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Quantity-Distance Assessment Session

WHAT DO QUANTITY-DISTANCES MEAN ?

by Jean Gabriel GOLIGER

ABSTRACT

Quantity-Distances ensure the minimum practicable risk to life and property, including ammunition. Several kinds of QD are traditionally provided by safety manuals towards internal facilities (explosive magazines and workshops, other workshops and office buildings) and external facilities (public traffic routes, inhabited buildings, other categories of meeting places and buildings). Levels of protection against instantaneous propagation of explosion for 1.1. products, and against propagation of combustion for 1.3 products are well described. Levels of damage to persons and properties are well described from 1.1. products. They have to be precised from 1.2 and 1.3 products. This implies to define consistent levels of acceptable damage towards each category of possible exposed item.

French regulation defines six potential damage zones, separated by five (red, orange, yellow, green, blue) lines with defined decreasing potential damage. It provides a list of accepted exposed items, to be tolerated in these damage zones.

* SNPE - GTS - 91710 - VERT LE PETIT - FRANCE.

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WHAT DO "QUANTITY-DISTANCES" MEAN ?

SUMMARY

- INTRODUCTION
- THE NEED
- THE FRENCH REGULATION APPROACH
- SUGGESTIONS
- CONCLUSIONS

INTRODUCTION

- QUANTITY-DISTANCE = QD

QD = THE MINIMUM PERMISSIBLE DISTANCE BETWEEN A POTENTIAL EXPLOSION SITE CONTAINING A GIVEN QUANTITY OF EXPLOSIVES AND AN EXPOSED SITE. IT IS BASED ON AN ACCEPTABLE RISK TO LIFE AND PROPERTY (INCLUDING AMMUNITION)

THERE ARE 4 KINDS OF QD

INTER-MAGAZINE DISTANCES.
EXPLOSIVES WORKSHOP DISTANCES.
PUBLIC TRAFFIC ROUTE DISTANCES.
INHABITED BUILDING DISTANCES.

- PES = POTENTIEL EXPLOSIVE SITE

- ES = EXPOSED SITE

- MANUALS PROVIDE QD

WHAT LEVELS OF ACCEPTABLE DAMAGES DO
THESE QD IMPLY ?

THE NEED

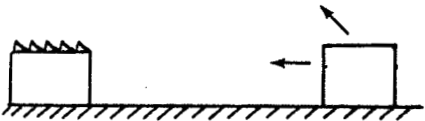
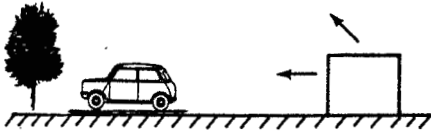
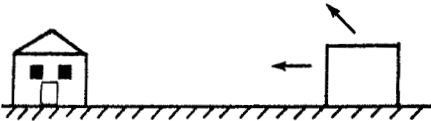
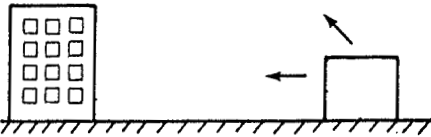
- LEVELS OF PROTECTION AGAINST INSTANTANEOUS PROPAGATION OF EXPLOSION FOR 1.1 PRODUCTS, PROPAGATION OF COMBUSTION FOR 1.3 PRODUCTS ARE WELL DESCRIBED IN MANUALS IN FUNCTION OF QUANTITIES AND DISTANCES FROM THE PES.

- LEVELS OF DAMAGE TOWARDS PERSONS AND PROPERTIES, FROM 1.1 PRODUCTS ARE WELL DESCRIBED, AS WELL.

- LEVELS OF DAMAGE FROM 1.2, 1.3 AND 1.4 PRODUCTS IN FUNCTION OF QUANTITIES AND DISTANCES ARE POORLY DESCRIBED, IN GENERAL.

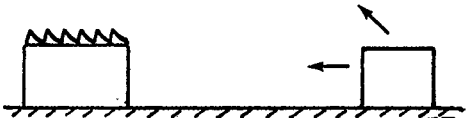
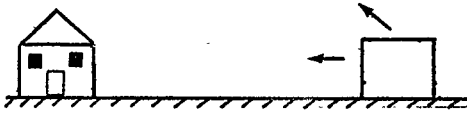
**EXAMPLE OF LEVELS OF DAMAGES TOWARDS PERSONS
DECRIBED BY NATO MANUAL D/258
FROM 1.1 PRODUCTS**

PES = LIGHT STRUCTURE, UNBARRICADED

CONFIGURATION ES/PES	RECOMMENDED QD	EXPECTED INJURIES AT THESE QD
	<p>QD = 8 Q 1/3</p>	<p>SERIOUS INJURIES WHICH MAY RESULT IN DEATH.</p>
	<p>QD = 15 Q 1/3 QD = 22 Q 1/3 (Busy roads)</p>	<p>NO SERIOUS INJURIES INJURIES CAUSED BY GLASS BREAKAGE OR DEBRIS AND FRAG.</p>
	<p>QD = 22 Q 1/3</p>	<p>POSSIBLE INJURIES CAUSED BY GLASS BREAKAGE</p>
	<p>QD = 44 Q 1/3</p>	<p>OR FLYING/FALLING DEBRIS. POSSIBLE INJURIES ONLY BY GLASS BREAKAGE.</p>

**EXAMPLES OF LEVELS OF DAMAGE TOWARDS PERSONS
DESCRIBED BY MANUALS
(1.3 PRODUCTS, COMPATIBILITY GROUP C)**

PES = LIGHT STRUCTURE, UNBARRICADED

CONFIGURATION ES/PES	RECOMMENDED QD	EXPECTED INJURIES
 <p>The diagram shows a rectangular structure with a jagged top edge on the left, representing an explosives workshop. To its right is a smaller square structure. A horizontal arrow points from the square structure towards the workshop, and a diagonal arrow points upwards from the square structure, indicating an explosion source.</p>	<p align="center">3.2 Q 1/3</p>	<p align="center">IMMUNITY FOR PERSONNEL WITHIN THE EXPLOSIVES WORKSHOP</p>
 <p>The diagram shows a simple house with a gabled roof on the left. To its right is a smaller square structure. A horizontal arrow points from the square structure towards the house, and a diagonal arrow points upwards from the square structure, indicating an explosion source.</p>	<p align="center">6.4 Q 1/3</p>	<p align="center">NO DEATH, NOR SERIOUS INJURIES TO THEIR OCCUPANTS</p>

USING A SNPE COMPUTER CODE "THAFT" WE HAVE TRIED TO DESCRIBE ACTUAL DAMAGES AT RECOMMENDED QD. THE COMPUTER CODE THAFT PROVIDES TWO DISTANCES :

DSR = DISTANCE WITH STATIC RECEPTOR : THE MAXIMAL DISTANCE AT WHICH A STATIC PERSON IS BURNT AT THE 2nd DEGREE, BARE SKIN.

DDR = DISTANCE WITH DYNAMIC RECEPTOR : THE MAXIMAL DISTANCE AT WHICH A DYNAMIC PERSON IS BURNT AT THE 2nd DEGREE, BARE SKIN. DYNAMIC, MEANS THAT THE PERSON IS SUPPOSED TO RUNAWAY AT 5 m/s IN THE GOOD DIRECTION AFTER A TIME OF REACTION EQUAL TO TWO SECONDS.

PES

- a) 10,000 Kg OF GUNPROPELLANT IN PLASTIC BAGS SUPPOSED TO BURN IN 15 s,
- b) 70,000 Kg OF GUNPROPELLANT IN PLASTIC BAGS SUPPOSED TO BURN IN 30 s.

	10,000 Kg	70,000 Kg
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QD FOR EXPLOSIVES WORKSHOP	70 m	140 m
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QD FOR INHABITED BUILDINGS	135 m	265 m
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ES	10,000 Kg	70,000 Kg
EXPLOSIVES WORKSHOP	EVEN IF THEY RUNAWAY, PEOPLE IN THE OPEN ARE BURNT AT THE 2 nd DEGREE BARE SKIN	
INHABITED BUILDING	EVEN IF THEY DON'T MOVE PEOPLE ARE NOT BURNT	IN THE OPEN, IF THEY RUNAWAY PEOPLE ARE NOT BURNT. IF THEY ARE STATIC, THEY ARE BURNT AT 2 nd DEGREE, BARE SKIN

ACTUAL EXPECTED INJURIES AT RECOMMENDED QD FO
PEOPLE IN THE OPEN

WHAT DOES IT MEAN ?

1 - FOR INHABITED BUILDINGS THE SAME QD DON'T PROVIDE CONSISTENT LEVELS OF PROTECTION FROM 1.3 PRODUCTS.

2 - WE REALIZE THAT FOR AN EXPLOSIVES WORKSHOP, PEOPLE IN THE OPEN CAN BE BURNT AT THE 2nd DEGREE, BARE SKIN, EVEN IF THEY RUNAWAY.

3 - WE REALIZE THAT FOR INHABITED BUILDINGS, PEOPLE IN THE OPEN HAVE TO RUNAWAY AND LOOK FOR A SHADOW.

FURTHER WORK MUST BE DONE ON LEVELS OF ACCEPTABLE DAMAGE FROM 1.3 PRODUCTS.

FRENCH REGULATION APPROACH

FRENCH REGULATION DEFINES 6 AREAS OF DECREASING LEVEL OF POTENTIAL DAMAGES TOWARDS PERSONS AND PROPERTIES DIVIDED BY 5 (RED, ORANGE, YELLOW, GREEN, BLUE) LINES.

Z1 RED LINE	LETHAL INJURIES IN MORE THAN 50 % OF CASES, VERY SEVERE DAMAGES TO PROPERTIES
Z2 ORANGE LINE	SERIOUS INJURIES WHICH MAY BE LETHAL, SEVERE DAMAGES
Z3 YELLOW LINE	INJURIES, MEDIUM AND SLIGHT DAMAGES
Z4 GREEN LINE	POSSIBILITIES OF INJURIES, SLIGHT DAMAGES
Z5 BLUE LINE	VERY LOW POSSIBILITY OF SLIGHT INJURY, VERY SLIGHT DAMAGE
NDZ	NO DANGER ZONE

IN FUNCTION OF THE PROBABILITY OF ACCIDENT, CLASSIFIED IN FIVE LEVELS P1 TO P5, AND OF THE NATURE OF THE POTENTIAL EXPOSED SITE, FRENCH REGULATION DESCRIBES IN A TABLE WHAT IS ACCEPTABLE OR NOT

EXAMPLE : ES = INHABITED HOUSE

(Nota P1 = PROBABILITY FOR A STORAGE CONFIGURATION)

P_i Z_i	P1	P2	P3	P4	P5
	INCREASING LEVEL OF PROBABILITIES OF ACCIDENTS				
Z1	NOT ACCEPTABLE YELLOW LINE				
Z2					
Z3					
Z4	INHABITED ISOLATED HOUSES ONLY OR LINKED TO THE ESTABLISHMENT GREEN LINE		NOT ACCEPTABLE		
Z5	INHABITED HOUSES EXCEPT (SEE UNDER) BLUE LINE			ISOLATED HOUSES ONLY	
NDZ	BUILDINGS OF GREAT HEIGHT, DENSELY INHABITED AREAS, GATHERING PLACES (CHURCHES,)				

ASSOCIATED TECHNICAL CRITERIA CAN
COMPLETE THE DEFINITION OF DAMAGE
(EXAMPLE FROM SNPE)

- Z2 = "SERIOUS INJURIES WHICH MAY BE
LETHAL"
----- FOR FRAGMENTS HAZARDS.

ASSOCIATED CRITERION FOR Z2 is $CPL < 0.1$

WHERE CPL IS THE CONDITIONAL PROBABILITY
OF LEHALITY DEFINED AS THE PROBABILITY OF
KILLING SOMEBODY, SUPPOSING HE IS PRESENT
IN A GIVEN AREA, SUPPOSING THE EXPLOSION
HAS OCCURRED, TAKING INTO ACCOUNT THE
DEGREE OF LEHTALITY (DEPENDING ON ITS
KINETIC ENERGY) OF EACH PROJECTION.

LIMIT	DAMAGE DUE TO PROJECTION	
RED LINE	CPL = 0.5	
ORANGE LINE	CPL = 0.1	
YELLOW LINE	CPR = $3 \cdot 10^{-2}$	} BY PROJECTIONS WITH AN ENERGY ABOVE 8 JOULES
GREEN LINE	CPR = 10^{-2}	
BLUE LINE	YFR = 10^{-7}	

CPL = CONDITIONAL PROBABILITY OF LETHALITY OF SOMEBODY *

CPR = CONDITIONAL PROBABILITY OF REACHING OF SOMEBODY *

YFR = YEARLY FREQUENCY OF REACHING OF SOMEBODY *

* SUPPOSING HE IS PRESENT ON THE LINE, SUPPOSING THE EXPLOSION HAS OCCURRED.

SUGGESTIONS

1 - WE SUGGEST THAT THE DIFFERENT MANUALS INTRODUCE THE NOTION OF COLOURED LINES WHICH WOULD MATERIALIZE HAZARDOUS ZONE LIMITS.

EXPECTED ADVANTAGES

THREE MAIN ADVANTAGES ARE EXPECTED THROUGH THIS NEW PRESENTATION OF QD. THESE ARE :

- CONSISTENCY

THE LEVEL OF POTENTIAL DAMAGES IS SIMILAR BETWEEN TWO LINES, WHATEVER IS THE HAZARD DIVISION AND THE TYPE (ABOVEGROUND OR UNDERGROUND) OF THE STORAGE.

- ACCURACY

QUANTITY-DISTANCES MAY BE CIRCULAR, BUT, FOR EXAMPLE IN UNDERGROUND MAGAZINES, THE EFFECTS ARE MAINLY ORIENTED. LINES TO DRAW SEEM MORE APPROPRIATE TO USE THAN CIRCLES.

- SIMPLICITY

USING THE SAME COLOURED LINES BETWEEN THE DIFFERENT COUNTRIES WOULD MAKE TECHNICAL EXCHANGES BETWEEN EXPERTS EASIER.

EXAMPLE = "IN FRANCE, ISOLATED INHABITED BUILDINGS MUST BE LOCATED BEYOND THE YELLOW LINE". THIS SENTENCE SEEMS SIMPLE.

SUGGESTIONS

2 - DEFINITIONS AND DESCRIPTIONS GIVEN BY THE MANUALS FOR HAZARD DIVISION 1.1 COULD BE A GOOD START FOT THE REFLECTION ON ACCEPTABLE DAMAGES AND TECHNICAL CRITERIA FOR 1.2 AND 1.3 PRODUCTS.

CONCLUSIONS

EXISTING QD DON'T IMPLY ALWAYS CLEAR
AND CONSISTENT ACCEPTED DAMAGES.

A PROGRESS COULD BE ACHIEVED THROUGH
ADOPTION OF COLOURED LINES
MATERIALIZING DEFINED DAMAGE ZONES.