OCCUPATIONAL SAFETY AND MAJOR ACCIDENT HAZARD AT AN INDUSTRIAL PARK

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Summary

- Brindisi Industrial Park
- Major Accident Hazard and Occupational Safety and Health
- Quantified Occupational Risk in Industrial Plants
- WORKER IS NOT A TARGET – HE IS AN ACTOR!
- Index method Theory
- Index method Exercise
- Conclusions

Brindisi Industrial Park

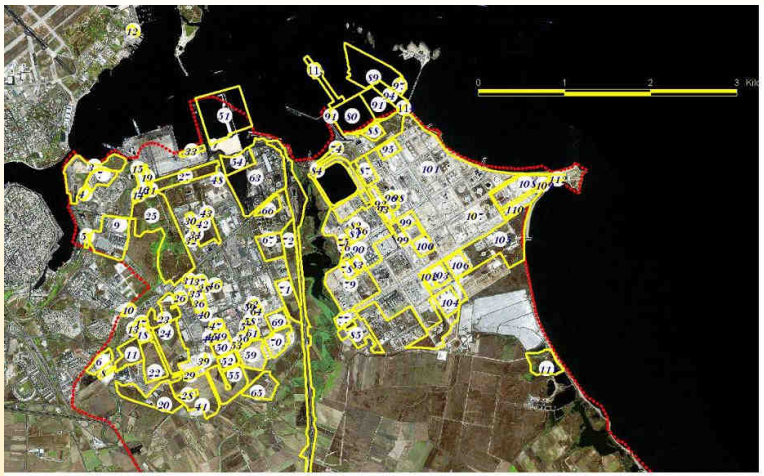
200 firms, 5000 workers

A few larger petrochemical and chemical plants (Large Multinational Companies) Massive Production (Polymers – Energy) (1/3 workers)

Many small firms (local enterprises) supply of mechanical and chemical goods, maintenance, transport, services, manufacturing of final products. (2/3 workers)

Occupational Safety and Health is managed by 200 independent employers... But the most OSH risk area shared by a number of firms.

Major Accident Scenarios managed by 5 operators involve workers of many firms



Major Accident Hazard and Occupational Safety and Health

Two separate issues?

MAH Higher Consequences - Lower Probability - OSH Lower Consequences – Higher Probaility

In an industrial clusters where many firms in a very restricted area and most risk are shared by many operators (including contractor, transport, and maintenance firms).

Brindisi, most workers are employed by **medium and small sized enterprises – SME's**

A few simple sharable methods may fit better the purpose of coordinating a number of independent firms.

The proposed model, which has been tested at the Brindisi park, aims to define an integrated Occupational and accidental risk index.

Quantified Occupational Risk in Industrial Plants 1

Quantified Occupational Risk in Industrial Plants 2

RISK

IS FUNCTION OF

SEVERITY OF INJURY

AND

PROBABILITY OF INJURY

- **Exposure to hazard**
- **Event probabilty**
- **Capability of avoiding consequences**

Quantified Occupational Risk in Industrial Plants 3

Hazard exposure = time spent within the area of potential damage: Factors to be accounted

- Needs of accessing hazardous area (normal operations, anomalies, inspections, Maintenance,
- Time spent within hazardous areas
- Number of worker authorized to accessing dangerous areas
- Frequency of accesses

Hazardous events

loss of containment (as considered in MAH studies)

but also machines failures - Potentially explosive atmosphere, falls, cuts, …

- Events related to Equipment Reliability & Human Reliability

WORKER IS NOT A TARGET – HE IS AN ACTOR! 1

Capability of avoiding/ limitating concequences

Capability is related to

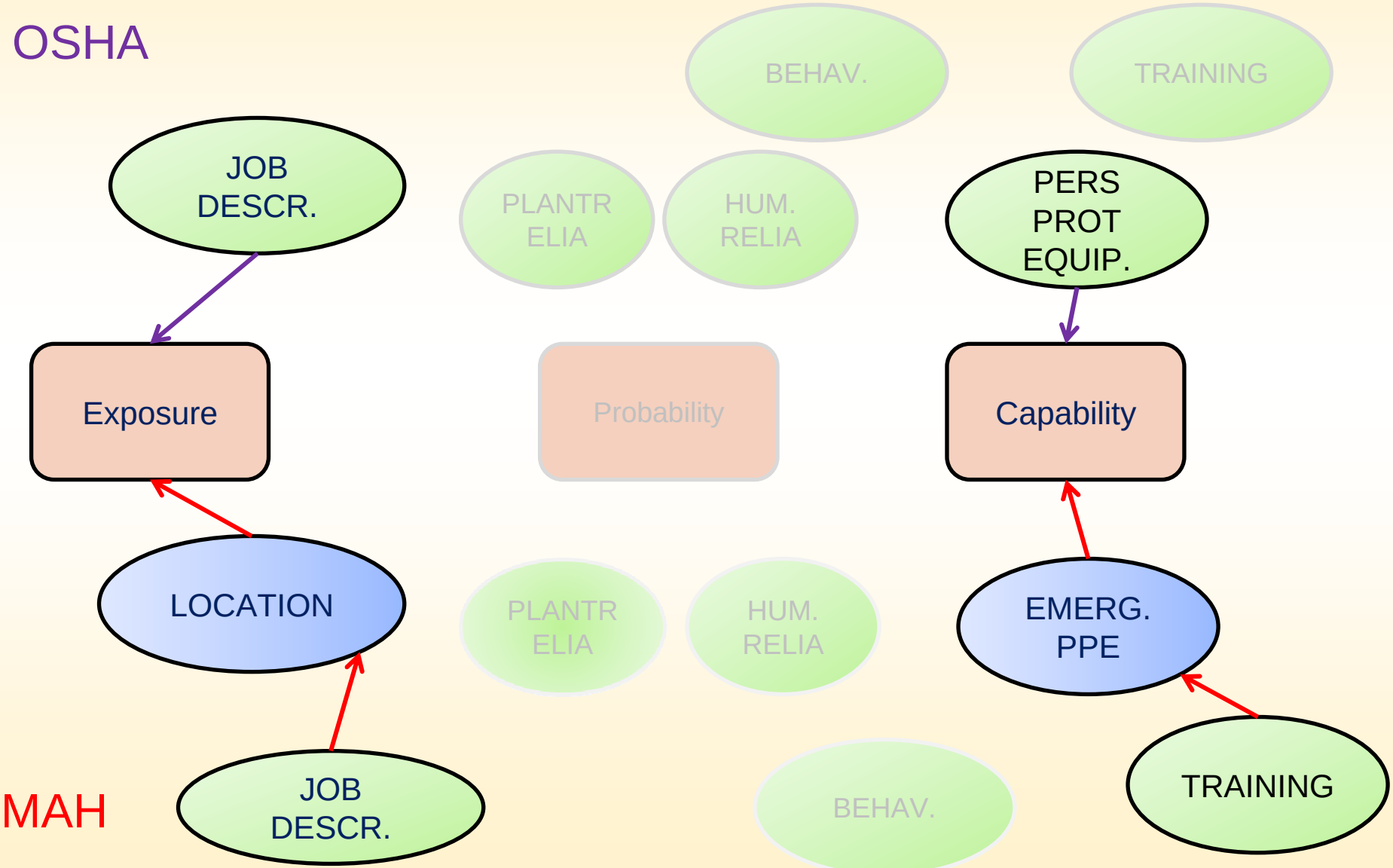
- Collective – Personal Protection equipment
- Information - Personal skill and behavior
  - Different types of worker
    - Employees (working in the unit)
    - Employees (working in other units /establishments)
    - Contractors – Inspectors – Truck drivers
    - Visitors

Time from event to damage

- immediate (e.g. explosion)
- fast (e.g. Fire - Machinery)
- slow (e.g. Toxic)

	In	Out
Explosion	1	1
Fire	0,5	0,9
Toxic	0,1	0,8

THE WORKER IS AND ACTOR! 2



Index method 1

An unified metric of hazard elements and of safety measures, suitable for occupational incidents, chemical exposure and accidental losses.

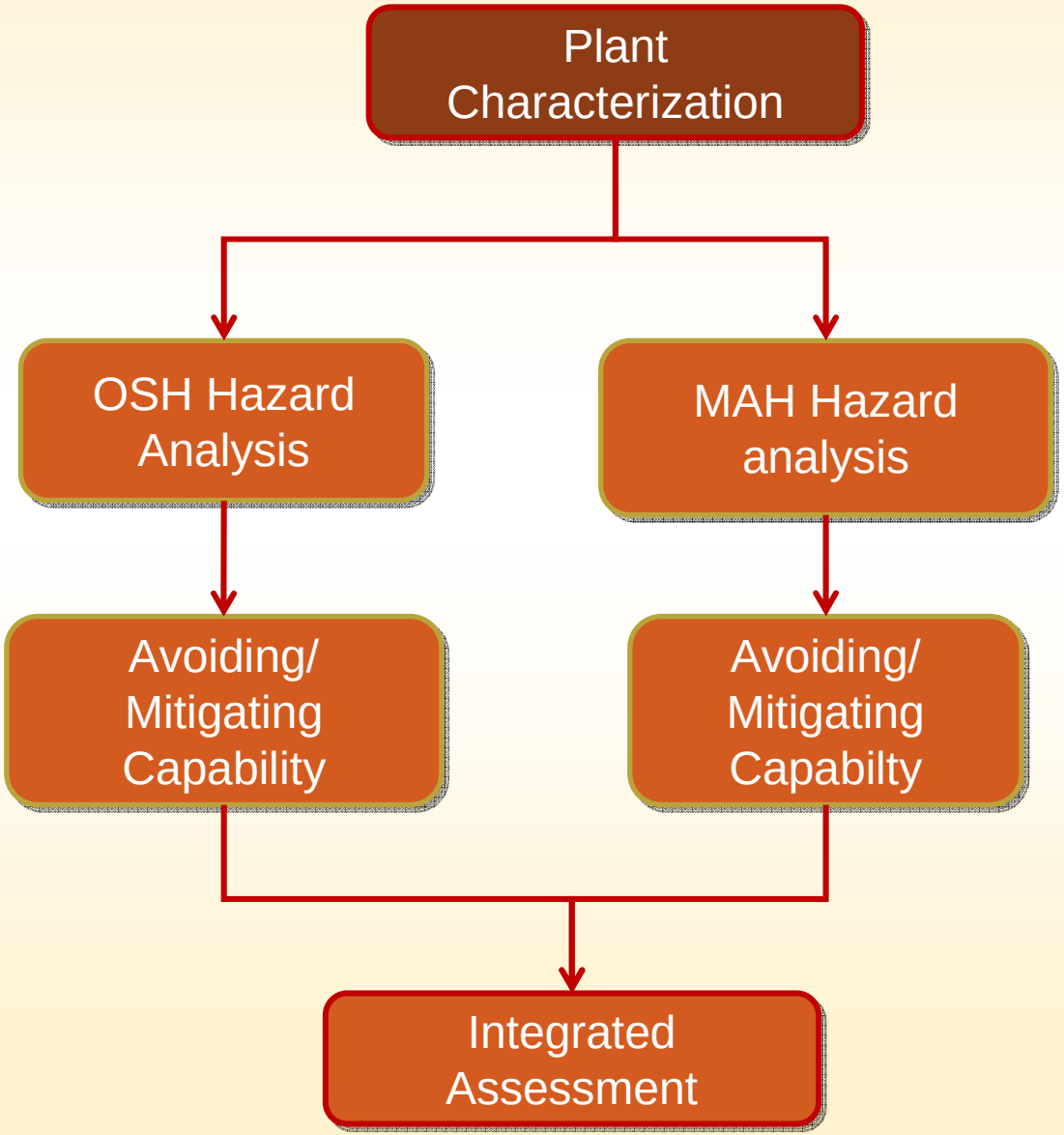
A quick and easy assessment, which may be shared among duty-holders and regulators and may address control activities.

In chemical industry, for the issue of major accident hazard, index methods have been very popular for thirty years.

Based on a check list or a questionnaire, with a number of elementary evaluations. Question responses are grouped into scores to capture a basic evaluation both of hazards and the prevention and reduction measures.

A dynamic tool which integrates quantitative risk analysis with organizational issues in order to support mainly an optimization of prevention activities.

Index method 2



INDEX Method 3 – Plant Characterization

MAH
Safety Report

OSH
Risk Assessement Document

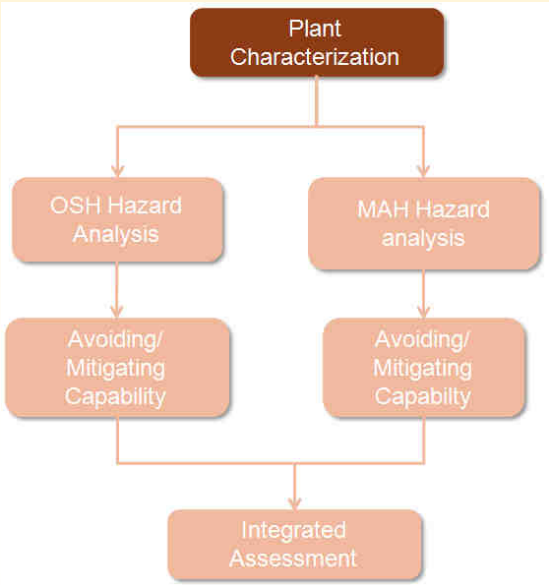
PERSONS

ORGANIZATION

MATERIALS

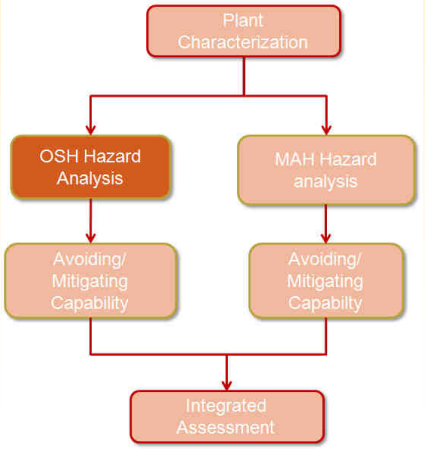
EQUIPMENT

QUESTIONAIRE



INDEX Method 4 - OSH Index

$$(I_{OSH})_k = \sum_{j=1}^{Njob} \sum_{i=1}^{Nhaz} (E_i \cdot F_i) \cdot C_i$$



Where k represents the unit, j the job in the unit,
i the hazard in the job

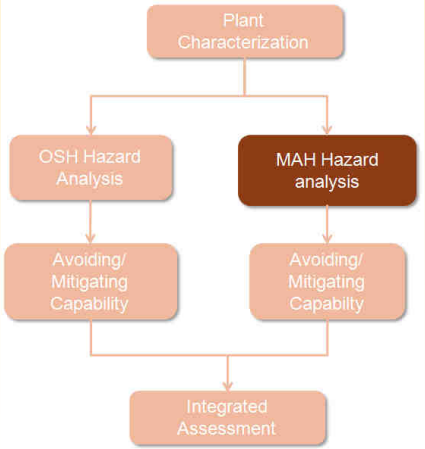
E_i represents the exposure time (in hours) to the i-th hazard evaluated for the j-th job;

F_i represents the likelihood estimated for each i-th hazard.
If the exposure time is continuous, the F_i value is 1.

C_i represents a corrective factor which allows to evaluate Avoiding/mitigation for reducing i-th risk.

INDEX Method 5 - MAH index

$$(I_{MAH})_k = \sum_{i=1}^{Ntop} (F_i \cdot A_i) \cdot C_i$$



where *i* represents top event and k the unit

F_j is its probability derived from Safety Reports.

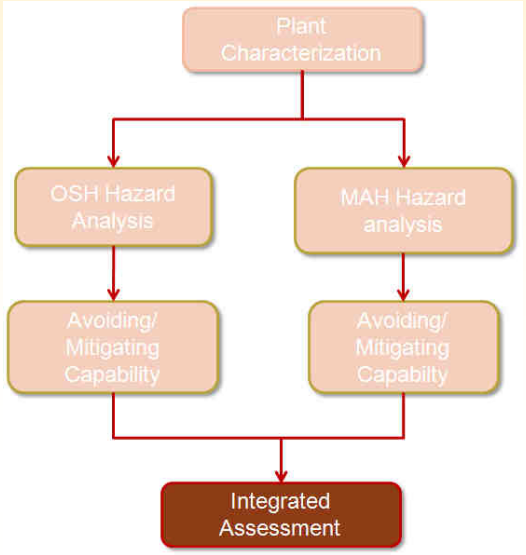
A_j represents the percentage of k-th unit potentially affected by the i-th top event

C_i represents a corrective factor which Avoiding/mitigation for reducing i-th event

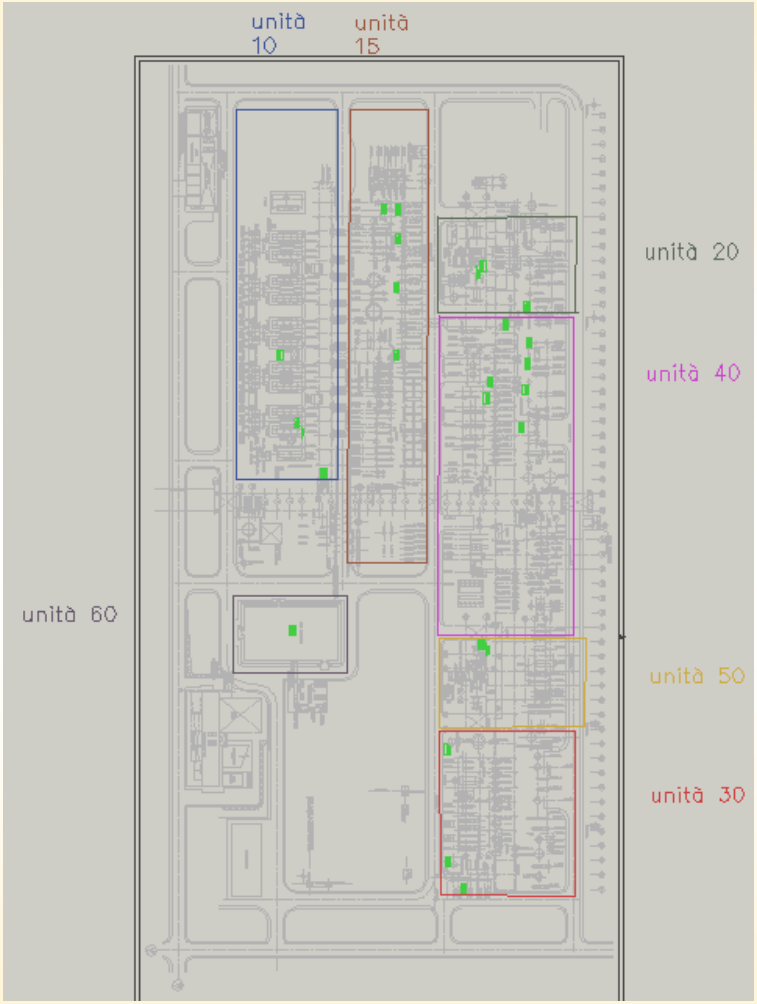
	In	Out
Explosion	1	1
Fire	0,5	0,9
Toxic	0,1	0,8

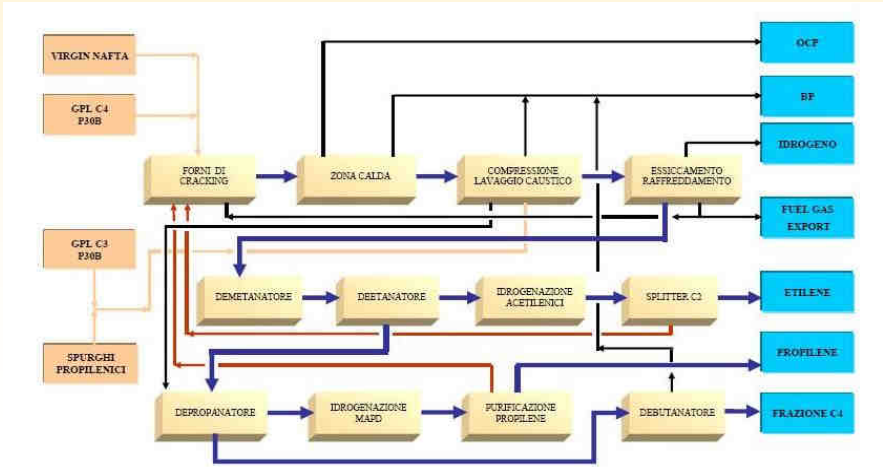
Index Method 6 - Combined

$$(CI)^k = I_{OSH}^k + I_{MAH}^k$$



Application to a Plant 1





UNIT 10	OVENS
UNIT 15	HOT ZONE Quench+ Fractioning
UNIT 20	Compression
UNIT 30	COLD ZONE
UNIT 40	MIDDLE ZONE
UNIT 50	Refrigerator
UNIT 60	Control Room

Application 2 - JOB Descriptions - Observation

MAPPA AMBIENTALE DEL REPARTO :

P1 CR : IMPIANTO DI CRACKING

Data : 09.05.2009

Foglio 1 di 2

	Posizione di Lavoro	HSE AMB	Area : P101	Area : P102		Area : P103					
			Punto P10101	Punto P10201	Punto P10202	Punto P10301	Punto P10303	Punto P10304	Punto P10305	Punto P10306	Punto P10307
	Mansioni		**Tempi di esposizione in minuti primi**								
1	Capo reparto	P10001	405	7	9	2	4	4	3	3	3
2	1° Assistente di impianto	P10002	362	10	10	4	8	8	8	8	8
3	Ass.di giornata zona calda	P10003	308	60	60	7	9	9	9	9	9
4	Ass.di giornata zona fredda	P10004	318								
5	Responsabile in turno	P10005	380	10	10	4	6	4	4	4	4
6	Ass. formazione e Sicurezza Imp.	P10015	210	30	30	10	10	10	10	10	10
7	Quadrista zona calda	P10007	480								
8	Coordinatore I/E zona calda e forni	P10008	260	60	60		20	20	20	20	20
9	Operatore esterno zona forni	P10009	90	120	120	150					
10	Operatore esterno zona calda	P10010	90			150	50	50	50	45	45
11	Quadrista zona fredda	P10011	480								
12	Coordinat. I/E zona media e fredda	P10012	220								
13	Operatore esterno zona media	P10013	60								
14	Operatore esterno zona fredda	P10014	90								
15	Op.di impianto zon. calda. e fredda	P10016	60	20	20	20	20	20	20	20	20
	Agenti di rischio chimico-fisici										
1	Microclima	R 011	x	x	x	x	x				
2	Rumore	R 001	x	x	x	x	x	x	x	x	x
3	Benzolo	R 105						x	x	x	
4	Toluolo	R 104						x	x	x	
5	Xilolo	R 118						x	x	x	
6	1.3 - Butadiene	R 133									
7	Metanolo	R 127									
8	IPA	R 265						x	x	x	

Legenda Aree e Punti di campionamento

Area P101 ► **Punto** P10101 : Sala controllo / Uffici / Varie

Area P102 ► **Punto** P10201 : Centro Zona
Punto P10202 : Durante Lettura Pirometrica

Area P103 ► **Punto** P10301 : cabina operatore
Punto P10303 : pompe circolazione quench oil
Punto P10304 : presso pompe P 1506 A/B
Punto P10305 : presso pompe P 2003 A/B
Punto P10306 : colonna C 2001 – stripper B.P.
Punto P10307 : centro zona

Note :

Microclima : rilievi mensili limitatamente ai mesi da Giugno + Settembre.

Rumore : rilievi con frequenza biennale.

Agenti chimici e fisici : prelievi con frequenza semestrale.

Application 3 - Computing OSH Index UNIT 15

Punti in cui si trovano gli operatori	agenti di rischio
Punto 5	Microclima; Rumore
Punto 6	Rumore; Benzolo; Toluolo; Xilolo
Punto 7	Rumore; Benzolo; Toluolo; Xilolo
Punto 8	Rumore; Benzolo; Toluolo; Xilolo
Punto 9	Rumore

JOB	TEMPO DI ESPOSIZIONE RISCHIO Benzolo; Toluolo; Xilolo (min/giorno)	E(zona calda, (Benzolo; Toluolo; Xilolo))
1	4	0,008
2	24	0,05
3	27	0,056
5	12	0,025
6	30	0,062
7	60	0,125
10	145	0,302
13	60	0,125

JOB	TEMPO DI ESPOSIZIONE RISCHIO MICROCLIMA (min/giorno)	E(zona calda, microclima)
1	4	0,008
2	8	0,016
3	9	0,019
5	6	0,012
6	10	0,021
7	20	0,042
10	50	0,104
13	20	0,042

JOB	TEMPO DI ESPOSIZIONE RISCHIO RUMORE (min/giorno)	E(zona calda, rumore)
1	17	0,035
2	40	0,083
3	45	0,094
5	22	0,046
6	50	0,104
7	100	0,208
10	240	0,5
13	100	0,208

Application 4 - OSH Index UNIT 15

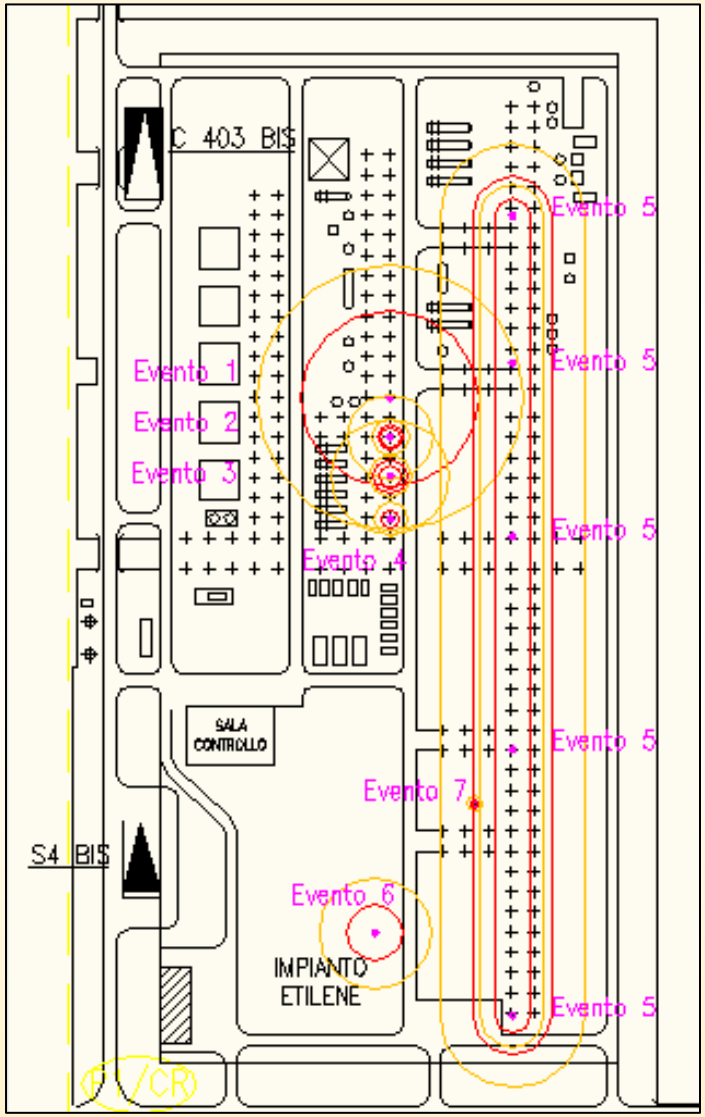
JOB	INDICE DI RISCHIO OCCUPAZIONALE DOVUTO AD ESPOSIZIONE CONTINUA -- unit 15 --
1	0,052
2	0,15
3	0,169
5	0,083
6	0,187
7	0,375
10	0,906
13	0,375

Application 5 - OSH index All Units

JOB	unit 10	unit 15	Unit 20	Unit 40	Unit 50	unit 30	unit 60	**somma**
1	0,075	0,052	0,012	0,085	0,010	0,05	0,844	**1,129**
2	0,1	0,15	0,019	0,112	0,012	0,075	0,754	**1,223**
3	0,529	0,169					0,642	**1,340**
4			0,062	0,312	0,037	0,225	0,662	**1,3**
5	0,1	0,083	0,019	0,1	0,012	0,075	0,792	**1,181**
6	0,292	0,187	0,062	0,312	0,031	0,187	0,437	**1,510**
7	0,5	0,375					0,542	**1,417**
8			0,125	0,625	0,042	0,25	0,458	**1,5**
9	1,625						0,187	**1,812**
10	0,625	0,906					0,187	**1,719**
11			0,212	1,535			0,125	**1,873**
12					0,048	1,529	0,1875	**1,765**
13	0,25	0,375	0,125	0,625	0,042	0,25	0,125	**1,792**
14							1	**1**
15							1	**1**

Application 6 - Computing MAH index

Evento incidentale	*Frequenza evento incidentale*	*Incidente rilevante*	*Frequenza incidente rilevante*
Evento 1	$4,6 * 10^{-5}$	Flash fire	$4,0*10^{-5}$
Evento 2	$4,6 * 10^{-5}$	Flash fire	$4,5*10^{-5}$
		Pool fire	$9,2*10^{-7}$
Evento 3	$4,6 * 10^{-5}$	Flash fire	$3,9*10^{-5}$
		Pool fire	$2,3*10^{-6}$
Evento 4	$4,6 * 10^{-5}$	Pool fire	$9,2*10^{-7}$
Evento 5	$2,4 * 10^{-5}$	Flash fire	$1,9*10^{-5}$
		Pool fire	$2,4*10^{-6}$
Evento 6	$4,6 * 10^{-5}$	Jet dispersion	$2,3*10^{-6}$
Evento 7	$5,88 * 10^{-5}$	Jet dispersion	$1,2*10^{-6}$



Application 7 - Computing MAH Index for UNIT 15

Evento incidentale	incidente rilevante	raggio di danno: sicuro impatto(m)	% di area coinvolta	raggio di danno: lesioni irreversibili (m)	% di area coinvolta
Evento 1	Flash fire	70	**21,00**	105	**25,85**
Evento 2	Flash fire	10	**0,84**	34	**4,36**
	Pool fire	8	**0,54**	15	**1,36**
Evento 3	Flash fire	14	**1,65**	46	**10,35**
	Pool fire	9	**0,68**	17	**1,76**
Evento 4	Pool fire	7	**0,41**	14	**1,24**

IRseveso_zona calda	
SICURO IMPATTO	**LESIONI IRREVERSIBILI**
0,00007547	**0,01307096**

Application 8 - MAH Index for all Units

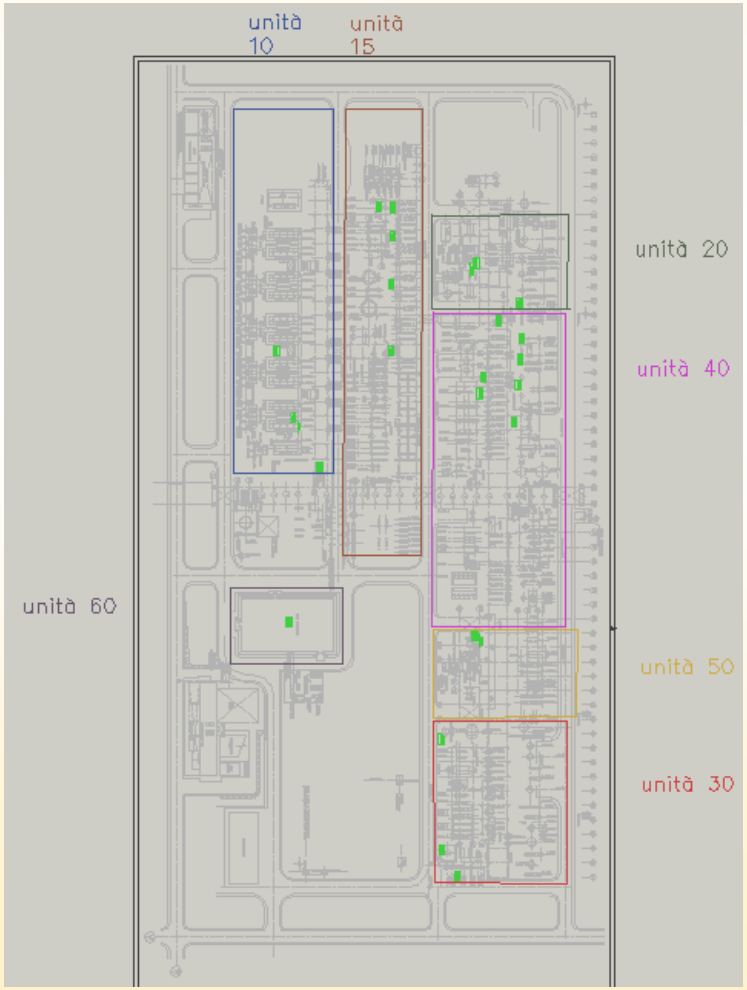
UNITÀ PRODUTTIVA	ESTENSIONE (m^2)	% AREA SICURO_IMPATTO	$IR_{SEVESO\_SICURO\_IMPATTO}$	% AREA LESIONI_IRREVERSIBILI	$IR_{SEVESO\_LESIONI\_IRREVERSIBILI}$
UNIT 10		0	0	0	0
UNIT 15 Hot area	**37.200**	25%	**$7,5 * 10^{-5}$**	44,92	**$1,307 * 10^{-2}$**
UNIT 20 Compression	**12.000**	51,40 %	**$1,07 * 10^{-2}$**	97,48	**$1,77 * 10^{-2}$**
UNIT 30 Cold area	**17.700**	20,54 %	**$2,62 * 10^{-3}$**	59,63	**$6,41 * 10^{-3}$**
UNIT 40 Middle area	**40.500**	21,65 %	**$5,21 * 10^{-3}$**	36,52	**$7,71 * 10^{-3}$**
UNIT 50 Refrigerated Area	**9.600**	37,87 %	**$4,84 * 10^{-3}$**	83,762	**$1,06 * 10^{-2}$**
UNIT 60		0	0	0	0

Application 9 - Global risk index (OSH+MAH)

JOB Description	unità 10	unità 15	unità 20	unità 40	unità 50	unità 30	unità 60
1	0,0750	0,0521	0,0863	0,0902	0,0148	0,0526	0,8440
2	0,1000	0,1501	0,0933	0,1172	0,0168	0,0776	0,7540
3	0,5290	0,1691	0,0743	0,0052	0,0048	0,0026	0,6420
4	0,0000	0,0001	0,1363	0,3172	0,0418	0,2276	0,6620
5	0,1000	0,0831	0,0933	0,1052	0,0168	0,0776	0,7920
6	0,2920	0,1871	0,1363	0,3172	0,0358	0,1896	0,4370
7	0,5000	0,3751	0,0743	0,0052	0,0048	0,0026	0,5420
8	0,0000	0,0001	0,1993	0,6302	0,0468	0,2526	0,4580
9	**1,6250**	0,0001	0,0743	0,0052	0,0048	0,0026	0,1870
10	0,6250	0,9061	0,0743	0,0052	0,0048	0,0026	0,1870
11	0,0000	0,0001	0,2863	**1,5402**	0,0048	0,0026	0,1250
12	0,0000	0,0001	0,0743	0,0052	0,0528	**1,5316**	0,1875
13	0,2500	0,3751	0,1993	0,6302	0,0468	0,2526	0,1250
14	0,0000	0,0001	0,0743	0,0052	0,0048	0,0026	1,0000
15	0,0000	0,0001	0,0743	0,0052	0,0048	0,0026	1,0000

Global risk Ind All units

indice di rischio globale normalizzato per unità produttiva						
unità 10	unità 15	unità 20	unità 40	unità 50	unità 30	unità 60
4,0960	2,2971	0,7103	3,7112	0,2388	2,6436	1,9425



indice di rischio globale per JOB	
JOB	**RISCHIO GLOBALE LE_z**
1	1,2151
2	1,3091
3	1,4271
4	1,3851
5	1,2681
6	1,5951
7	1,5041
8	1,5871
9	1,8991
10	1,8051
11	1,9591
12	1,8516
13	1,8791
14	1,0871
15	1,0871

Conclusions

This analysis represents a first attempt; further development will be oriented to apply the proposed model to an higher number of plant units as it could be useful to define corrective coefficients which have to characterize the whole plant.

Results in this preliminary analysis could be improved by assigning weights to each parameters. A panel of experts, including INSPECTORS, OCCUPATIONAL PHYSICIANS, SAFETY MANAGERS, WORKERS REPRESENTATIVE will be involved for deciding weights.

Further development are focusing on the full scale application of the model in the cluster area. The model could support a more effective and integrated approach for managing safety issues in the cluster both from safety managers as well as regulators

OCCUPATIONAL SAFETY AND MAJOR ACCIDENT HAZARD AT AN INDUSTRIAL PARK

Thanks for your attention!