTIONS / 500 cubic meter of sand

CATANIA, June 2015
 British Air Bomb mod. GP MK IV 230 Lbs
 from 1600 m to 1000 m
 142 HESCO BASTIONS / 180 cubic meter of sand

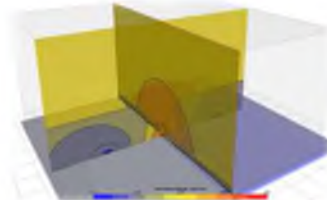


AMMUNITION AND EXPLOSIVES EXPLOSION EFFECTS ENGINEERING CONTROLS



Verona, June 2015

FEMA:
FINITE ELEMENT METHOD OF ANALYSIS



US Air Bomb mod. AN M64 500 Lbs
from 1800 m to 700 + 1000 m



Rome, September 2015



COVERING

