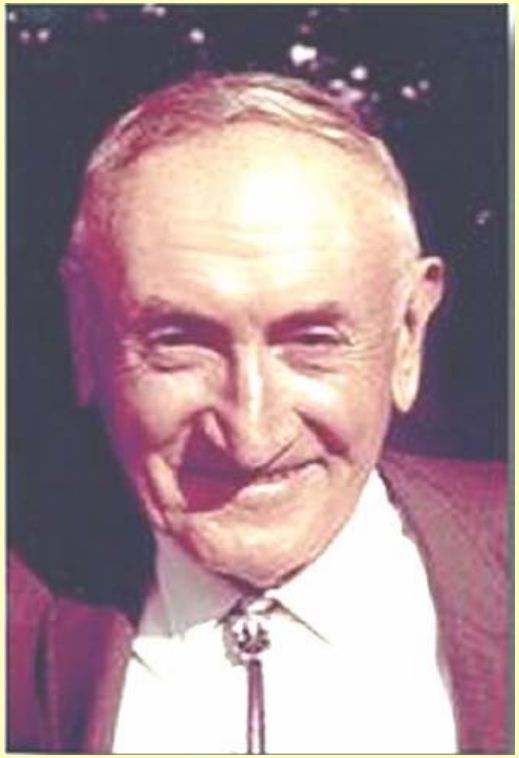
FOI
SWEDISH DEFENCE
RESEARCH AGENCY

General Morphological Analysis

Swedish National Defense Research Agency

Stockholm

FOI: Stockholm (1995-2004)



Fritz Zwicky

1898-1974

Professor of Astronomy (1942-1968)
California Institute of Technology

Co-founder of Aerojet Engineering

President of ”International Academy of Astronautics”

- Discovered evidence for ”dark matter” in galaxies (1933)
- Triple-hypothesis: ***supernova***, ***neutron stars*** & ***cosmic rays***(1934)
- Galaxies and galaxy clusters act as gravitational lens (1937)
- Developed **morphological analysis** as a general method for non-quantified modelling using a ”***morphological field***”

Morphological Analysis:

A GENERALISED METHOD FOR STRUCTURING AND ANALYSING COMPLEX PROBLEM FIELDS WHICH:

- **ARE INHERENTLY NON-QUANTIFIABLE**
- **CONTAIN NON-RESOLVABLE UNCERTAINTIES**
- **CANNOT BE CAUSALLY MODELLED OR SIMULATED**
- **REQUIRE A JUDGMENTAL APPROACH**

What is MA used for?

Mess = Complex issue which is not well formulated or defined; "wicked problem"

Problem = Well formulated/defined issue, but with no single, clear-cut solution (various solutions depending on…)

Puzzle = Well defined problem with a specific solution which can be worked out.

Russel Ackoff: Re-designing the Future, 1974

"One of the greatest mistakes that can be made when dealing with a mess is to carve off part of the mess, treat it as a problem and then solve it as a puzzle -- ignoring its links with other aspects of the mess."

(Pidd, M: *Tools for Thinking,* 1996)

For What ?

LONG-TERM PLANNING and STRATEGY EVALUATION

- **DEVELOPING ALTERNATIVE FUTURES SCENARIOS**
- **STRUCTURING AND ANALYSING COMPLEX POLICY SPACES**
- **RELATING ENDS & MEANS IN STRATEGIC PLANNING (Process support for decision-making)**
- **POSITIONAL ANALYSIS (STAKEHOLDER ANALYSIS)**

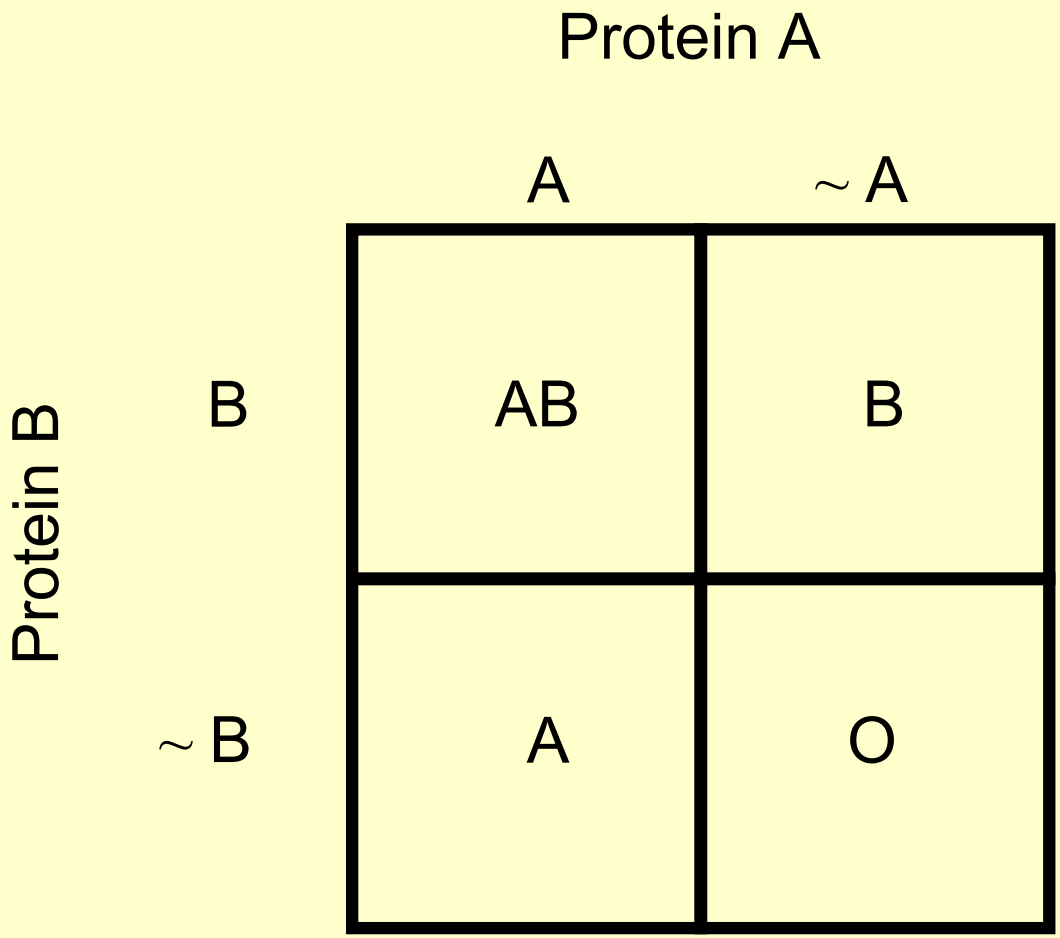
Philosophy:

THE METHOD SHOULD BE:

- Group & Process oriented
- Generic (general method for NQM)
- Transparent (No black boxes)
- Traceable (”Audit trail”)
- Easy to update results

Results:

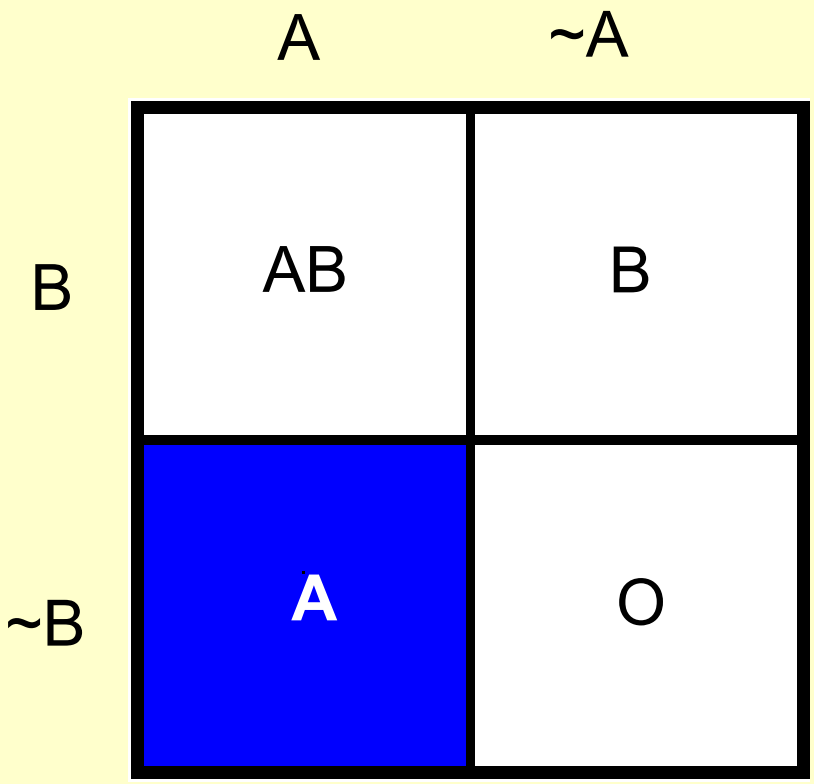
- A structured (dimensioned) problem
- Simple (scenario) laboratory
- Complex (scenario-strategy) laboratory
- Validated IO-model/instrument



Four-fold table
(simplest typology)

Protein A	Protein B
A	B
~A	~B

Morphological field



Four-fold table

Protein A	Protein B
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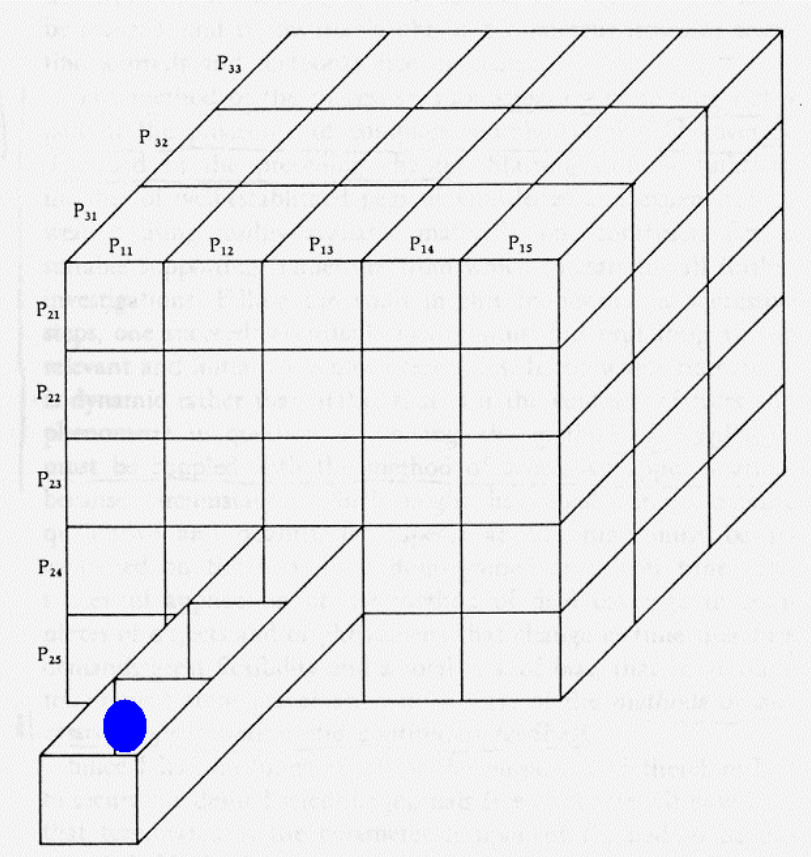
Morphological field



3-dimensional typology
”Zwicky-box”

Parameter X	Parameter Y	Parameter Z
X1	Y1	Z1
X2	Y2	Z2
X3	Y3	Z3
X4	Y4	
X5	Y5	

3-dimensional morphological field

Organisational structure

Organisation TYPE	Leadership culture	Buyer structure	Dominate product/ service	Co-operation strategies	Employee profile	Main empolyee incentive
Official state agency	Bureaucratic hierarchy	Ministry dominated	Process + method support	Outside help when needed	Life-long service	Money
Government owned enterprise	Strong scientific leadership	Military and material dominated	Soft studies	Joint ventures	Career researcher	Managerial career
Academy (á la university)	Marketing division leadership	Defence Industry	Hard studies	Consultant purchasing	Development engineer	Pleasure in one's work
Trade institute	Umbrella management	Civilian agencies	Basic research	Mediator only	"Consultant"	Educational motivation
Consultant firm	Gatekeeping	Private markets (national)	Testing, construction		Entrepreneur	Titles, specialist career
"Learning organisation"	Skunk-works (ad hocrati)	International markets	Second opinion		Elite troops	Organisation gives status

Morphological field containing 186,000 configurations

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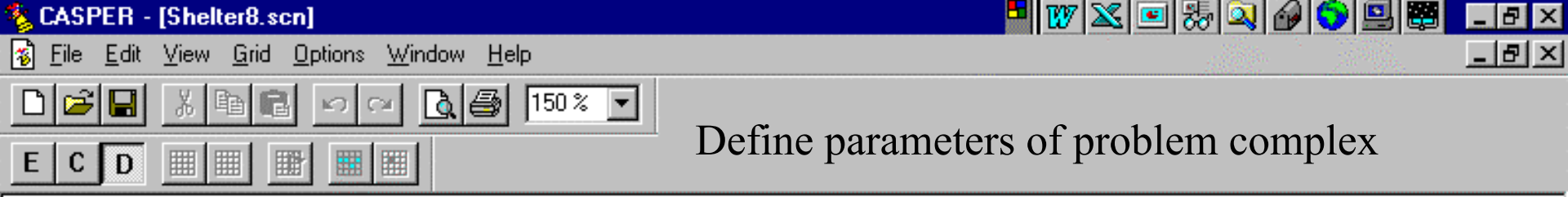

Define parameters of problem complex

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy

Segment of morphological field for Swedish bomb shelter program

Define range of "values" for each parameter

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
Metropoles	All socio-tech. functions	Large, not crammed	With new construction	More frequent maintanance	All get same shelter quality
Cities + 50,000	Tech support systems	Large & crammed	Compensation	Current levels	All take same risk
Suburbs and countryside	Humanitarian aims	Small, not crammed	New only for defence build up	No maintanance	Priority: Key personnel
No geo-priority	Residential	Small & crammed			Priority: Needy

Field configuration (of total 2304)

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
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Identify contradictory conditions

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
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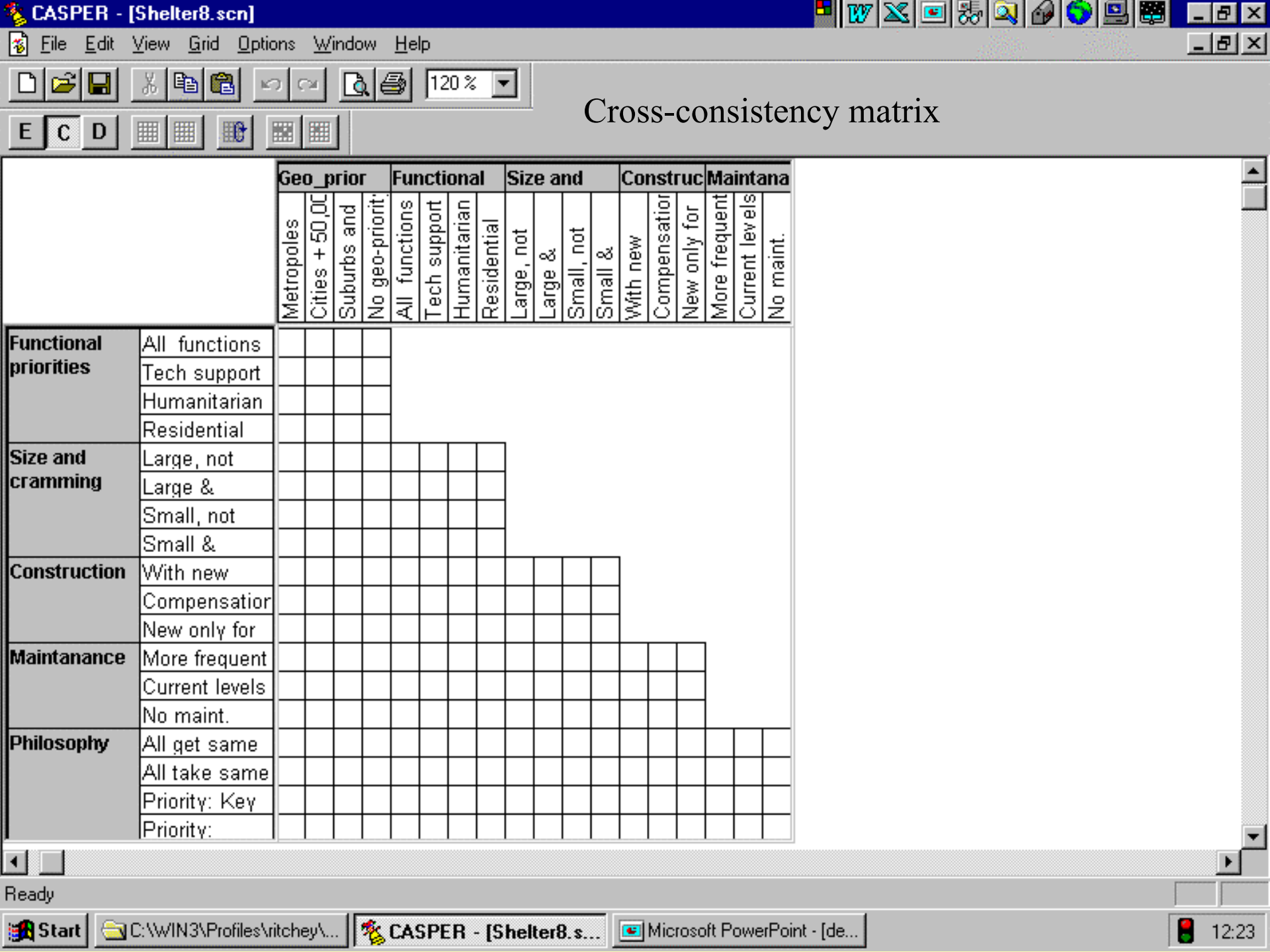
432 configurations are reduced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List of consistent configurations

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
Metropoles	All socio-tech. functions	Large, not crammed	With new construction	More frequent maintanance	All get same shelter quality
Cities + 50,000	Tech support systems	Large & crammed	Compensation	Current levels	All take same risk
Suburbs and countryside	Humanitarian aims	Small, not crammed	New only for defence build up	No maintanance	Priority: Key personnel
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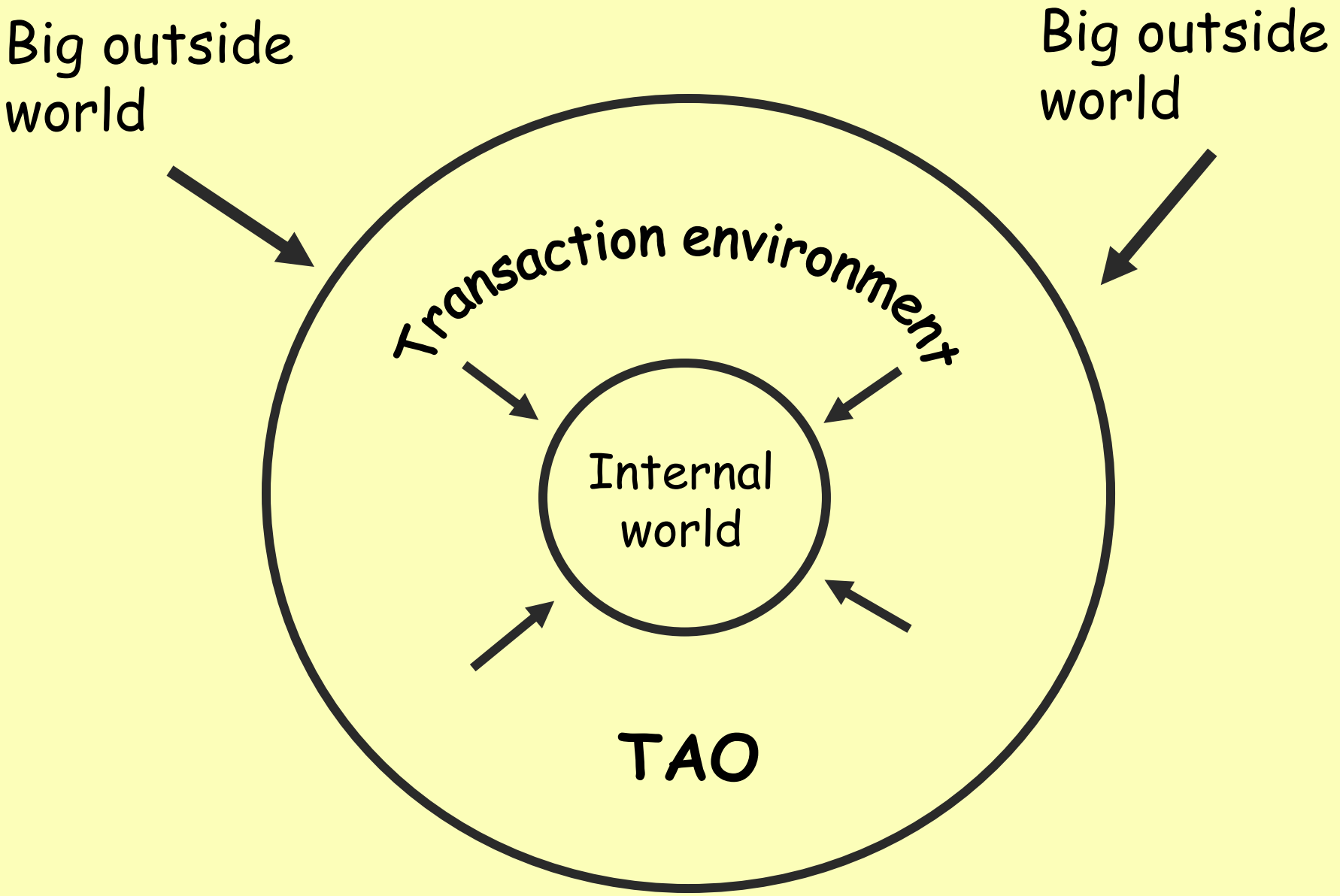
Big outside world
Big outside world
Transaction environment
Internal world
TAO

Linked fields:

Scenario field

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Strategy field

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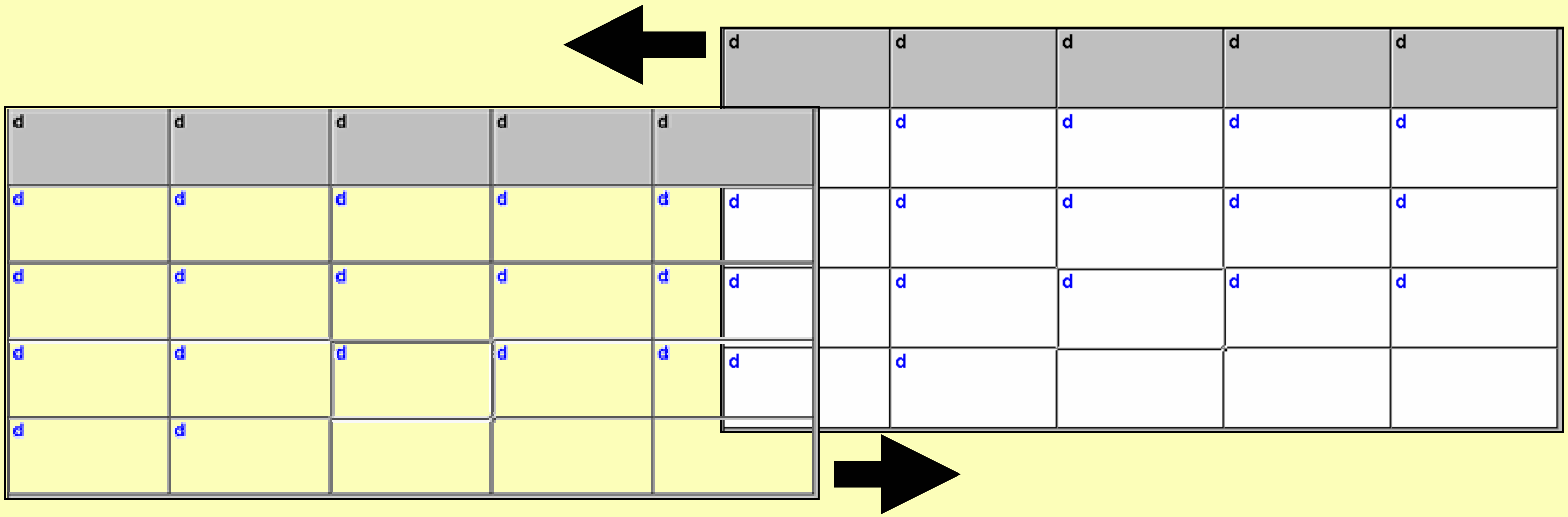
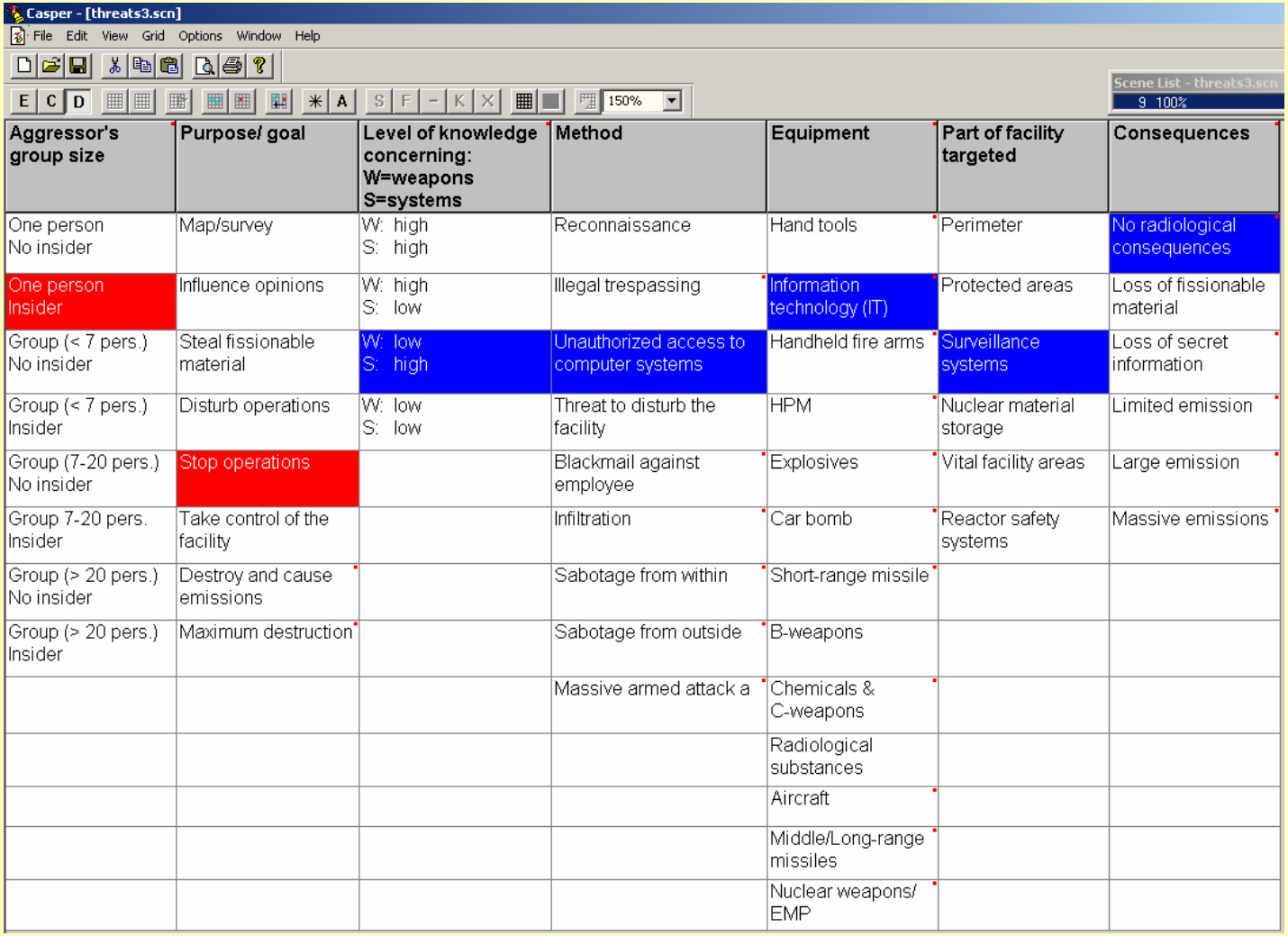
Overlay techniques:

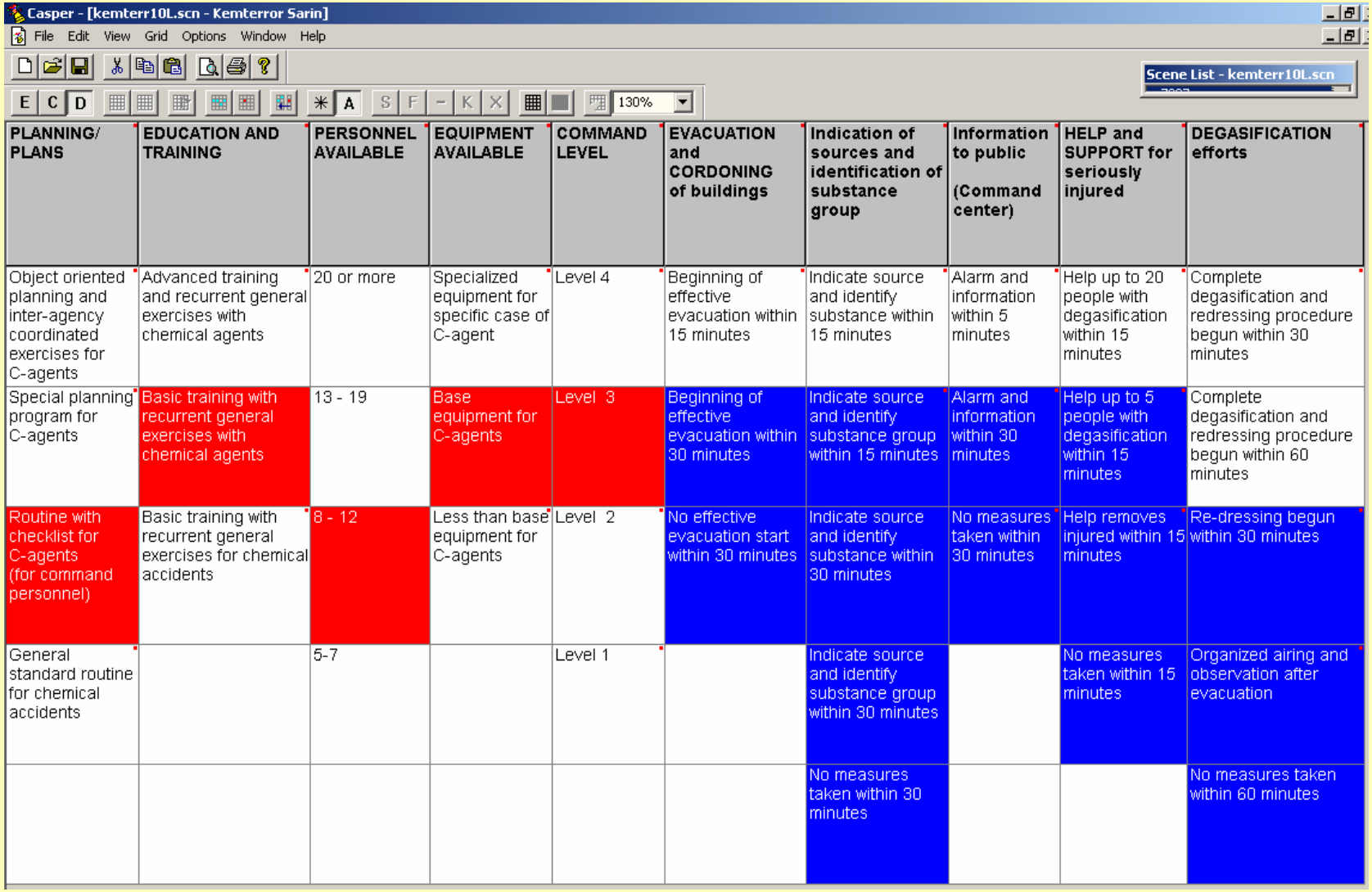
Scenario/strategy overlay methods





Aggressor's group size	Purpose/ goal	Level of knowledge concerning: W=weapons S=systems	Method	Equipment	Part of facility targeted	Consequences
One person No insider	Map/survey	W: high S: high	Reconnaissance	Hand tools	Perimeter	No radiological consequences
One person Insider	Influence opinions	W: high S: low	Illegal trespassing	Information technology (IT)	Protected areas	Loss of fissionable material
Group (< 7 pers.) No insider	Steal fissionable material	W: low S: high	Unauthorized access to computer systems	Handheld fire arms	Surveillance systems	Loss of secret information
Group (< 7 pers.) Insider	Disturb operations	W: low S: low	Threat to disturb the facility	HPM	Nuclear material storage	Limited emission
Group (7-20 pers.) No insider	Stop operations		Blackmail against employee	Explosives	Vital facility areas	Large emission
Group 7-20 pers. Insider	Take control of the facility		Infiltration	Car bomb	Reactor safety systems	Massive emissions
Group (> 20 pers.) No insider	Destroy and cause emissions		Sabotage from within	Short-range missile		
Group (> 20 pers.) Insider	Maximum destruction		Sabotage from outside	B-weapons		
			Massive armed attack a	Chemicals & C-weapons		
				Radiological substances		
				Aircraft		
				Middle/Long-range missiles		
				Nuclear weapons/ EMP		

One of the morphological models used to generate “terrorist threat scenarios” for the Swedish Nuclear Power Inspectorate.



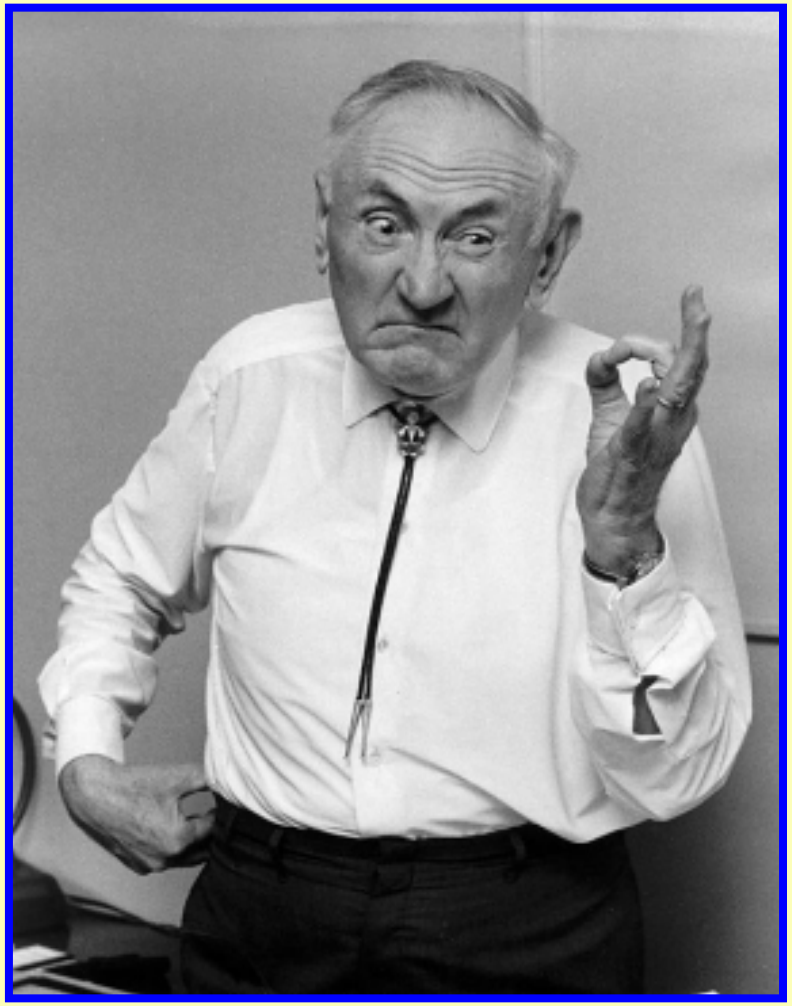
PLANNING/ PLANS	EDUCATION AND TRAINING	PERSONNEL AVAILABLE	EQUIPMENT AVAILABLE	COMMAND LEVEL	EVACUATION and CORDONING of buildings	Indication of sources and identification of substance group	Information to public (Command center)	HELP and SUPPORT for seriously injured	DEGASIFICATION efforts
Object oriented planning and inter-agency coordinated exercises for C-agents	Advanced training and recurrent general exercises with chemical agents	20 or more	Specialized equipment for specific case of C-agent	Level 4	Beginning of effective evacuation within 15 minutes	Indicate source and identify substance within 15 minutes	Alarm and information within 5 minutes	Help up to 20 people with degasification within 15 minutes	Complete degasification and redressing procedure begun within 30 minutes
Special planning program for C-agents	Basic training with recurrent general exercises with chemical agents	13 - 19	Base equipment for C-agents	Level 3	Beginning of effective evacuation within 30 minutes	Indicate source and identify substance group within 15 minutes	Alarm and information within 30 minutes	Help up to 5 people with degasification within 15 minutes	Complete degasification and redressing procedure begun within 60 minutes
Routine with checklist for C-agents (for command personnel)	Basic training with recurrent general exercises for chemical accidents	8 - 12	Less than base equipment for C-agents	Level 2	No effective evacuation start within 30 minutes	Indicate source and identify substance within 30 minutes	No measures taken within 30 minutes	Help removes injured within 15 minutes	Re-dressing begun within 30 minutes
General standard routine for chemical accidents		5-7		Level 1		Indicate source and identify substance group within 30 minutes		No measures taken within 15 minutes	Organized airing and observation after evacuation
						No measures taken within 30 minutes			No measures taken within 60 minutes

Linked morphological fields for accessing preparedness for terrorist actions involving the release of a chemical agent.

More information and articles on morphological analysis at:

www.foi.se/ma

Thank you



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