INVESTIGATION OF EXPLOSION CAUSES – POSSIBILITIES AND LIMITATIONS

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ABSTRACT: The explosion investigation should be carried out in a methodical way by a two-step-procedure:
- correlating the individual traces with the typical traces of all known explosion types, generally by an eliminating process,
- investigation of the explosion cause belonging to the explosion type found out before, also generally by elimination.

This procedure can be applied in the majority of cases and it can help to avoid misinterpretations and possibly misjudgements. The method is limited by the lack or the accident related loss of expressive traces or by the ambiguity of traces.

KEYWORDS: Explosion types; Explosion causes; Forensic explosion investigation.

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This paper gives a short survey about the field of explosion types and of explosion investigation. It will touch only on several subjects which are well know, but point out some less known explosion types and subtypes. It has been illustrated in the oral presentation by examples, and it has been shown the complexity of those cases.

Because of the different nature of the explosion types (Figure 1) a diverse and extensive knowledge is necessary, especially about:
- the way how an explosible system can be generated,
- the conditions under which an explosible system is critical,
- the circumstances under which an explosion can be initiated,
- the effects of the different explosion types onto human beings or/and objects.

In almost all cases it is possible to achieve the result of the explosion investigation by a two-step-procedure (Table I).

Fig. 1. Scheme of explosion type.

TABLE I. EXPLOSION INVESTIGATION. METHODOLOGICAL PROCEEDING

1.	Identifying of the centre of explosion (crater, point or area of maximum destruction), possibly the number of explosion centres
2.	Assessing of trace constellations (formation of craters or fragments; impact of blast in air or ground; impact of heat-irradiation; impact by fragments on targets)
3.	Linking up of trace constellations with explosion types; finding out the explosion type which correlates with the trace constellations or the explosion types which can not be eliminated
4.	Investigating of explosion causes concerning the explosion type found out by the first elimination process; applying a second elimination process to the explosion causes
5.	Documenting of the constellations of visible (non-latent) traces
6.	Searching and securing of material evidences({visible and latent ones)
7.	Analysing of these traces
8.	Assessing of all gained evidences with regard to the goal

1. First step. This step is the attempt to correlate the individual traces of an explosion as:
   – onto human beings or animals like dismembering of flesh or/and bones, tearing up of arteries and lungs, bursting of eardrums etc. and
   – onto objects as building structures like cratering, crushing of strong materials, tearing of sheet metal to pieces, shattering of glass to fragments, arching and denting of containers, scorching of wooden surfaces etc.

With the typical traces which are produced by each separate explosion type (Table II) – in a methodical way, generally by eliminating step by step each type which does not match to the traces. In many cases all types, except for one, can be eliminated ("negative corpus").

TABLE II. CORRELATION OF EXPLOSION TRACES WITH EXPLOSION TYPES

Explosion types	Maximally possible Explosion traces
Explosive Explosion	
– Detonation	Very severe pressure impact in the vicinity by local demolishing of structures (cratering and/or crushing of concrete, bricks, wood, iron/steel and/or tearing of sheet metal to peaces), catapulting of fragments over great distances; severe pressure impact in greater distances; pressure impact dominant versus heat impact
– Deflagration	Comparatively weak to severe pressure impact in the vicinity and in greater distances; no demolishing of structures like by detonation, but damaging of great surfaces possible; besides frequently considerably high heat impact
Thermal explosion ("Run away explosion")	Comparatively weak pressure impact by rupture of the vessel, frequently only few fragments catapulted to the vicinity, but severe heat impact and sporadically spraying out of hot substances like peroxides
Volume explosion	
– Detonation	Very severe damage of the walls of vessels {tearing up to little pieces) or of buildings (demolishing of structures)
– Deflagration	Severe damage of the walk of vessels or buildings
Vapour cloud explosion	Mmoderately severe to severe damage of buildings and chemical plants Erom the outside
BLEVE	Moderately severe to severe pressure impact against neighbouring buildings, but high rate of heat by radiation against persons and objects
Bubble resonance explosion	Very severe pressure impact in the vicinity, like by explosive explosion
Vessel overpressure rupture	Comparatively weak to severe pressure impact, frequently only few fragments catapulted to the vicinity, no heat impact – except for systems which were heated before

2. Second step. This step has also to be done in a methodical way – generally by eliminating all those causes of the investigated explosion type which could not initiate the explosion (one example in Figure 2).

Fig. 2. Example of an explosion investigation.

In some constellations the direct way ("positive corpus") is reliable and wholly sufficient, for example if the traces on persons or/and on objects can only be interpreted by an explosive explosion and this one can only be triggered by a fuse.

Often – related to the most frequent type of fuel-gas/air and fuel-vapour/air explosions – more than one cause ("triggering factor" as ignition source)

cannot be excluded, but this circumstance should not disappoint the investigator; rather it is negligible in the majority of cases whether the flame of a gas-fired heater or a spark in a light switch or in a thermostat switch of a deep freezer was the ignition source precisely.

Only in few cases the question is significant which ignition source triggered the explosion and not the question why and in which way a dangerous mixture of a gas or vapour with air was created – such cases are exceptional ones.

Not rarely it can be of great importance to make clear that glowing tabacco can not be the ignition source for dispersive systems – except mixtures of H_2, C_2H_2 and CS_2 with air.

The two step method of explosion cause investigation enables to solve many cases more systematically, in some cases without doubt and sometimes more quickly because detours and errors can be avoided – this is the advantage of this method, but there are also limitations:

- it can not be differentiated in individual cases between explosion types if the typical traces are not formed out or are not present,
- because the damage capability of the explosion has been considerably less than the maximum or
- because the traces, for instance thermal influence on a surface or adherence of chemical traces (almost always latent ones!) which were present at first have been destroyed by a following fire or got lost in another way ("ambiguity" in Figure 3, path "b", "c", "d").

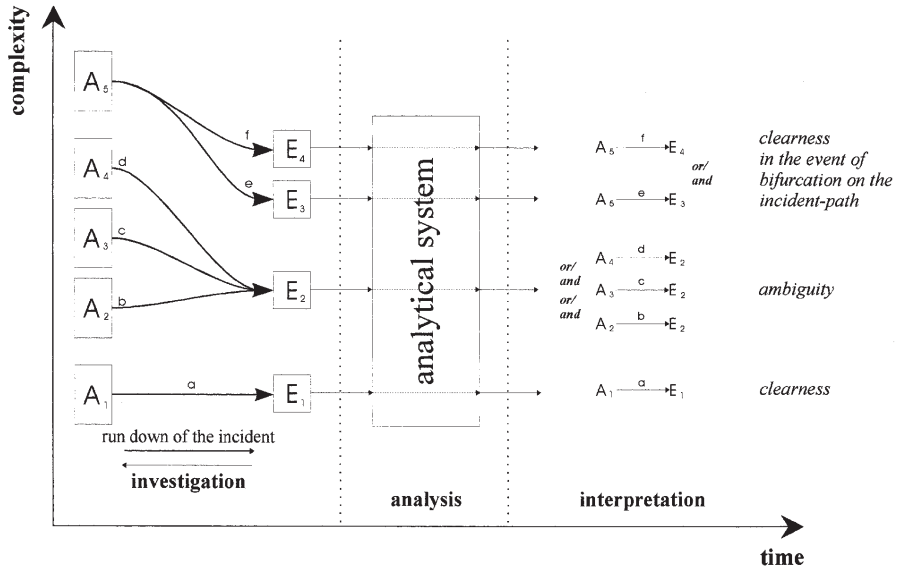

Fig. 3. Explosion cause investigation model.