DIEM-SSP

Disasters and emergencies management for safety and security in industrial plants

Scenarios Overview and State of the Art

OUTLINE

Example of major disasters world wide in industrial plants

- **Oil storage disaster, Buncefield, England**
- **Oil pipeline explosion , Qindao, China**
- **Factory collapse disaster , Savar, Bangladesh**
- **Factory fire disaster, Prato, Italy**
- **Mine disaster , Tallmansville, VA, USA**
- **Aluminum factory disaster , Ajka, Hungary**
- **Mine disaster , Montcoal, VA, USA**

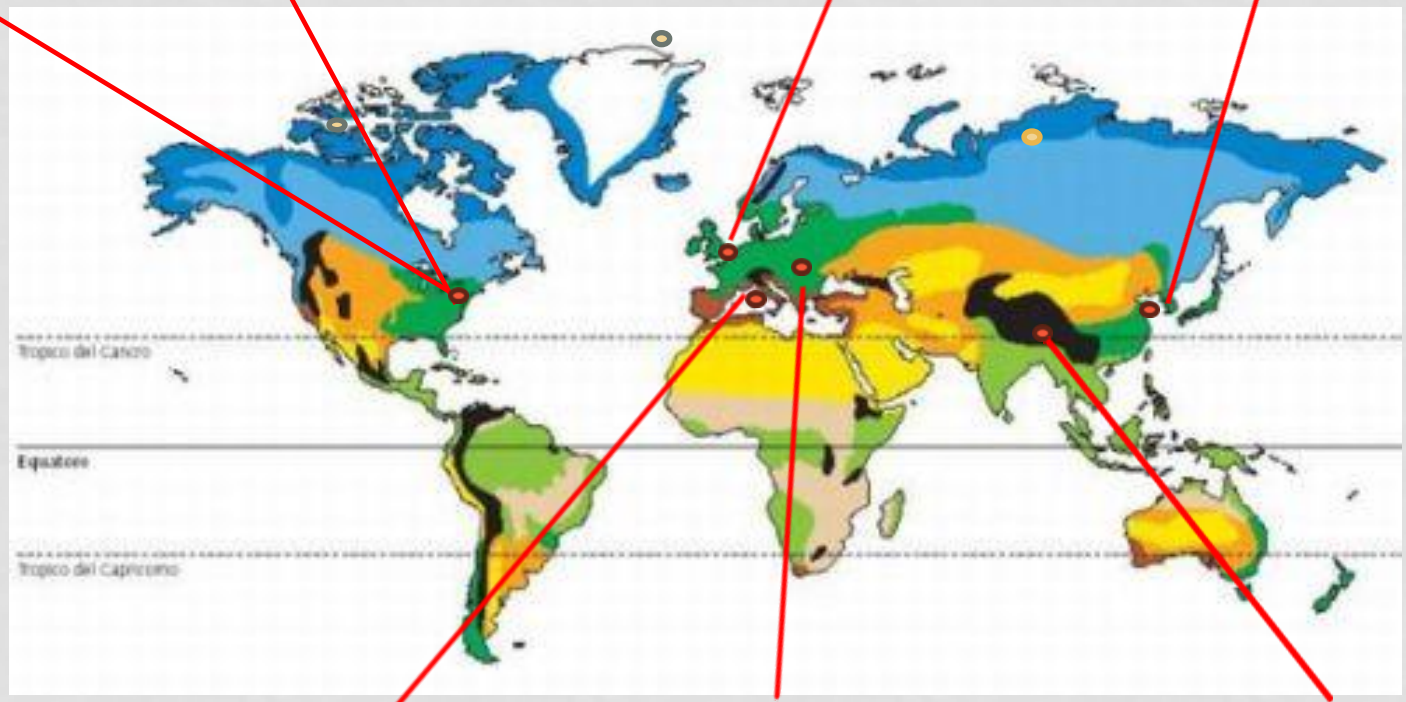
GEOGRAPHICAL LOCATION OF DISASTERS

MINE DISASTER
Tallmansville , West Virginia, USA

MINE DISASTER
Montcoal , West Virginia, USA

OIL STORAGE DISASTER
Buncefield , London, England

OIL PIPELINE EXPLOSION DISASTER
Qindao , China



FACTORY FIRE DISASTER
Prato , Italy

ALUMINUM FACTORY DISASTER
Ajka , Hungary

FACTORY COLLAPSE DISASTER
Savar , Bangladesh

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OIL STORAGE DISASTER, BUNCEFIELD
DECEMBER 11, 2005

✧ **DESCRIPTION**

an explosion in a fuel depot caused the most severe fire in England after the war.

✧ **ESTIMATED VICTIMS**

43 serious injuries

✧ **MAIN ENTITIES INVOLVED**

- Total UK, Buncefield depot Operator
- Hertfordshire Oil Storage Limited (HOSL) – Joint Venture between Total uK and Chevron
- British Pipeline Agency (BPA)- Owner/ Operator of part of the Buncefield site – Shell& BP Joint Venture
- TAV Engineering – Level switch maker
- Health & Safety Executive (UK HSE, like US OSHA)
- Environment agency (UK EA, like US EPA)
- COMAH Competent authority (CA)

OIL STORAGE DISASTER, BUNCEFIELD DECEMBER 11, 2005 (2)

✧ **MAIN RESCUE UNITS**

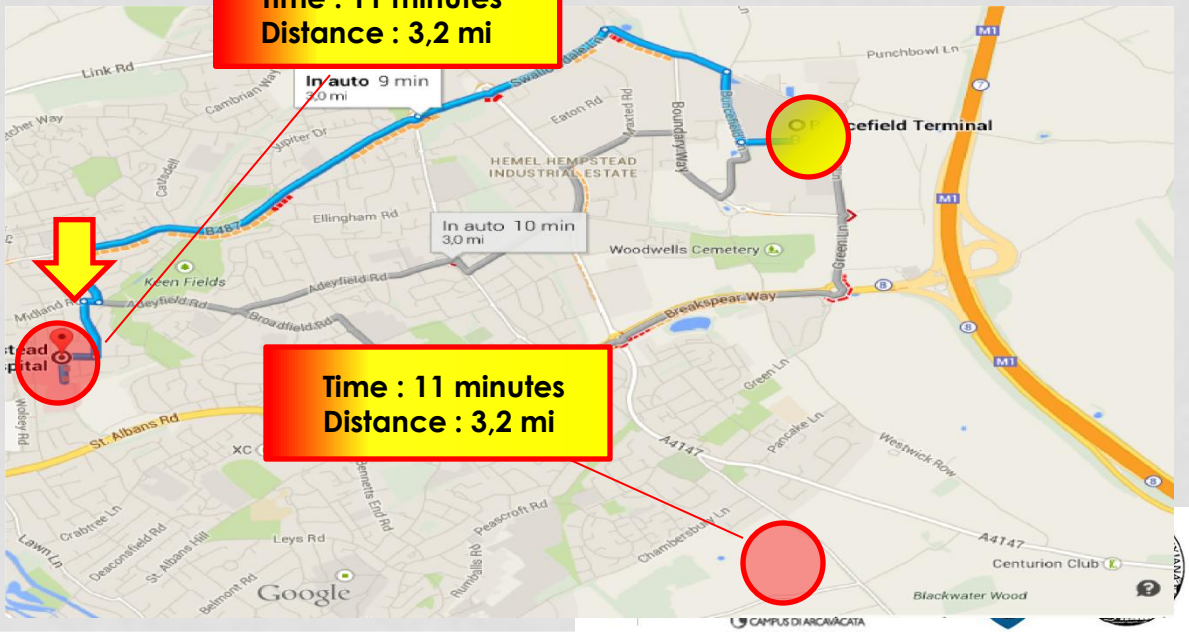
- **Fire department of Hertfordshire**

More than 150 people involved in rescue operations

- **United Kingdom Fire Service Search and Rescue Teams (UKFSSART)**
- **Urban Search and Rescue Teams (USAR)**

✧ **RESCUE PROCEDURES**

Hundreds of homes in the Hemel Hempstead area were evacuated, and about 2,000 people had to find alternative accommodation;



✧ **MAIN INVOLVED HOSPITALS**

- **Hemel Hempstead Hospital**
- Watford General Hospital

OIL PIPELINE EXPLOSION, QINDAO NOVEMBER 23, 2013

✧ **DESCRIPTION**

The incident occurred while several workers were trying to repair a leak in the pipes produced owned by Sinopec, the largest Chinese oil company, to be oozing crude oil

✧ **ESTIMATED VICTIMS**

52 dead, 166 injured

✧ **MAIN ENTITY INVOLVED**

Sinopec China Petroleum

✧ **MAIN RESCUE UNITS**

- Firefighters Huangdao oil hub of Sinopec
- Chinese Army

OIL PIPELINE EXPLOSION , QINDAO NOVEMBER 23, 2013 (2)

✧ **RESCUE PROCEDURES**

Rescue operations were hampered by heavy rain. After the explosion of the pipeline, which destroyed whole streets, overturned cars and smashed all the windows and the windows in a wide radius, 18,000 people were evacuated from Qingdao

✧ **MAIN INVOLVED HOSPITALS**

- **Qindao west coast Medical Center**
- International Clinic of Qingdao Municipal Hospital (ICQD)
- ChengYang People's Hospital

FACTORY COLLAPSE DISASTER , SAVAR APRIL 24, 2013

✧ **DESCRIPTION**

An eight-store building collapsed. The structure housed several textile factories in Bangladesh, who built clothes for western companies.
Among them was also the Italian Benetton.

✧ **ESTIMATED VICTIMS**

233dead, 700 injured

✧ **MAIN ENTITY INVOLVED**

- Industries Association of Bangladesh
- International Labor Organization (ILO)
- Benetton Group

✧ **MAIN RESCUE UNITS**

- **Firefighters of Division of Savar**

FACTORY COLLAPSE DISASTER , SAVAR APRIL 24, 2013 (2)

✧ **RESCUE PROCEDURES**

Rescuers immediately have saved about 2,500 people, but there were many missing. the exact number of people who have remained under the rubber is not defined .

Many hours were needed to extinguish the flames

Despite the fatigue and the sickening odor of decomposing bodies, rescuers continue to dig for days

✧ **MAIN INVOLVED HOSPITALS**

- **Enam Medical College & Hospital, Division of Savar**
- Monorom Hospital
- Prime Hospital

FACTORY FIRE DISASTER, PRATO
DECEMBER 2, 2013

✧ **DESCRIPTION**

A tragic fire broke out at dawn in a shed in an industrial area on the outside of Prato. The fire caused the collapse of part of the building that was used as a dormitory.

✧ **ESTIMATED VICTIMS**

7 dead, 10 injured

✧ **MAIN ENTITY INVOLVED**

- Cisl Toscana

✧ **MAIN RESCUE UNITS**

- National body firefighters health emergency Italy
- Department of Civil Protection
- *Croce d'oro di Prato*
  Association of First Aid and assistance

FACTORY FIRE DISASTER, PRATO
DECEMBER 2, 2013 (2)

✧ **RESCUE PROCEDURES**

Within a few moments came the firemen and the first of 118 ambulances.

Fighting operations began immediately and was immediately realized that there were other people inside the shed.

Time : 10 minutes
Distance : 6,7 km

Time : 12 minutes
Distance : 5,7 km

Time : 10 minutes
Distance : 4,4 km

✧ **MAIN INVOLVED HOSPITALS**

- **Santo Stefano Hospital**
- Associazione di Pubblica Assistenza Croce D'Oro
- Croce Rossa Italiana

MINE DISASTER TALLMANSVILLE , JANUARY 3, 2006

✧ **DESCRIPTION**

An explosion has rocked wells and tunnels in the Sago mine, trapping 13 miners, of whom 12 have died due to carbon monoxide

✧ **ESTIMATED VICTIMS**

15 dead, injured

✧ **MAIN ENTITY INVOLVED**

- International Coal Group's Sago Mine

MINE DISASTER TALLMANSVILLE , JANUARY 3, 2006 (2)

✧ **MAIN RESCUE UNITS**

- **Mine Safety and Health Administration(MSHA)**

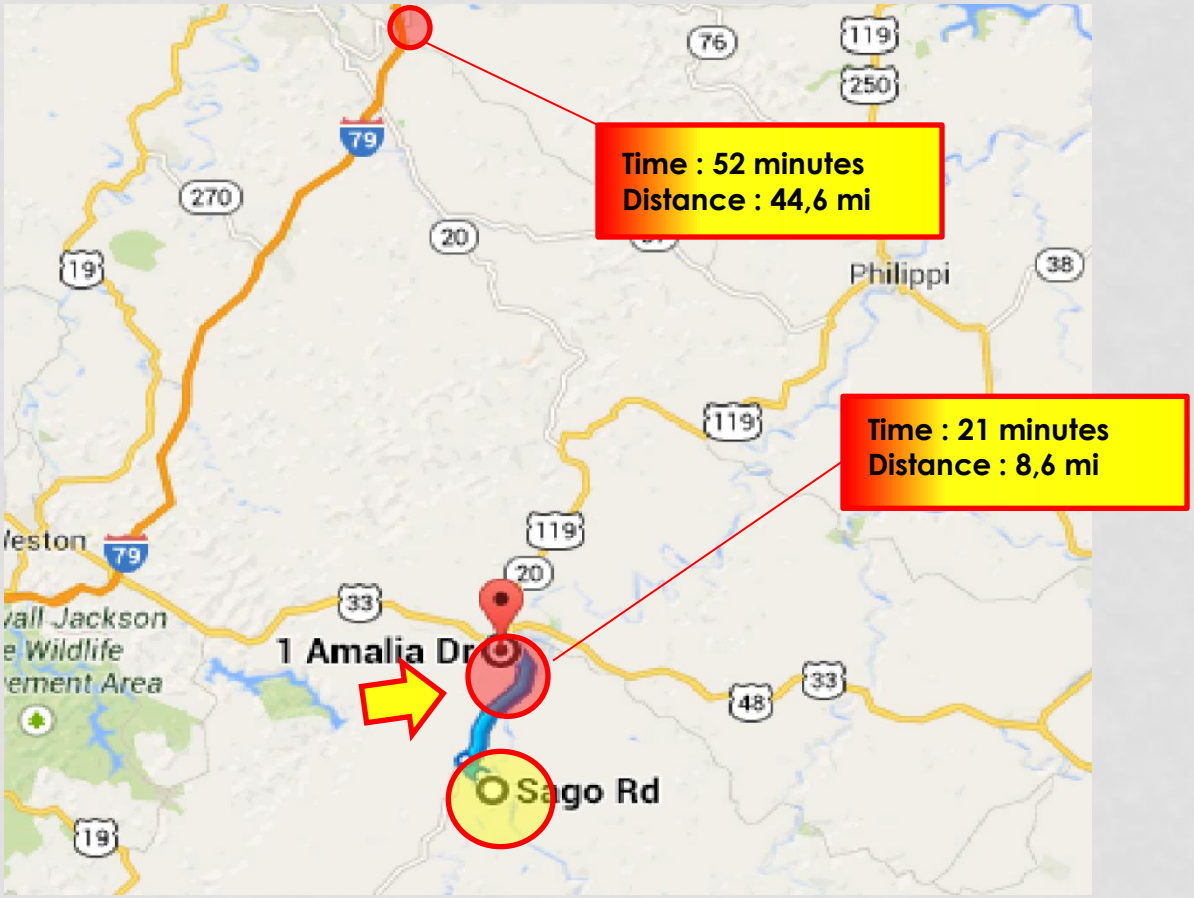
✧ **RESCUE PROCEDURES**

The company notified with the MSHA at 8:30.

Even after the gases abated, rescue teams had to proceed with caution, continually testing for hazards such as water seeps, explosive gas concentrations, and unsafe roof conditions.

✧ **MAIN INVOLVED HOSPITALS**

- **St. Joseph's Hospital**
- United Hospital Center



ALUMINUM FACTORY DISASTER, AJKA OCTOBER 4, 2010

✧ **DESCRIPTION**

a large pond sludge of an aluminum plant near the town of Ajka in western Hungary gave way suddenly releasing a huge mass of water and red mud which stepped in the surrounding countryside.

✧ **ESTIMATED VICTIMS**

A Kolontár four people drowned in the river.
The red mud is dangerous because of its high pH it could cause an alkaline reaction in contact with the skin, **90 people appear to have been taken to hospital with chemical burns**

✧ **MAIN ENTITY INVOLVED**

- Mal *(Magyar Aluminium)* S.A
- National Directorate General for Disaster Management (NDGDM)

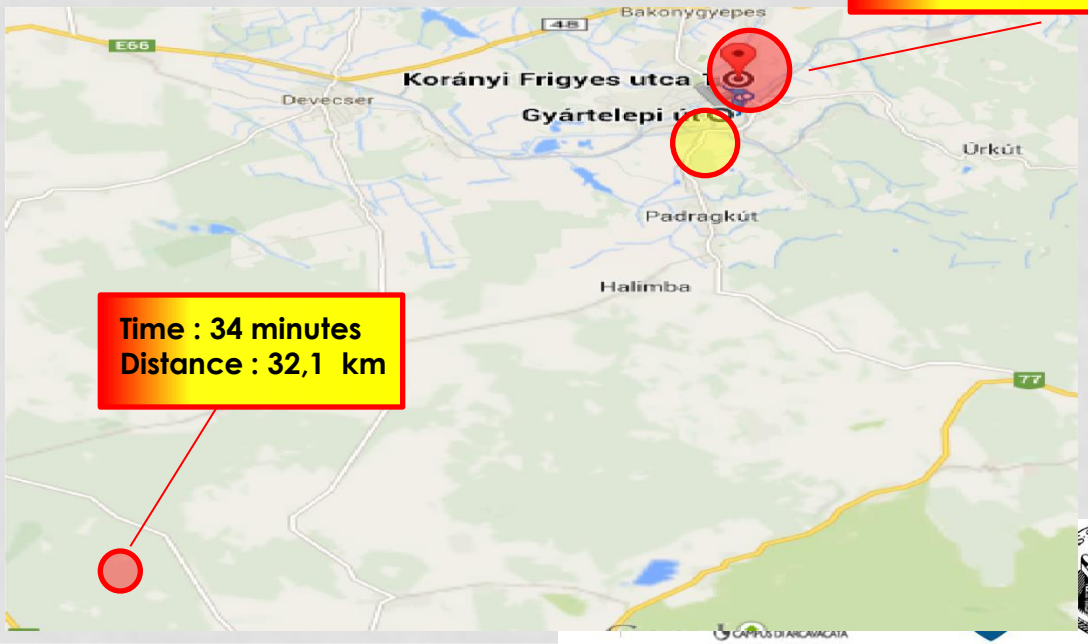
ALUMINUM FACTORY DISASTER , AJKA OCTOBER 4, 2010 (2)

✧ **MAIN RESCUE UNITS**

- **Hungarian Civil Protection**
- Hungarian army

✧ **RESCUE PROCEDURES**

On the back, the river that runs through the area affected by the disaster, and the Marcal been paid as a countermeasure were tons of plaster to try to tie the red mud and prevent the spread downstream



✧ **MAIN INVOLVED HOSPITALS**

- **Magyar Imre Hospital**
- Tapolcai Hospital

MINE DISASTER , MONTCOAL
APRIL 5, 2013

✧ **DESCRIPTION**

An explosion has rocked wells and tunnels in the Sago mine, trapping 13 miners, of whom 12 have died due to carbon monoxide

✧ **ESTIMATED VICTIMS**

25 dead, injured

✧ **MAIN ENTITY INVOLVED**

- Massey Energy

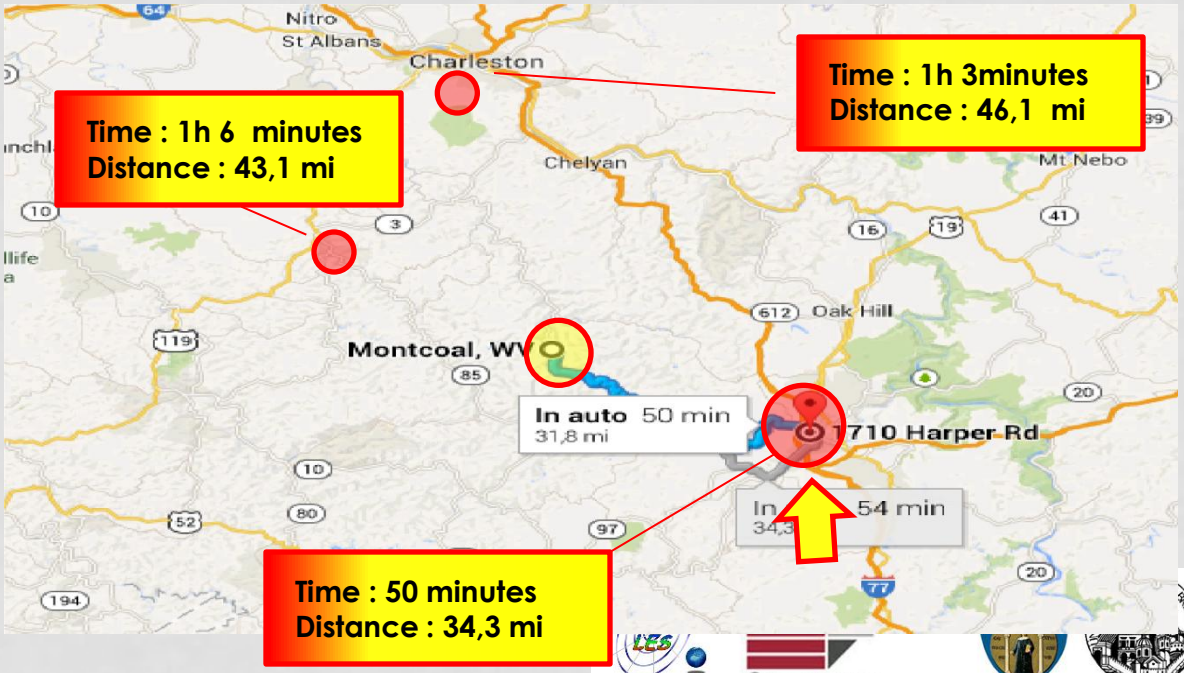
MINE DISASTER , MONTCOAL
APRIL 5, 2013 (2)

✧ **MAIN RESCUE UNITS**

Department of Montcoal firefighters

✧ **RESCUE PROCEDURES**

After the suspension of research at the dawn rescuers began to dig holes to bring air into the tunnels, but were required many hours to make the tunnels viable



✧ **MAIN INVOLVED HOSPITALS**

- Boone Memorial Hospital
- **Raleigh General Hospital**
- Saint Francis Hospital

EMERGENCY MANAGEMENT – RULES

MANAGEMENT OF AN EMERGENCY LEADS TO A CHANGE OF THE NORMAL PROCEDURES AND BEHAVIORS THAT USUALLY ARE IMPLEMENTED IN RESCUE ORDINARY

- **NOT IMPROVISE**

planning behaviors and procedures to be implemented is crucial

- **RESPECT THE ROLES**

it is one of the most difficult to follow. In extreme conditions, it is essential to know WHO DOES AND WHAT IT DOES.
During an emergency, there are several figures that interact at various levels, it is necessary to know who they are and who deal

- **COLLABORATION**

this element is often confused by the rescuer with the instinct to intervene in the event apart from the other figures on the field,.

that is why this point is highly dependent on the previous

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EMERGENCY MANAGEMENT COMMUNICATION

COMMUNICATIONS DURING A DISASTER MAY BE VERY DIFFICULT

- The mobile phone in case of a high volume of communications can become overloaded and therefore present difficulties of communication (or even the disaster may involve mobile phone lines)
- on the location of the event is preferable to use the radio communication minimizing voice communications
- Communication rumors must be kept under control and correctly evaluated
- Information sharing among different rescue entities (authorities, depts, agencies, etc.) is a critical point

COMMUNICATIONS FIELD SHOULD NOT BE UNDERESTIMATED

EMERGENCY MANAGEMENT- ELEMENTS

The following elements should be carefully taken into account from an engineering and medical point of view

STRATEGY
defined as the development of organizational responses

LOGISTIC
set of movements, personnel, equipment and materials

TACTICS
application of plans with the performance of the chain of aid

EMERGENCY MANAGEMENT COORDINATION

- **The proper and effective management of an emergency scenario is based on a scheme of work in which specific roles held by doctors nurses and rescue workers (with adequate training) are identified.**

TECHNICAL AID **HEALTH AID**

work together co-ordinated by the standard
ICS (Incident command System)
currently adopted in Italy and used by the management system of interdepartmental accidents in the USA and by FEMA
integration among the forces on the ground can not take place only in times operating!

EMERGENCY MANAGEMENT
CHAIN OF RESCUE

CHAIN OF RESCUE

chronological sequence of an ideal management

- ALARM
- IMPROVISATION
- RECONNAISSANCE
- ORGANIZATION
- SECTORALISATION
- RESCUE
- MEDICALIZATION
- EVACUATION
- HOSPITALIZATION

sequence of steps for the path of the wounded

- SPOT
- YARD
- COLLECTION AREA
- NORIA RESCUE (or small Noria)
- ADVANCED MEDICAL POST
- NORIA EVACUATION (or big Noria)

EMERGENCY MANAGEMENT CHRONOLOGICAL SEQUENCE

Chronological sequence of an ideal management

- **ALARM**

the operating center (usually medical) collects the alarm. A trained operator via telephone interview defines the critical event and inform the other institutions

- **IMPROVISATION**

Moment immediately after the event. the shock and emotional involvement of friends or family to bring an attitude of loss or chaos in the worst case

- **RECONNAISSANCE**

is made within the first few minutes after the activation of the emergency from the first rescue vehicle arrives on site and therefore should not deal with ONLY the direct relief of the victims.

CRITICAL STAGE

- **ORGANIZATION**

is the stage where the relief effectively manage the incident

VERY CRITICAL STAGE

EMERGENCY MANAGEMENT CHRONOLOGICAL SEQUENCE (2)

Chronological sequence of an ideal management

- **SECTORALISATION**

breakdown in the functional areas of work to rationalize resources

- **RESCUE**

set of operations aiming to move the victims in a safe place

- **MEDICALIZATION**

ensure accident victims to ensure the best transport to hospitals

- **EVACUATION**

moving to places of definitive care

- **HOSPITALIZATION**

preparing contingency plans for a large number of victims

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EMERGENCY MANAGEMENT
SEQUENCE OF PATH OF THE WOUNDED

- **SPOT**

  Place of incident where there are wounded

- **YARD**

basic unit in which the spot is split to divide the rescue

- **COLLECTION AREA**

area immediately next to the spot where it is possible to group the wounded through **TRIAGE system**

- **NORIA RESCUE (or small Noria)**

circuit of the stretcher-bearers who turn away from the vicinity of the wounded to the advanced medical post

- **ADVANCED MEDICAL POST**

Medical structure interposed between the place of the incident and hospitals

- **NORIA EVACUATION (or big Noria)**

circuit ambulance (or other means of medical transport) by the advanced medical post to hospitals

EMERGENCY MANAGEMENT
TRIAGE SYSTEM

- TRIAGE is the process of determining the priority of patients' treatments based on the severity of their condition.

- This rations patient treatment efficiently when resources are insufficient for all to be treated immediately

  - procedures triage more complex predict that the contact with the patient more the visit does not exceed 5 minutes

TRIAGE TOOLS : triage algorithms, cards, bracelets, badges

START TRIAGE

Red code	EXTREME URGENCY
Yellow Cod	PRIMARY EMERGENCY
Green Cod secondary urgency	
Black Cod	DECEASED

the execution of the start triage must be possible in every link in the chain of emergency

EMERGENCY MANAGEMENT
MEDICAL IMPORTANT FIGURE

EMERGENCY DIRECTOR

doctor responsible for any type of health intervention in the area of operations. Has to deal with the equivalent of firefighters and police, remaining always readily identifiable.

ADVANCED MEDICAL POST DIRECTOR

role played by a physician who has the responsibility for the registration card of patients and consequently their input based on the severity code

TRIAGE DIRECTOR

responsible for the coordination of the triage nurse. this office was taken generally by the first nurse who comes on the site

TRANSPORT DIRECTOR

This role may be played by a rescuer and / or a central technical and / or a central nurse.

EMERGENCY MANAGEMENT
MEDICAL TRANSPORT

The **TRANSPORT DIRECTOR** is a position of considerable importance because the tasks are varied:

- determine the position of **CHECK POINT** (obligatory point of passage for all vehicles entering and exiting the site)

the check point is the point at more risk of confusion in the chain of relief because it must be the meeting point between the operations center and the place of event (as far as vehicles are concerned)

- **CENSUS** and the available means, communicate and adjust their movements according to the demands of the post of director of advanced medical and relief

- **RECORDING** incoming and outgoing patients using the appropriate forms even for additional recording to be performed before in the hospital

NOTE

ACCORDING TO THE TYPE OF PATIENT WILL BE ASKED FOR A SUITABLE TRANSPORT TO THE DIRECTOR OF TRANSPORTATION FOR A SUITABLE TARGET (IN SUCH SITUATIONS MEDICALIZED CREWS CAN BE SPLIT TO MAKE THE MOST OF THE STAFF)

EMERGENCY MANAGEMENT
MEDICAL TRANSPORT (2)

MEDICAL TRANSPORT CAPACITY

defines the number of theoretically ambulances to evacuate within 1 hour all patients, since the average time of rotation used for cover, at a speed of 60 km/h, the distance between the place the incident and hospitals, assuming a load of 2 patients time.

- **usually one needs to break the journey of the wounded to hospitals, stopping in several places, although it may seem like a contradiction this is due to the fact that we must prevent hospitals from collapsing due to overloading of patients**

- **very often the distance separating hospitals from the scene of the accident is such that the ambulance would take a very long time to evacuate all the wounded directly**

EMERGENCY MANAGEMENT
EMOTIONAL INVOLVEMENT

HUMAN REACTIONS

Rescuers involved in a situation of emotional stress to the limit and are involved in the intervention to deal with people in a state of bewilderment, shock and confusion.

Sometimes emotional involvement creates instinctive reaction harmful to the administration of the intervention

SAVAR, APRIL 24, 2013

during the disaster non-professional rescuers have partnered operations. The sight of corpses and mangled bodies under the rubble has created in them a shock strong enough to require rescue and therefore making the disaster management even more complex

NEW YORK , SEPTEMBER 11 , 2001

Although there were extremely strict protocols on how to place safety in emergency vehicles in interventions with buildings collapsing, knowing well the dangers of falling glass and debris, the magnitude of this incident created an emotional involvement that these protocols were not respected and the collapse of the south tower caused the loss of 15 ambulances.

EMERGENCY MANAGEMENT CRITICAL ISSUES ANALYSIS

BUNCEFILED OIL STORAGE EXPLOSION

Issues during the reconnaissance

- there were problems due to smoke in determining the exact size of disaster
- establish the toxicity of the smoke and thus the flow of relief

Issues during the organization

- lack of communication with local radio and TV for the evacuation of neighboring areas and consequent disorder
- limited availability of equipment and materials
- communication of decisions among entities not timely (information sharing problem)

Issues during medical rescue

- Forms used to collect data by the police were incompatible with forms used in the hospitals
- inconsistencies in the behavior of bodies with similar roles (operating in the same place) and exposed to the same dangers

EMERGENCY SIMULATION
STATE OF THE ART

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- **Evacuation**

Christian Sell and Iris Braun (2009)

The attention is focused on

- **Restricted situational overview**
- **No support for resource management**
- **Lack of flexibility**
- **No support for delegation**

SOLUTION PROPOSED

Use Wfms to support the modeling, execution and management of emergency plans

- **The WfMS must always depict the current state of the deployment**
- **The WfMS must allow the adaptation of the workflow before and during execution**
- **The WfMS must support the delegation of measures**
- **The WfMS must support the execution of workflows**

EMERGENCY SIMULATION
STATE OF THE ART (2)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- **Evacuation**

Jianyong Shi et al. (2008)

The attention is focused on

- **a system simulation model in which a physical model and a mathematical model are included**
- **an intelligent technology is induced in this model to represent self-motivation, response and decision-making ability of human in the escape progress**

SOLUTION APPROACH

Based on the agent technology, a computer program is developed to simulate and analyze the egress progress in large public buildings through combining rule reasoning with numerical calculation, and some crowd pedestrian flow phenomenon, such as aching, rerouting

EMERGENCY SIMULATION
STATE OF THE ART (3)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- Transport patients

Chia-Ying Chen et al (2010)

The attention is focused on

- emergency resource assignment
- novel emergency vehicle dispatching system to reduce emergency response time, which includes automatic emergency resource assignment and driving path planning to reduce unnecessary time delay caused by human misjudgment or the delay caused by traffic jam
- a lane reservation scheme for emergency vehicles to minimize the crash risks

SOLUTION APPROACH

A traffic simulator written in C++ is developed to evaluate the approach and compare to the shortest path approach in different traffic conditions. it is created accident scenes randomly and record the traveling time of the EV between the departure location and the destination. it is assigned different number of vehicles according to the congestion rate and use the congestion rate to express the ratio of the congested road segments in the area

EMERGENCY SIMULATION
STATE OF THE ART (4)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- **Transport patients**

Marion S. Rauner (2012) et al.

The attention is focused on

- **By evaluating realistic scenarios, policy model is shown to enhance the scheduling and outcomes at operative and online levels.**
- **training medical emergency staff to best cope with a variety of realistic scenarios, some of which may be rare in nature**
- **the flow of an individual, injured at the incident site, moving through pre-triage, rescue, triage, and treatment in rooms to transportation to a hospital**

SOLUTION APPROACH

Scheduling of injured persons for care at an advanced medical post, including the resources required for such care in the European model for mass casualty incidents, comprises a dynamic, complex management task.

Use of the software package AnyLogic by XJ Technologies to implement the proposed DES policy model.

EMERGENCY SIMULATION
STATE OF THE ART (5)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- **Transport patients**

Bruno Jezek et al. (2012)

The attention is focused on

- **uses GIS technology to process communication network data to calculate the transport time necessary to bring responders to the incident location or to deliver patients from the incident location to medical facilities**
- **application of the methodology in verification of law requirements on emergency medical services response times within a specified territory.**

SOLUTION APPROACH

use a novel combination of simulation approach and geographical information system technologies to model and present large volumes of different kinds of information. The suggested methodology was used to evaluate system readiness for a major incident

EMERGENCY SIMULATION
STATE OF THE ART (6)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- **Transport patients**

Yen-Hung Lin, (2009) et al.

The attention is focused on

- **logistics model in a disaster relief operation for delivery of critical items**
- **multi-objective, multi-period, multi-commodity, and multi-vehicle scenario**

SOLUTION APPROACH

Two heuristic approaches are introduced to solve the logistics problem. In the first approach, a genetic algorithm is applied as the tour generator to reduce the size of the problem. In the second approach, a vehicle assignment heuristic is proposed by decomposing the original multi-vehicle, multi-location problem into several sub-problems consisting of only a partial number of clusters in the main problem

EMERGENCY SIMULATION STATE OF THE ART (7)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- Hospitalization

Manel Taboada et al. (2011)

The attention is focused on

- creating a simulator that, used as decision support system (DSS), aids the heads of the ED to make the best informed decisions possible
- Communication model: 1-to-1, between two individuals, 1-to-n, representing an individual addressing to a group, 1-to-location, when an individual speaks to all occupants of a specific area

SOLUTION APPROACH

Actions of agents and the communication between them will be represented using Moore state machines extended to include probabilistic transitions. A simulation has been created using NetLogo

EMERGENCY SIMULATION
STATE OF THE ART (8)

PROJECT ANALYSIS WILL IDENTIFY THREE MAIN PHASES

- **Hospitalization**

Ofer Amram B.A, (2009)

The attention is focused on

- **increase in the speed of data transfer between client and server computers, web based SDSS enable greater information sharing and heightened use by no experts**
- **Web based SDSS also allow for the building of customized GIS applications that can be used with a remote server.**
- **The application interface allows the user to map the incident location and assists in the execution of triage decisions.**

SOLUTION APPROACH

web-based SDSS utilizes pre-calculated driving times to estimate the actual driving time to each hospital within the inclusive trauma system of the large metropolitan region within which it is situated.

TARGET OF THE SIMULATION MODELS

- **Define the perimeter of a simulation model with which to assess and improve, through the definition of appropriate performance indicators, systems of intervention through the containment of the "effects" to people and the environment from failure events occurring in production systems**

SCOPE OF THE MODEL

Level of detail of the simulation

1. Simulation of the cause of the disaster
2. Simulation event of failure (due to the disaster))
3. Simulation of the effects related to the event of failure
4. Simulation of the behavior of systems of intervention

Cause of Disasters | **System Failures** | **Disaster Consequences**

Initiating Disaster → **Compound Causes** → **Partial Failures** → **Inevitable Failures** → **Failure Propagations** → **Disaster Response** → **Final System Damage**

Mar, 3, 2011 14:46, East of Sendai, Japan Earthquake above 9.0 Richter

- Tsunami Strike
- Nuclear Reactor Automatic Hold

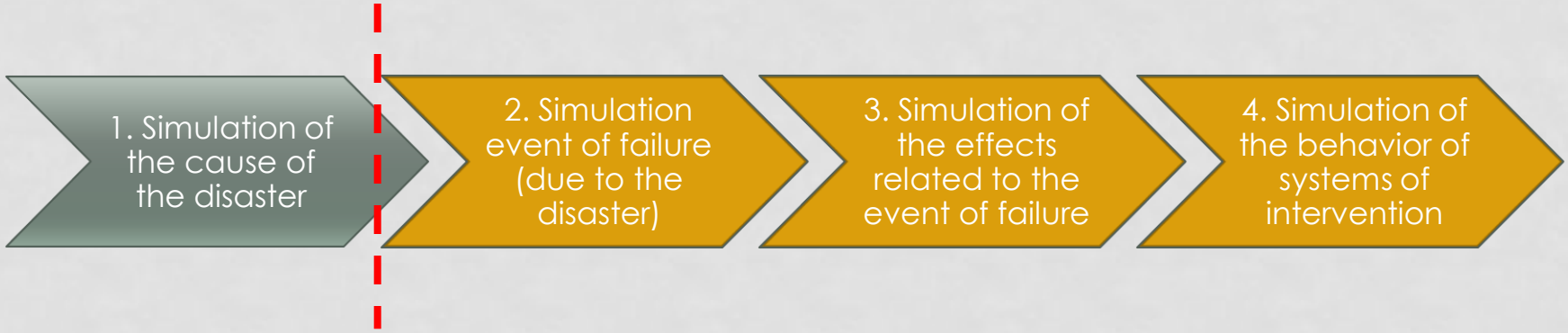
- Widerange Blackout including Reactor Cooler
- Emergency Power generation Failure

- Reactor Cooling Failure
- Radioactive Contamination

Amplified Damage by Initial Disaster

Taken from:
Review on Modeling and Simulation of Large-scale and Complex Disaster Scenarios

SCOPE OF THE MODEL (2)



* Excluding the simulation of the cause of the disaster and acting on the events of failure (due to the disaster employed) would allow the simulator:

1. **Simulate the event of failure**
2. **Simulating effects related to the cause of failure**
3. **Simulate the behavior of systems of intervention**

EXAMPLE (NOT EXHAUSTIVE)

1. Simulation of the cause of the disaster	• EARTHQUAKE
2. Simulation event of failure (due to the disaster)	• FAILURE OF THE STRUCTURE OF A FUEL TANK CONTAINING
3. Simulation of the effects related to the event of failure	• EXPLOSION AND ITS EFFECTS (FORMATION OF A FIRE CLOUD WITH TOXIC SUBSTANCES SPILL DANGER ETC ...)
4. Simulation of the behavior of systems of intervention	• INTERVENTION OF CONTAINMENT OF PROTECTION SYSTEMS (FIRE CONTAINMENT / SPILL; AID INJURED) AND CALCULATION OF PERFOMANCE (No. DEATHS; AFFECTED AREA, ETC ...)

PARAMETERS AND VARIABLES (NOT EXHAUSTIVE)

		parameters	variables
1. Simulation of the cause of the disaster	• EARTHQUAKE	• Initial definition of the scenario description of the effect on the environment (Richter scale, ...)…	• Because of the type of disaster (earthquake, flood, ...)…
2. Simulation event of failure (due to the disaster)	•FAILURE OF THE STRUCTURE OF A FUEL TANK CONTAINING	• Classification of earthquake resistance of structures to significant risk (risk analysis by type of occurrence)…	• Various effects can be checked against the chain of failure events that have already happened…
3. Simulation of the effects related to the event of failure	•EXPLOSION AND ITS EFFECTS (FORMATION OF A FIRE CLOUD WITH TOXIC SUBSTANCES SPILL DANGER ETC ...)	• weather Conditions • State of the procedures and systems of internal security…	• Various damage (of varying intensity) on the effects defined in punt0 2. • Outcome of security procedures and internal security • ...
4. Simulation of the behavior of systems of intervention	•INTERVENTION OF CONTAINMENT OF PROTECTION SYSTEMS (FIRE CONTAINMENT / SPILL; AID INJURED) AND CALCULATION OF PERFOMANCE (No. DEATHS; AFFECTED AREA, ETC ...)	• Terms of telecommunications networks • Conditions of transport networks • State of the reception facilities as a result of the event in step 1.	• Geographic distribution • Number and specialization of assistance units…

PARAMETERS AND VARIABLES (NOT EXHAUSTIVE) (2)

		parameters	variables
1. Simulation of the cause of the disaster	•EARTHQUAKE	• Initial definition of the scenario description of the effect on the environment (Richter scale, ...)…	• Because of the type of disaster (earthquake, flood, ...)…
2. Simulation event of failure (due to the disaster)	•FAILURE OF THE STRUCTURE OF A FUEL TANK CONTAINING	• Classification of earthquake resistance of structures to significant risk (risk analysis by type of occurrence)…	• Various effects can be checked against the chain of failure events that have already happened…
3. Simulation of the effects related to the event of failure	•EXPLOSION AND ITS EFFECTS (FORMATION OF A FIRE CLOUD WITH TOXIC SUBSTANCES SPILL DANGER ETC ...)	• weather Conditions • State of the procedures and systems of internal security…	• Various damage (of varying intensity) on the effects defined in punt0 2. • Outcome of security procedures and internal security • ...
4. Simulation of the behavior of systems of intervention	•INTERVENTION OF CONTAINMENT OF PROTECTION SYSTEMS (FIRE CONTAINMENT / SPILL; AID INJURED) AND CALCULATION OF PERFOMANCE (No. DEATHS; AFFECTED AREA, ETC ...)	• Terms of telecommunicatio ns networks • Conditions of transport networks • State of the reception facilities as a result of the event in step 1.	• Geographic distribution • Number and specialization of assistance units…

Performance of the system:

1. Time for action
2. Number of victims
3. Environmental damage
4. Costs of the intervention
5. Decontamination costs
6. …

SIMULATION AND ANALYSIS OF THE PERFORMANCE

DEFINITION OF THE SCENARIO

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CHOICE OF SETTING

- Given the complexity of the simulation model to realize you need to find a scope that allows to facilitate the validation phase
  - It is therefore necessary to choose between events occurring particularly documented and analyzed technically

PLANTS AT RISK OF A MAJOR ACCIDENT

In order to prevent major accidents involving dangerous substances and limit their consequences for man and the environment, the DM 9 May 2001, pursuant to art. 14 of Legislative Decree no. August 17, 1999, n. 334, determined with reference to the destination and use of the soil, the minimum safety requirements relating to town and country planning for the areas affected by PLANTS AT RISK OF MAJOR ACCIDENT, under Articles. 6, 7 and 8 of the said Decree.

► PLANT IN MAJOR ACCIDENT RISK means an area under the control of an operator where dangerous substances are present (as defined by Legislative Decree no. 334/99, integrated into the Legislative Decree no. 238/05) in one or more systems, in which an event may occur, such as emission, fire or explosion of great magnitude, resulting from uncontrolled developments that occur during its operation, and that would give rise to a serious threat, immediate or delayed, on human health or the environment, inside or outside the establishment.

TYPES OF PLANTS AT RISK OF A MAJOR ACCIDENT

The types of industrial activities are most widespread among plants RIR are as follows:

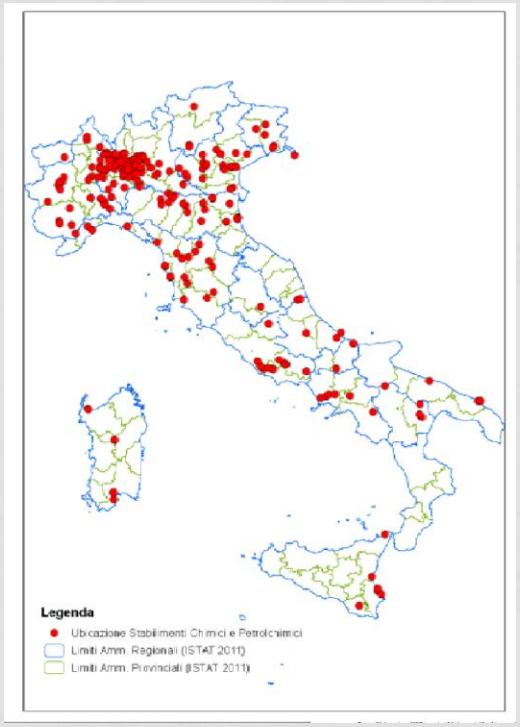
- **Chemical plants or petrochemical**
- **Liquefied gas storage**
- **Petroleum refining**
- **Deposits of mineral oils**
- **Deposits of pesticides**
- **Deposits of toxic**
- **Distillation**
- **Production or explosive storage**
- **Thermal power plants**
- **Electroplating**
- **Production and / or storage of technical gases**
- **Steel mills and metallurgical plants**
- **Treatment and recovery**
- **Underground storage of natural gas**

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

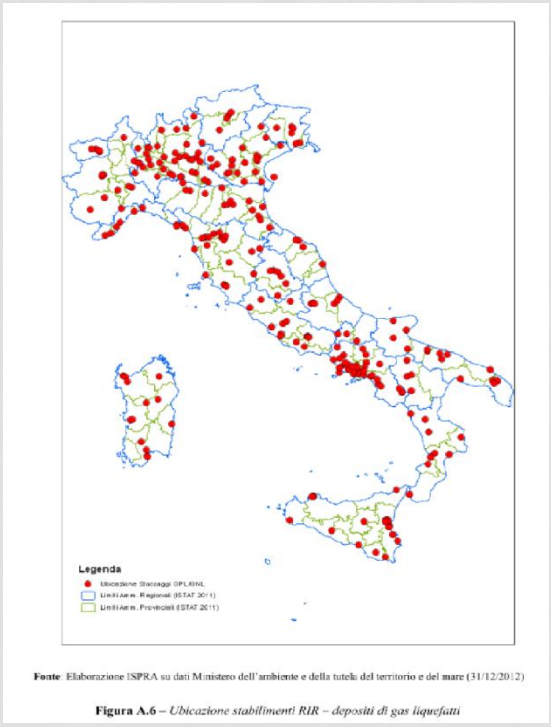
TYPES OF PLANTS AT RISK OF A MAJOR ACCIDENT (2)

The largest number of establishments in the national territory is constituted by:

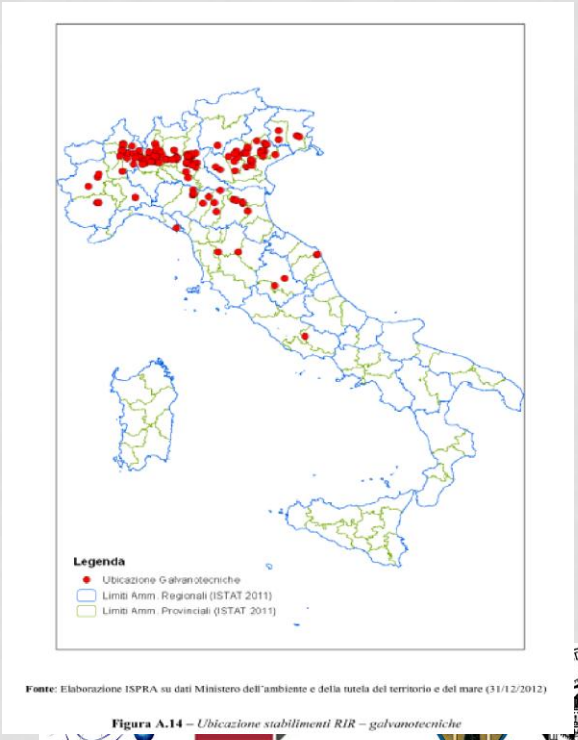
CHEMICAL OR PETROCHEMICAL PLANTS (282)



DEPOSITS OF LIQUID GAS (275)



ELECTROPLATING PLANT (129)



Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

TYPES OF PLANTS RISK OF A MAJOR ACCIDENT (3)

To membership of an establishment to one of the listed categories is possible to know in advance the dangers associated with this

DEPOSITS OF GAS LIQUID, EXPLOSIVES, DISTILLERY, PLANT AND / OR STORAGE OF GASES
prevalent or danger of fire and / or explosion effects attributable, in the event of an accident, primarily to irradiation and pressure relief, more or less elevated, which can then cause structural damage to buildings and equipment, and injury to humans.

CHEMICAL OR PETROCHEMICAL PLANTS, THE REFINERY, DEPOSITS OF TOXIC, DEPOSITS OF PESTICIDES AND POWER PLANTS
associate with the risk of fire and / or explosion, like the previous, the danger arising from the spread of toxic even at a distance, and therefore the possibility of danger, immediate and / or delayed in time, for the man and for the environment.

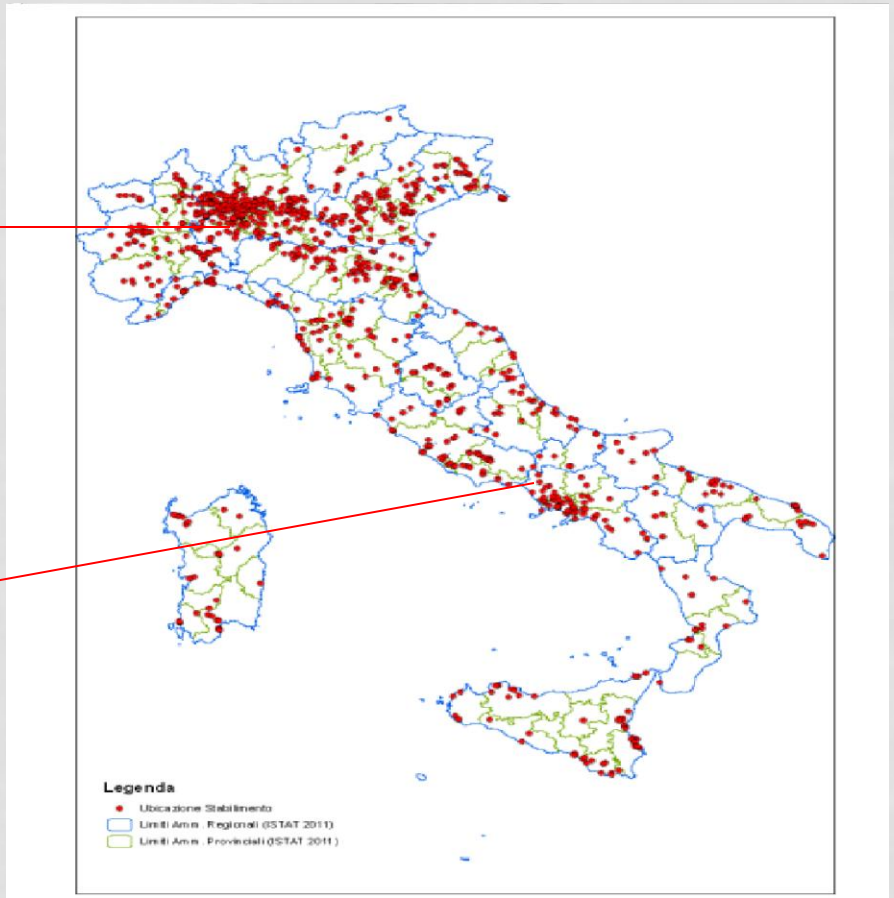
STEEL, ELECTROPLATING PLANTS AND TREATMENT PLANTS AND RECOVERY
prevalent danger of consequences for the environment and, thus, indirectly to human health; none the less some of the substances in these activities can determine directly or because the substances developed in the event of an accident (fire…), hazards to the 'humans.

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

NATIONAL DISTRIBUTION

The RIRs are on average throughout Italy, with higher density in the North in the country

A slight concentration is present in the Campania region with regard to the South Italy



Fonte: Elaborazione ISPRA su dati Ministero dell'ambiente e della tutela del territorio e del mare (31/12/2012)

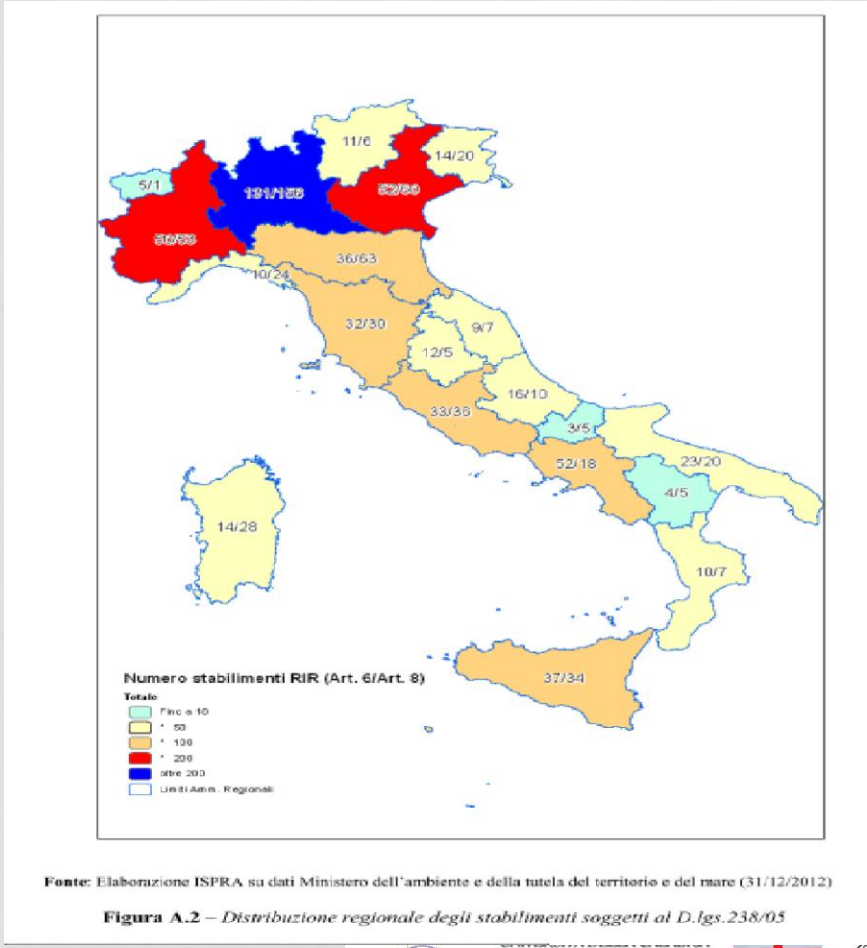
Figura A.1 – *Ubicazione sul territorio nazionale degli stabilimenti soggetti al D.lgs.238/05*

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

REGIONAL DISTRIBUTION

From an analysis of the regional distribution shows that:

- **about 25% of establishments are concentrated in Lombardy**
- **in four regions of northern Italy or Lombardy, Emilia Romagna, Veneto and Piedmont, is located more than 50% of establishments RIR on the national territory (25% in Lombardy and about 9% each in the other three regions).**



Fonte: Elaborazione ISPRA su dati Ministero dell'ambiente e della tutela del territorio e del mare (31/12/2012)

Figura A.2 – *Distribuzione regionale degli stabilimenti soggetti al D.lgs.238/05*

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

REGIONAL DISTRIBUTION(2)

A considerable number of establishments RIR is also found in some regions of south-central or Sicily, Lazio and Campania (each with just over 6%), Tuscany (about 5%), Puglia and Sardinia (about 4%).

The region with the lowest number of establishments RIR is the Valle d'Aosta with n. 6 plants RIR

Tabella A.I – *Distribuzione regionale degli stabilimenti soggetti al D.Lgs. 238/05*

Regione/Provincia Autonoma	N° stabilimenti		
	Artt.6/7	Art. 8	Totale
Piemonte	50	53	103
Valle d'Aosta	5	1	6
Lombardia	131	156	287
Provincia autonoma di Bolzano	5	2	7
Provincia autonoma di Trento	6	4	10
Veneto	52	60	112
Friuli Venezia Giulia	14	20	34
Liguria	10	24	34
Emilia Romagna	36	63	99
Toscana	32	30	62
Umbria	12	5	17
Marche	9	7	16
Lazio	33	36	69
Abruzzo	16	10	26
Molise	3	5	8
Campania	52	18	70
Puglia	23	20	43
Basilicata	4	5	9
Calabria	10	7	17
Sicilia	37	34	71
Sardegna	14	28	42
ITALIA	554	588	1142

Fonte: elaborazione ISPRA su dati Ministero dell'ambiente e della tutela del territorio e del mare (31/12/2012)

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

PROVINCIAL DISTRIBUTION

In almost all the Italian provinces is located at least one plant with major accident hazard.

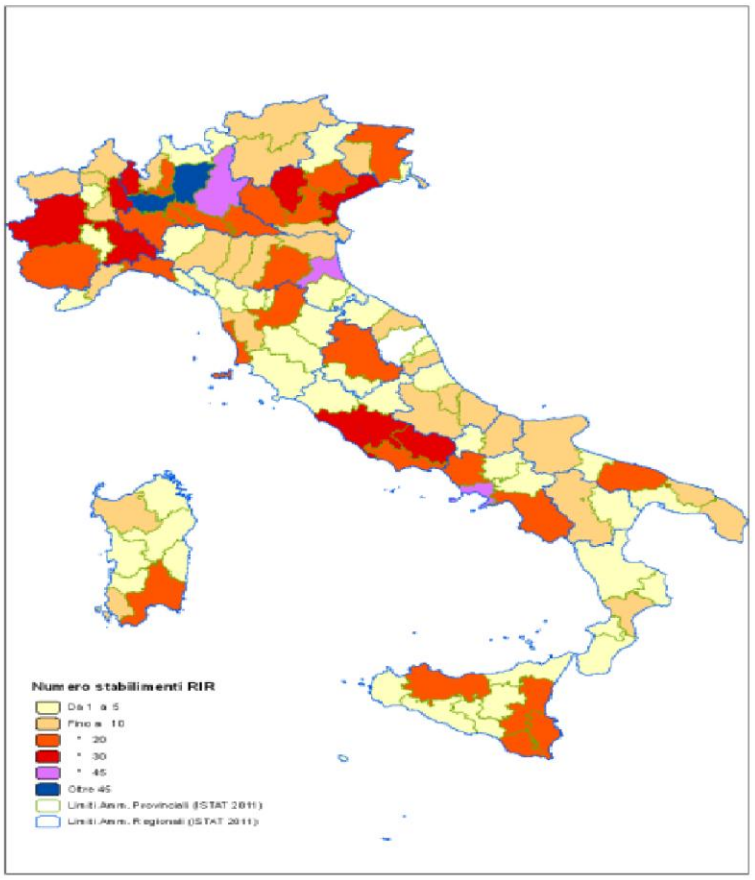
North (27 provinces): Milan (69 stab.), Bergamo (48), Brescia (45), Ravenna (37), Novara (28)

Varese (28) Venice (26) Torino (24), Vicenza (22), Alexandria (22), Bologna (20), Verona (19)

Monza and Brianza (19), Udine (19), Treviso (17), Genoa (17), Padua (16), Pavia (16), Cremona

(13), Lodi (13), Mantua (12), Lecco (12) Wedge (11), Ferrara (10), Trent (10), Savona (10)

Rovigo (10);



Fonte: Elaborazione ISPRA su dati Ministero dell'ambiente e della tutela del territorio e del mare (31/12/2012)

Figura A.3 – *Distribuzione provinciale stabilimenti soggetti al D.lgs.238/05*

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

PROVINCIAL DISTRIBUTION (2)

Center (6 provinces):
Rome (26), Frosinone (21), Livorno (17) Latin (14), Perugia (12), Florence (12);

South and Islands (10 provinces):
Naples (33), Syracuse (17), Salerno (17), Catania (13), Caserta (13) Cagliari (13), Bari (12), Dubrovnik (11), Palermo (11), Sassari (10).

Tabella A.III a – *Province con il maggior numero di stabilimenti soggetti al D.lgs.238/05*

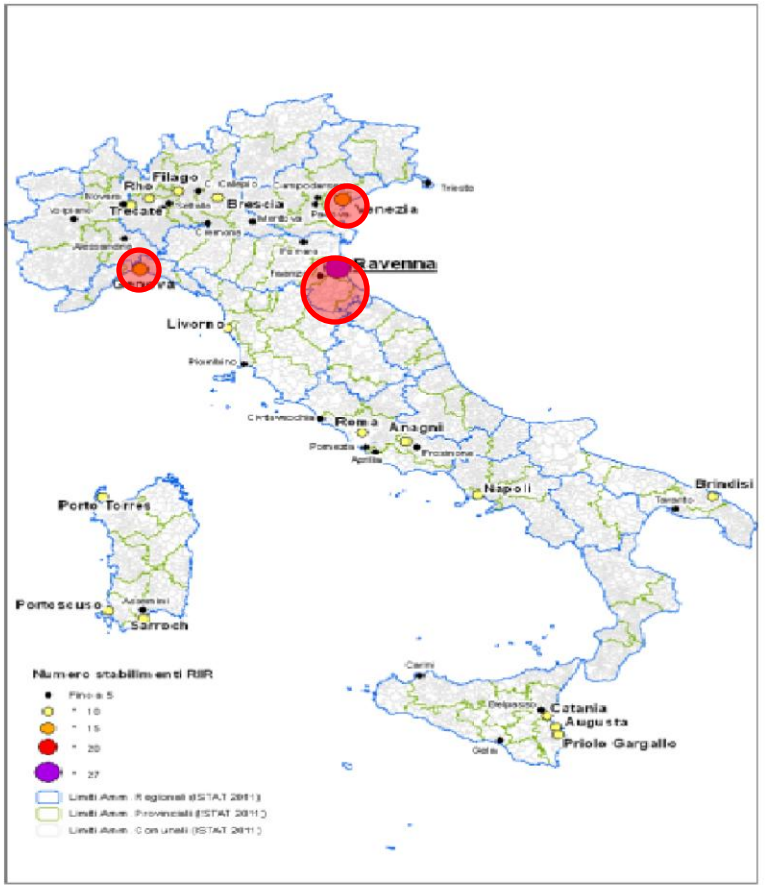
N.	Provincia	Regione	N° stabilimenti	N° Comuni interessati	N° Comuni nella Prov.	% Comuni interessati
1	Milano	Lombardia	69	47	134	35,0
2	Bergamo	Lombardia	48	29	244	11,9
3	Brescia	Lombardia	45	35	206	17,0
4	Ravenna	Emilia Romagna	37	6	18	33,3
5	Napoli	Campania	33	20	92	21,7
6	Novara	Piemonte	28	12	88	13,6
7	Varese	Lombardia	28	21	141	14,9
8	Venezia	Veneto	26	10	44	22,7
9	Roma	Lazio	26	8	121	6,6
10	Torino	Piemonte	24	17	315	5,4
11	Vicenza	Veneto	22	20	121	15,5
12	Alessandria	Piemonte	22	13	190	6,8
13	Frosinone	Lazio	21	9	91	9,9
14	Bologna	Emilia Romagna	20	15	60	25,0
15	Monza-Brianza	Lombardia	19	15	55	27,3
16	Verona	Veneto	19	15	98	15,3
17	Udine	Friuli	19	14	136	10,3
18	Siracusa	Sicilia	17	4	21	19,0
19	Salerno	Campania	17	15	158	9,5
20	Livorno	Toscana	17	5	20	25,0
21	Genova	Liguria	17	4	67	6,0
22	Treviso	Veneto	17	15	95	15,8
23	Pavia	Lombardia	16	14	190	7,9
24	Padova	Veneto	16	9	104	7,4
25	Latina	Lazio	14	8	33	24,2
26	Catania	Sicilia	13	5	58	8,6
27	Caserta	Campania	13	12	104	11,5
28	Cagliari	Sardegna	13	4	71	5,6
29	Cremona	Lombardia	13	9	115	7,8
30	Lodi	Lombardia	13	10	61	16,4
31	Perugia	Umbria	12	8	59	13,6
32	Bari	Puglia	12	10	41	24,4
33	Mantova	Lombardia	12	8	70	11,4
34	Lecco	Lombardia	12	9	90	10,0
35	Firenze	Toscana	12	10	44	22,7
36	Ragusa	Sicilia	11	6	12	50,0
37	Cuneo	Piemonte	11	9	250	3,6
38	Palermo	Sicilia	11	7	82	8,5
39	Ferrara	Emilia Romagna	10	5	26	19,2
40	Trento	P.A.di Trento	10	6	217	2,8
41	Savona	Liguria	10	6	69	8,7
42	Rovigo	Veneto	10	8	50	16,0
43	Sassari	Sardegna	10	2	66	3,0

Fonte: Elaborazione ISPRA su dati Ministero dell'ambiente e della tutela del territorio e del mare (31/12/2012)

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

MUNICIPAL DISTRIBUTION

Between the municipalities characterized by the presence of a large number of establishments are highlighted Ravenna (with 26 plants) and Venice (with 15 plants), followed by Genoa (14), Trecate (10), Naples, Brindisi and Livorno (9), Brescia, Filago and Rome (8)



Fonte: Elaborazione ISPRA su dati Ministero dell'ambiente e della tutela del territorio e del mare (31/12/2012)

Figura A.4 – *Ubicazione comuni in cui ricadono 4 o più stabilimenti RIR*

Data from: *Mappatura dei pericoli di incidente rilevante in Italia* Ed2013

EXAMPLE OF SCENARIO DEFINITION

THE SCENARIO ASSUMPTIONS CONSIDER THE FOLLOWING ELEMENTS:

- **TERRITORIAL LOCATION**
  - SITE
  - TRANSPORT SYSTEMS
- **TYPE OF PLANT**
  - PRODUCTION ACTIVITIES
  - MATERIALS STORED
- **ACCIDENT SCENARIO**
- **SCENARIO EFFECTS**
  - AREAS OF DAMAGE
- **DISTANCES FROM THE HEADQUARTERS OF FIRST AID**
- **VICTIMS BALANCE**

THYSENNKRUPP STYLE SCENARIO

Type of plant	• **STEELWORKS** • Plant location in Genova • Production of tool steel, special pieces, stainless steel • Activities carried out: sintering, combustion processes, surface treatment of metals and plastics
Event of failure (due to the disaster)	• **Accident on the pickling line** • Breakdown or malfunction of pipes • Ignition of the waxed paper due to the heat developed at the point of rubbing of the tape against the carpentry
Effects related to the event of failure	• Release and dispersion of flammable substances and consequent **jet fire** and **flash fire.** • Release and **dispersion of toxic substances** in the areas of storage and transfer • Expansion of the fire department and adjacent **hangar collapse**
Simulation of the behavior of entities involved	• **death operators line, injured on the adjacent line and in the next department** • Intervention of firefighters • Nearest hospital emergency health

THYSENNKRUPP STYLE – TERRITORIAL LOCATION

- **SITE**

The ILVA Cornigliano consists of the area corresponding to the workings of the "cold cycle" and related services (maritime installations, workshops, warehouses, etc.).

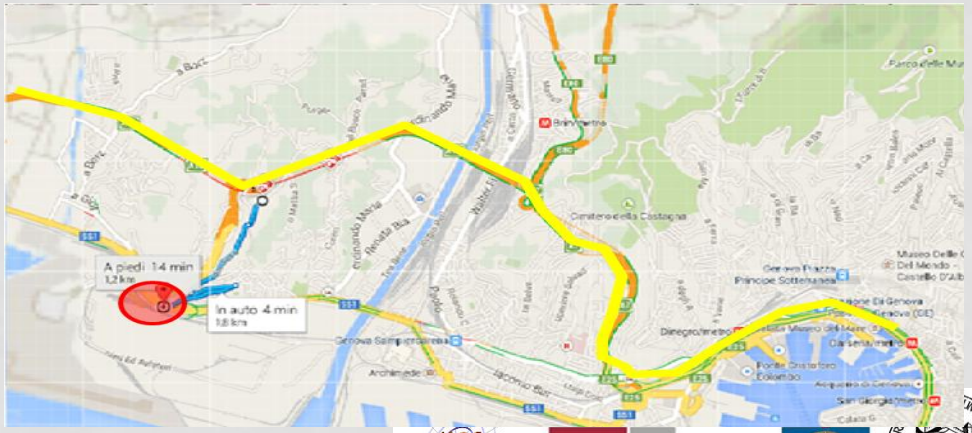
The area occupied by industrial facilities is bounded on the east by the Polcevera Creek to the west from Cristoforo Colombo airport and from the motorway to the north from the town of Cornigliano and Genoa-Ventimiglia railway line, while in the south, partly from the sea and, in part, from the airport.

THYSENNKRUPP STYLE – TERRITORIAL LOCATION (2)

The area is located in an area completely flat.
A part of the plant falls within the Airport area

The area is not affected by karst phenomena and / or seismic as, indeed, the entire territory of the Municipality of Genoa, which is not affected by particular earthquakes.

The area immediately adjacent to the plant is urbanized, the closest residential areas are located approximately 200 meters from industrial facilities



- **TRANSPORT SYSTEM**

The nearest highways are the A10 just over a mile, the motorway A7 Genoa-Serravalle and the E25

THYSENNKRUPP STYLE – PRODUCTION

STAINLESS STEEL

- BARS HOT AND COLD WORKED
- REBARS

STEEL TOOL

- ROUND AND FLAT

SPECIAL PRODUCTS

- SPINDLES, AXLES, AND ROLLERS

DUST

- DRIED POWDER TO CARRY WEAR

PRODUCTION OF SPECIAL STAINLESS STEEL

- From scrap metal
- Fusion in an electric oven
- continuous casting
- reheating
- machining
- pickling

STORAGE

- hydrofluoric acid
- oxygen
- methane

OTHER STORAGE

- hydrogen cylinders, necessary for the operation of the purification

DISTRIBUTION NETWORKS

- methane
- oxygen

THYSENNKRUPP STYLE – WORKING ON THE LINE

ASSUME DAMAGE ALONG THE LINE OF PICKLING

ANNEALING AND PICKLING LINE

- **Suppose analyze a line developed in 200 m long, 12m wide, 9m height**
- The line can work steel strips, cold rolled steel in thicknesses between 0.3 and 4.0 um, widths between 500 and 1,540 mm
- The rolls are rewound paper interposing between the coils in order to minimize any friction and damage

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THYSENNKRUPP STYLE – WORKING ON THE LINE (2)

SEQUENCE OF THE PROCESS

- ZONE INPUT
- AREA OF ACCUMULATION INPUT
- ZONE FURNACE AND COOLING
- AREA CHEMICAL OR PICKLING
- STORAGE AREA IN OUTPUT
- ZONE OUTPUT

THYSENNKRUPP STYLE - TOXIC SUBSTANCES

QUANTITIES OF SUBSTANCES IN THE FACTORY

SUBSTANCES	QUANTITY (t)
ACID HYDROFLUORIC <40% SOLUTION	54,00
ACID HYDROFLUORIC <7% SOLUTION	276,00
OXYGEN	96,90
HYDROGEN	0,07
METHANE (NETWORK)	2,00

TOXIC

COMBUSTIBLE

FLAMMABLE

THYSENNKRUPP STYLE – FAILURES

FAILURE	EFFECT
• SPARKS CAUSED BY THE FRICTIONOF THE BELT AGAINST THE CARPENTIERA THAT FALLING, BURNING THE WAX PAPER AND THE RESIDUAL OIL BELOW • IGNITION OF THE PAPER DUE TO THE HEAT DEVELOPED AT THE POINT OF RUBBING OF THE TAPE AGAINST THE CARPENTIERA	• fire burns the rubber linings of hydraulic hoses causing it to collapse • The collapse of the hose causes a violent jet of hydraulic oil which is sprayed generating a spray of tiny droplets. • The spray primer located in the outbreak of the fire developing JET FIRE and FLASH FIRE affecting a large area • The collapse of more flexible, increasing the fire
• RELEASE OF HYDROFLUORIC ACID SOLUTION PIPE FROM INSIDE THE DEPARTMENT OF PICKLING	• formation of a cloud of toxic fumes of hydrofluoric acid

THYSENNKRUPP STYLE – PEOPLE DIRECTLY INVOLVED

- **PEOPLE INVOLVED**

Workers line up to the pickling

- 1 observer
- 1 crane operator
- 3 line workers
- 1 assigned to the crane
- 1 shift supervisor production

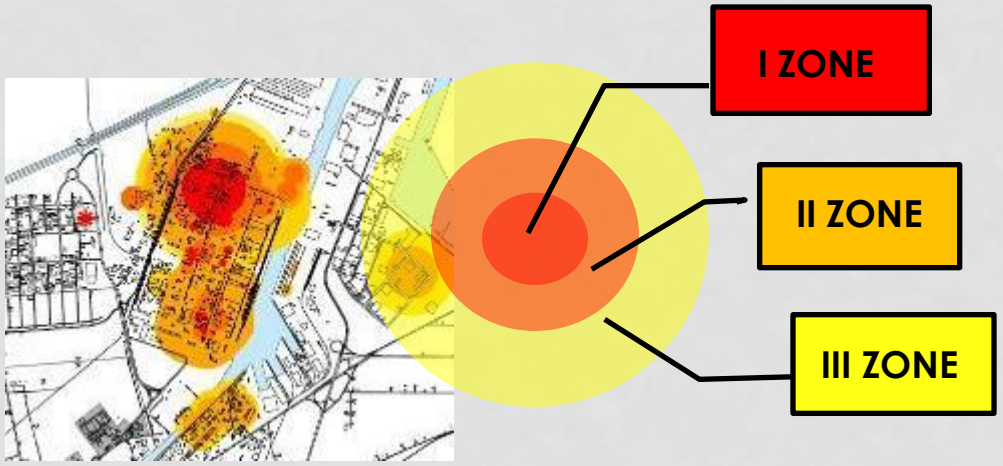
Inside the mill work three operators

- 1 assigned to the control
- 2 line workers

- 5 Workers in the adjacent dept
- 2 security guards
- 2 analysts
- 4 team officials emergency

THYSENNKRUPP STYLE – AREA OF DAMAGE

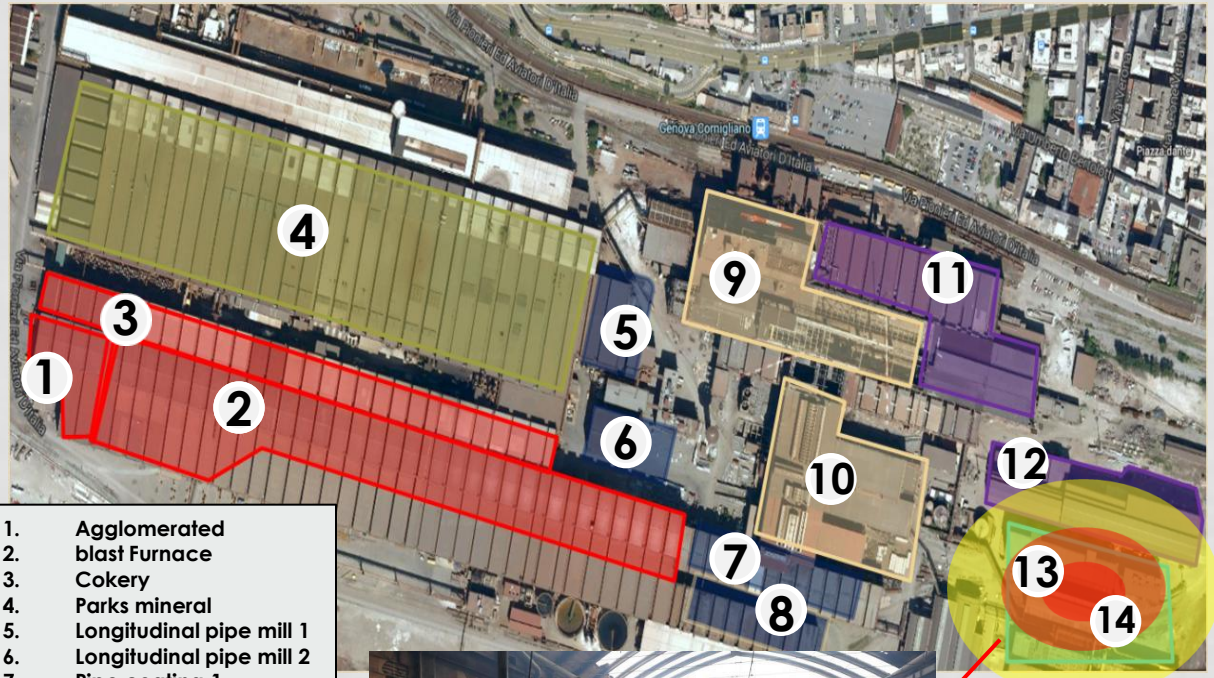
The **disaster area** is subdivided in three different parts according to level of lethality and level of injuries.



INCIDENT	I ZONE			II ZONE	III ZONE
	HIGH LETHALITY	START LETHALITY	IINJURIES IRREVERSIBLE	INJURIES REVERSIBLE	ATTENTION
Release and dispersion of flammable substances and consequent jet on fire and explosion	18 M	40 M	55 M	100 M	200 M
release hydrofluoric acid in the areas of storage and transfer	immediate vicinity of the pickling line	35 M	40 M	70 M	200 M

THYSENNKRUPP STYLE – DYNAMICS OF THE ACCIDENT

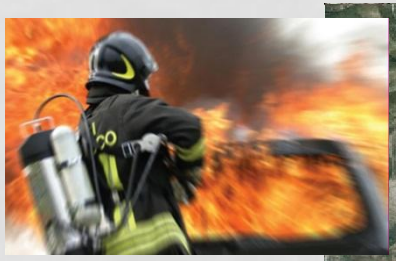
- The fire blazes up to the pickling line with a subsequent explosion
- The flash fire and explosion invested and killed 4 workers wounded 4 others.
- The fire spreads on the adjacent line causing 20 serious wounded and 10 surfaced injured
- The release of toxic vapors increases the extent of the damage and approaches to the production department tapes
- The fire causes the collapse of the shed

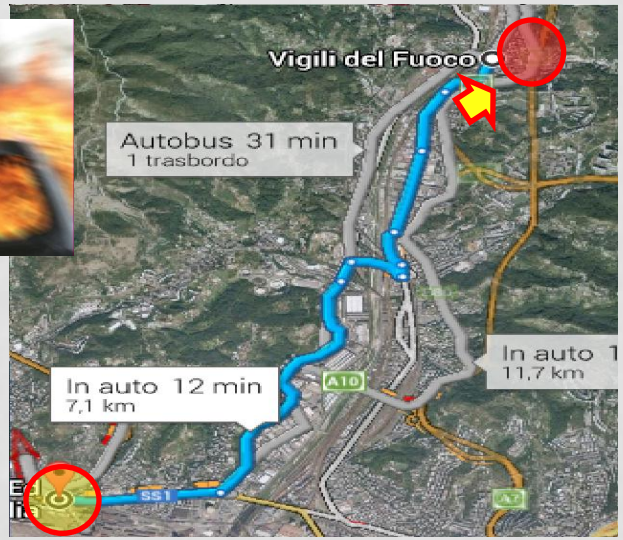


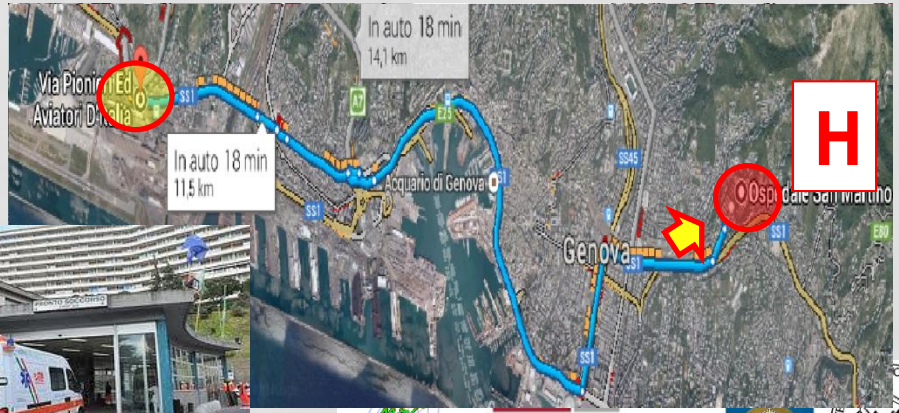
1. Agglomerated
2. blast Furnace
3. Cokery
4. Parks mineral
5. Longitudinal pipe mill 1
6. Longitudinal pipe mill 2
7. Pipe coating 1
8. Pipe coating 2
9. Steelwork 1
10. Steelwork 2
11. Production Tapes 1
12. Production tapes 2
13. sheet metal fabrication
14. Cold Rolling Mill

THYSENNKRUPP STYLE – FIRST AID

- The nearest office of the **firefighters** is about **7.1 km**, for an estimated arrival time **12 minutes**
- The **Protezione Civile** headquarters station is **21 km** away from the scene of the accident, an estimated time of arrival for **30 minutes**
- **The nearest hospital is San Martino Hospital**, about **15 km**, for an estimated arrival time **20 minutes**







THYSENNKRUPP STYLE – VICTIMS BALANCE

TYPE OF WOUNDED	INJURY REPORTED	APPROXIMATE NUMBER
DECEASED	• total burn • choking	**4**
SERIOUS INJURED	• Burns on 90% of body • breathing difficulties	**20**
SURFACE INJURED	• superficial burns • Bruises, trauma • pulmonary irritation	**10**

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- *.....OTHERS TO BE ADDED*

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