



Structural Fire Investigation and Forensic Engineering

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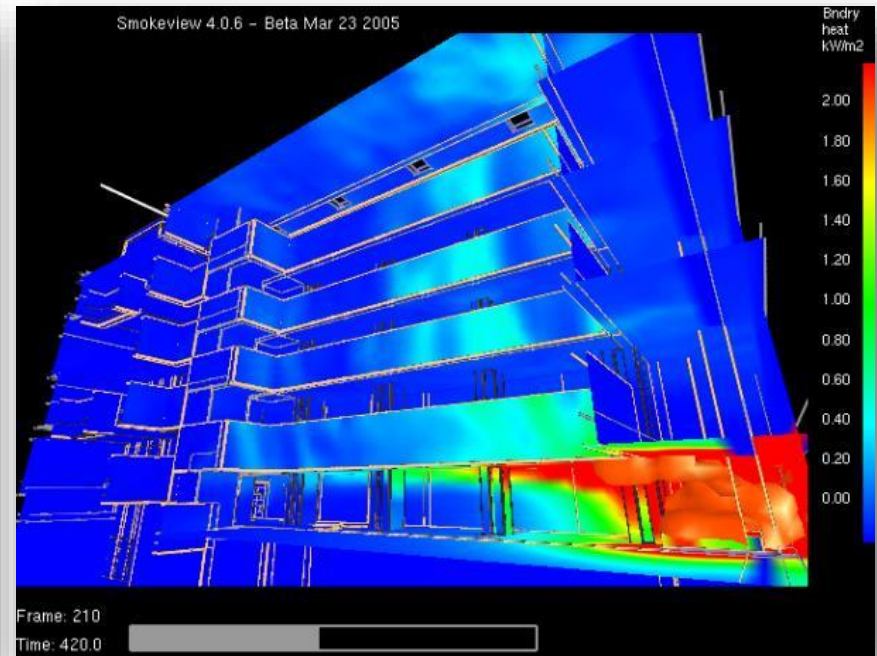
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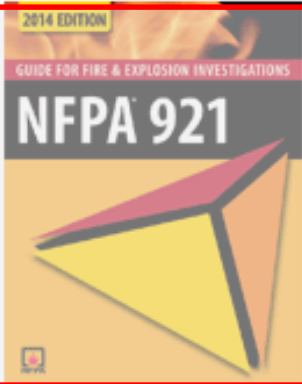
Forensic Engineering and Fire Investigation

Fire investigation is the analysis of fire-related incidents involves the examination of all fire-related incidents to determine the origin and the cause of fire. It can involve several disciplines, and it can be even more specialized if it is focused in Structural Fire Investigation, where the main purpose is to built a relationship, based on scientific principles, between structural behaviours and laws.



Forensic Engineering and Fire Investigation

The Structural Investigation process, somehow designed by NFPA 921 «*Guide for Fire and Explosion Investigations*», concern the exam and analysis of fire-damaged structures and requires a strong knowledge of fire safety and fire structural design, to define one of the possible cause of the fire.

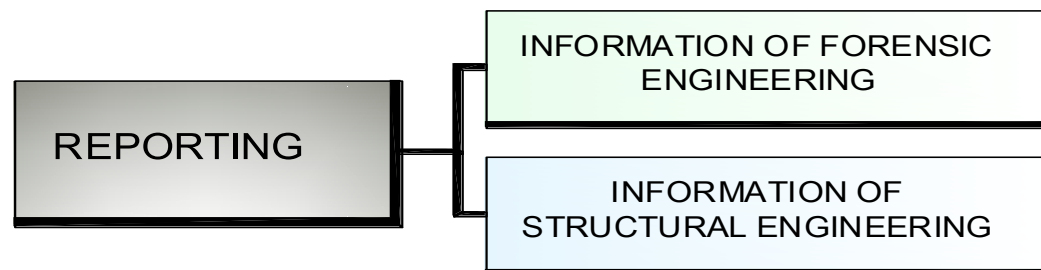
	Chapter 1 ADMINISTRATION	Chapter 10 FIRE RELATED HUMAN BEHAVIOR	Chapter 19 ANALYZING THE INCIDENT FOR CAUSE AND RESPONSIBILITY
	Chapter 2 REFERENCED PUBLICATIONS	Chapter 11 LEGAL CONSIDERATIONS	Chapter 20 FAILURE ANALYSIS AND ANALYTICAL TOOLS
	Chapter 3 DEFINITIONS	Chapter 12 SAFETY	Chapter 21 EXPLOSIONS
	Chapter 4 BASIC METHODOLOGY	Chapter 13 SOURCES OF INFORMATION	Chapter 22 INCENDIARY FIRES
	Chapter 5 BASIC FIRE SCIENCE	Chapter 14 PLANNING THE INVESTIGATION	Chapter 23 FIRE AND EXPLOSION DEATHS AND INJURIES
	Chapter 6 FIRE PATTERNS	Chapter 15 DOCUMENTATION OF THE INVESTIGATION	Chapter 24 APPLIANCES
	Chapter 7 BUILDING SYSTEMS	Chapter 16 PHYSICAL EVIDENCE	Chapter 25 MOTOR VEHICLE FIRES
	Chapter 8 ELECTRICITY AND FIRE	Chapter 17 ORIGIN DETERMINATION	Chapter 26 WILDFIRE INVESTIGATIONS
	Chapter 9 BUILDING FUEL GAS SYSTEMS	Chapter 18 FIRE CAUSE DETERMINATION	Chapter 27 MANAGEMENT OF MAJOR INVESTIGATIONS
		Chapter 28 MARINE FIRE INVESTIGATIONS	

Forensic Engineering and Fire Investigation

The progress in the development of an investigation could be divided in five main steps that the investigator could follow to close the investigation.



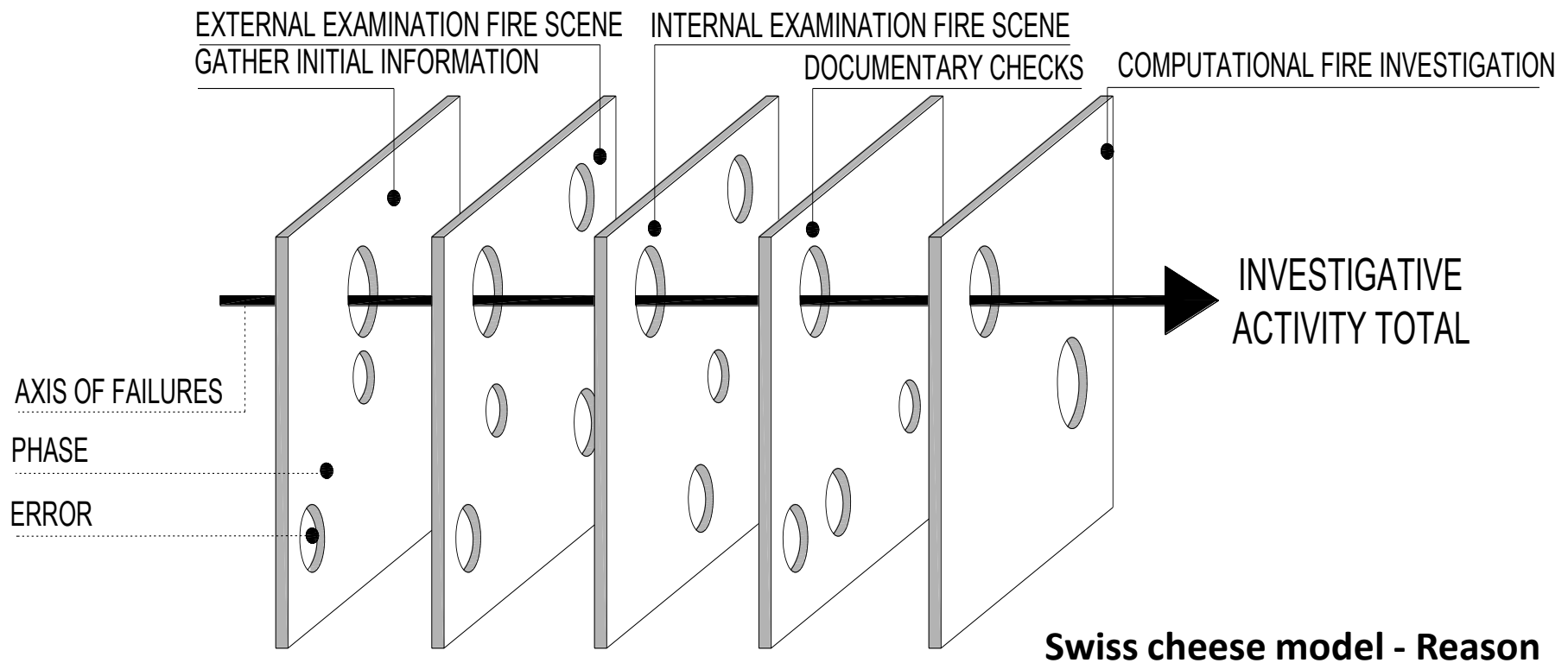
All those activities lead to a systematic investigation procedure.



This process is focused on the investigator's queries. It also is an auxiliary tool which aim is to present the investigator's results to those who are in charge of expressing a judgement.

Forensic Engineering and Fire Investigation

Poor evaluations, mistakes in collecting data during the inspection, or inappropriate simulations can lead to partial failures which, if combined, cause the failure of the entire investigation process.



Forensic Engineering and Fire Investigation

INVESTIGATIVE STEP

EXTERNAL INSPECTION

INTERNAL INSPECTION

ACTIVITIES OUTSIDE THE SCENE

GATHER INITIAL
INFORMATION

EXTERNAL EXAMINATION
FIRE SCENE

INTERNAL EXAMINATION
FIRE SCENE

DOCUMENTARY CHECKS

COMPUTATIONAL FIRE
INVESTIGATION

1

2

3

4

5

PHASES

Information geometry

Significant description
outside

Significant description
inside

Project documents

Modeling and simulation fire

Interviewing witnesses

Photo and video outside

Photo and video inside

Executive documents

Laboratory tests

Collecting significant
events

External structural
inspections

Fire load existing
at the time the fire

Maintenance documents

Weather conditions

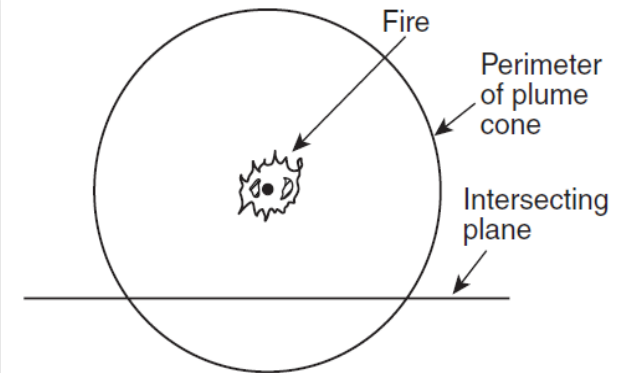
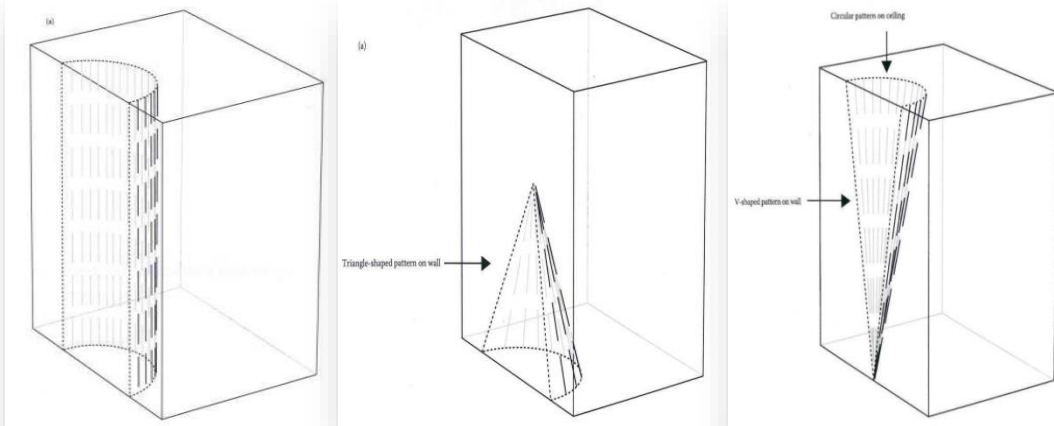
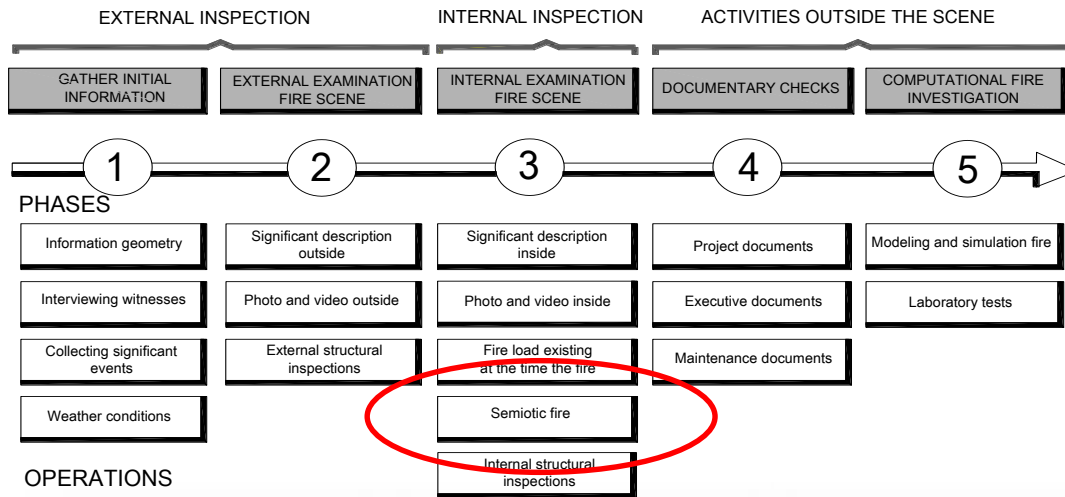
Semiotic fire

Internal structural
inspections

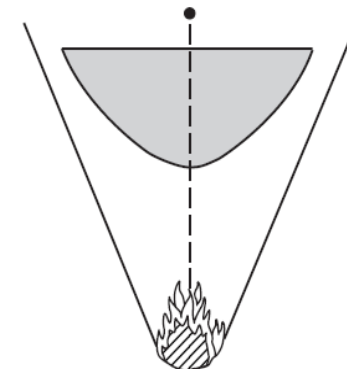
OPERATIONS

Forensic Engineering and Fire Investigation

For example, a fundamental operation when examining and evaluating an internal fire scene is the so called «Semiotic analysis», that includes the study of signs and sign processes (semiosis).



PLAN VIEW
Plume cone and intersecting plane

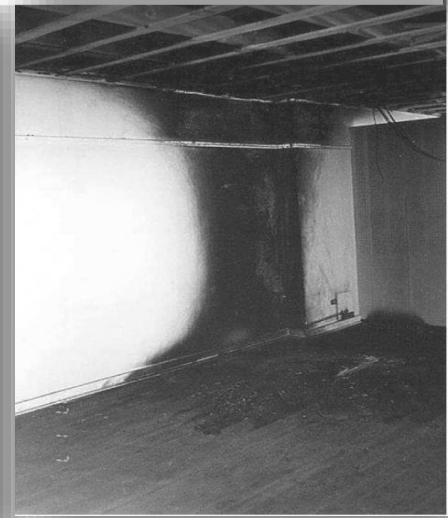


ELEVATION VIEW
Plume cone showing U-shaped pattern

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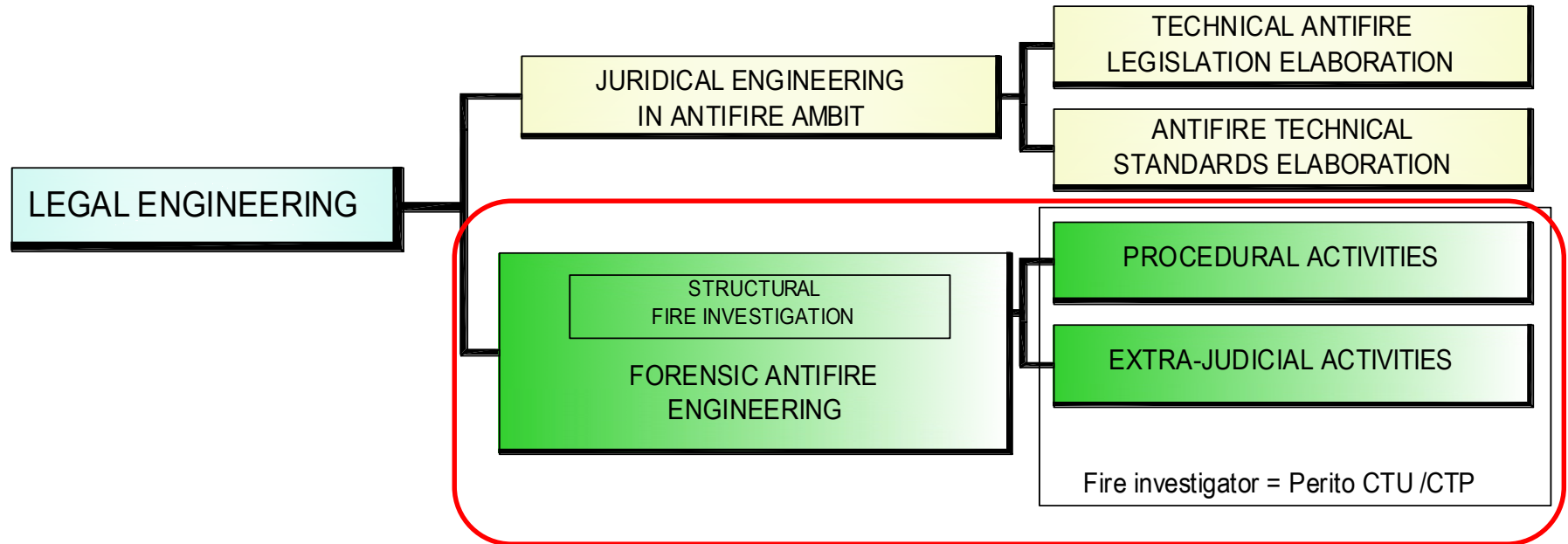
The science of interpreting burn patterns is considered important by fire investigators when establishing a fire's area of origin. Several examples are provided along with engineering calculations such as:

- Inverted Cone Patterns;
- Column-shaped Patterns;
- V-shaped or Cone Patterns;
- U-shapes and Double U-shaped Patterns;
- Hourglass Patterns;
- Protection Patterns;
- Ignitable Liquid Pour Patterns.



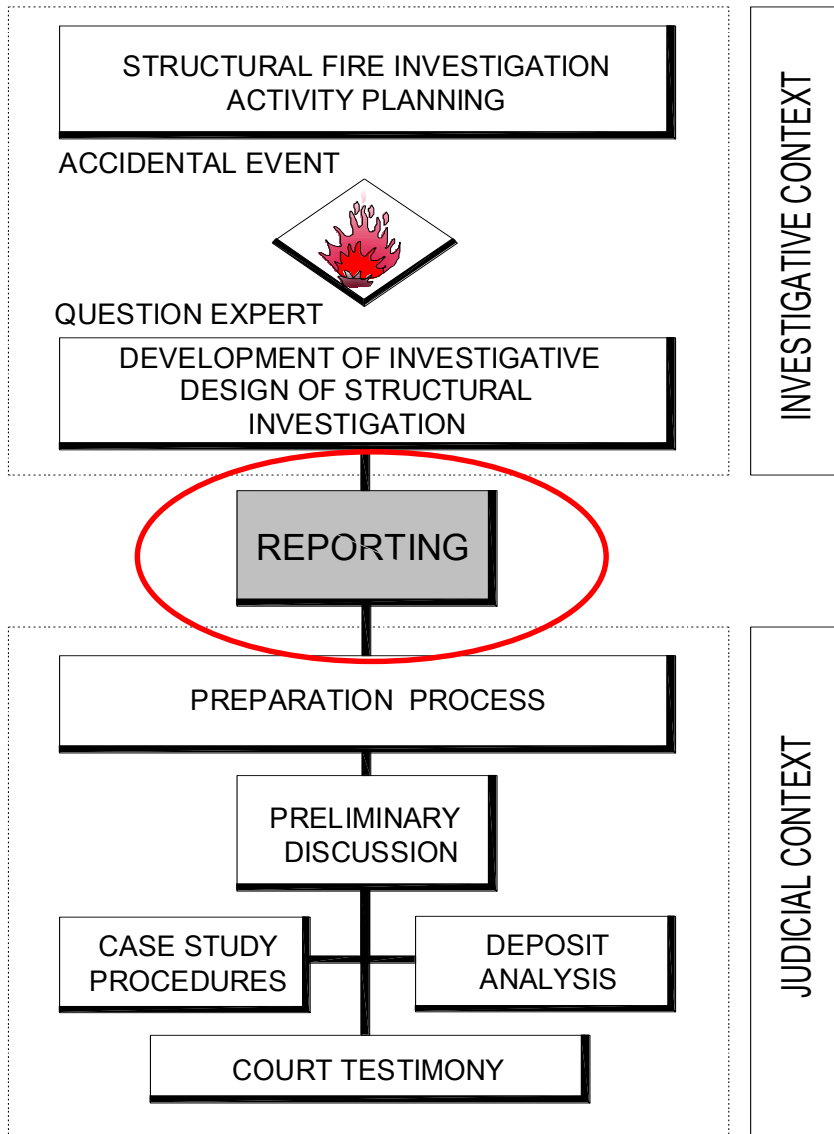
Forensic Engineering and Fire Investigation

Fire Investigation is part of the Forensic Engineering, and come out in the procedural and extra-judicial activity with the purpose of giving technical and scientific answers to judicial problems.



Therefore, *Fire Investigation* examines technical aspects of juridical nature while attempting to pair the technical point of view with the juridical impression.

Forensic Engineering and Fire Investigation



The *fire investigator* draft a report with the answers to the court questions, *emphasizing* the adopted methodology, and its scientific fundamentals to define the cause-event relationship.

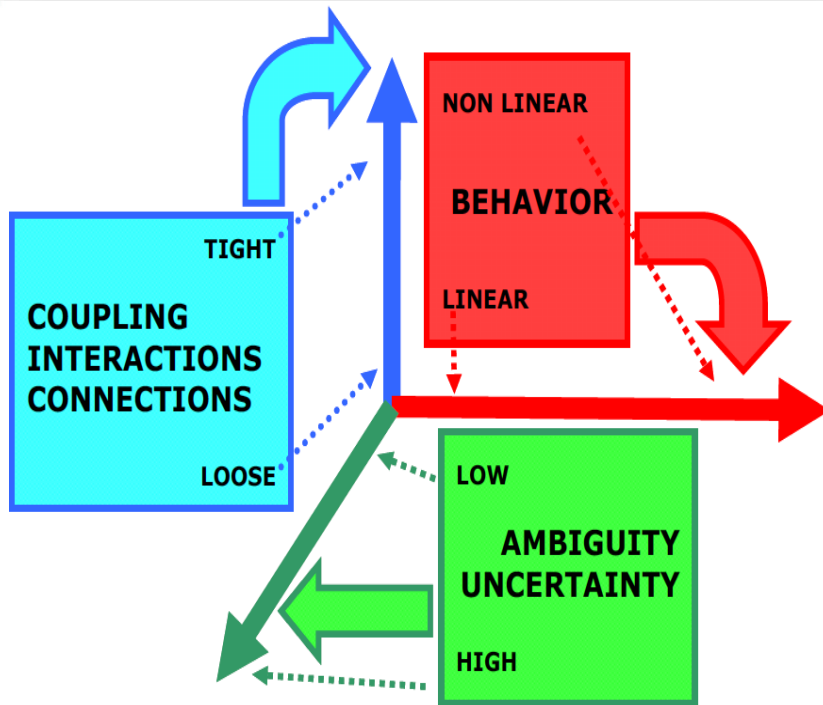
1. PREMESSA
2. DATI DEL LOCALE
- 2.1. DESCRIZIONE DELLA STRUTTURA
- 2.2. STIMA DEL CARICO DI INCENDIO
- 2.3. VENTILAZIONE DEL LOCALE
3. MODELLAZIONE DELL'INCENDIO
- 3.1. DESCRIZIONE DELLA MODELLAZIONE CON FDS
- 3.1.1. Graficizzazione della struttura
- 3.1.2. Dati di input della modellazione
- 3.1.3. Piani di studio per la rilevazione dati
- 3.2. RISULTATI DELLA MODELLAZIONE
- 3.2.1. Andamento dei fumi
- 3.2.2. Andamento delle fiamme
- 3.2.3. Profilo delle temperature nel bagno
- 3.2.4. Profilo delle temperature nella sala
4. SEMIOTICA DELL'INCENDIO E DELL'ESPLOSIONE
- 4.1. SEGNI DELL'INCENDIO
- 4.1.1. Orizzonti di fumo
- 4.1.2. Orizzonti di calore
- 4.1.3. Segni da clean burn e floor jet
- 4.1.4. Danni da spalling e surface pitting
- 4.1.5. Segni di protezione
- 4.2. SEGNI DELL'ESPLOSIONE
- 4.2.1. Tracce dell'esplosione
- 4.2.2. Danni da onda d'urto
5. CONCLUSIONI
- 5.1. ORIGINE E NATURA DELL'INCENDIO
- 5.2. ORIGINE E NATURA DELL'ESPLOSIONE



Forensic Engineering and Fire Investigation

Fire Investigation is generally based on elements such as:

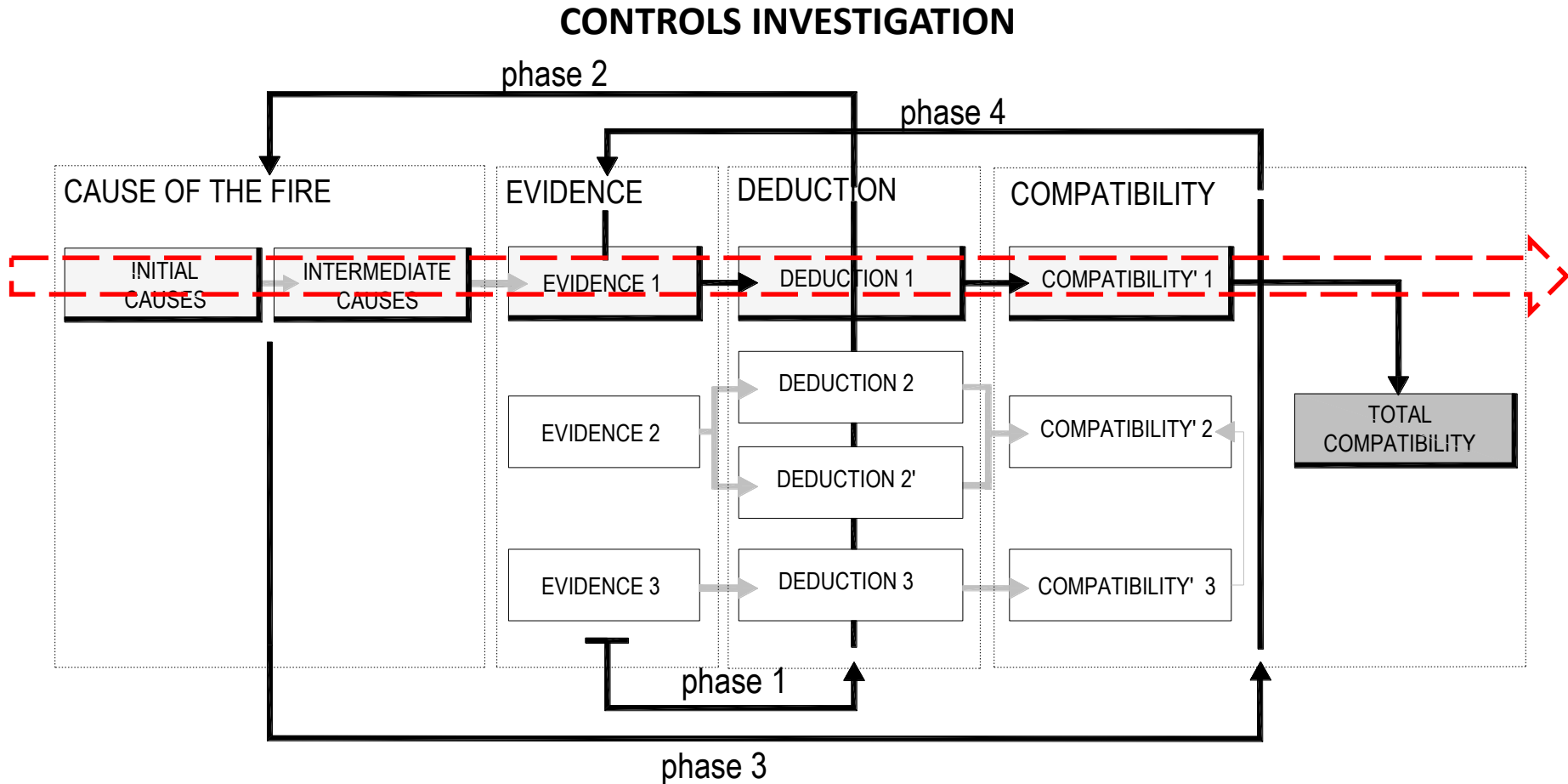
- **causality** - (also referred to as causation) is the relation between an event (the cause) and a second event (the effect) where the first event is understood to be responsible for the second;
- **causal nexus** is the connection between a cause and an effect and it is studied to link a certain event with fact in a assumption.



The *Structural Fire Investigation*, examining the complexity of the fire and the structure related parameters, apply analysis methods with the purpose to acquire the **causative link**. The evaluation parameter of the causative link is to determine of the refers to.

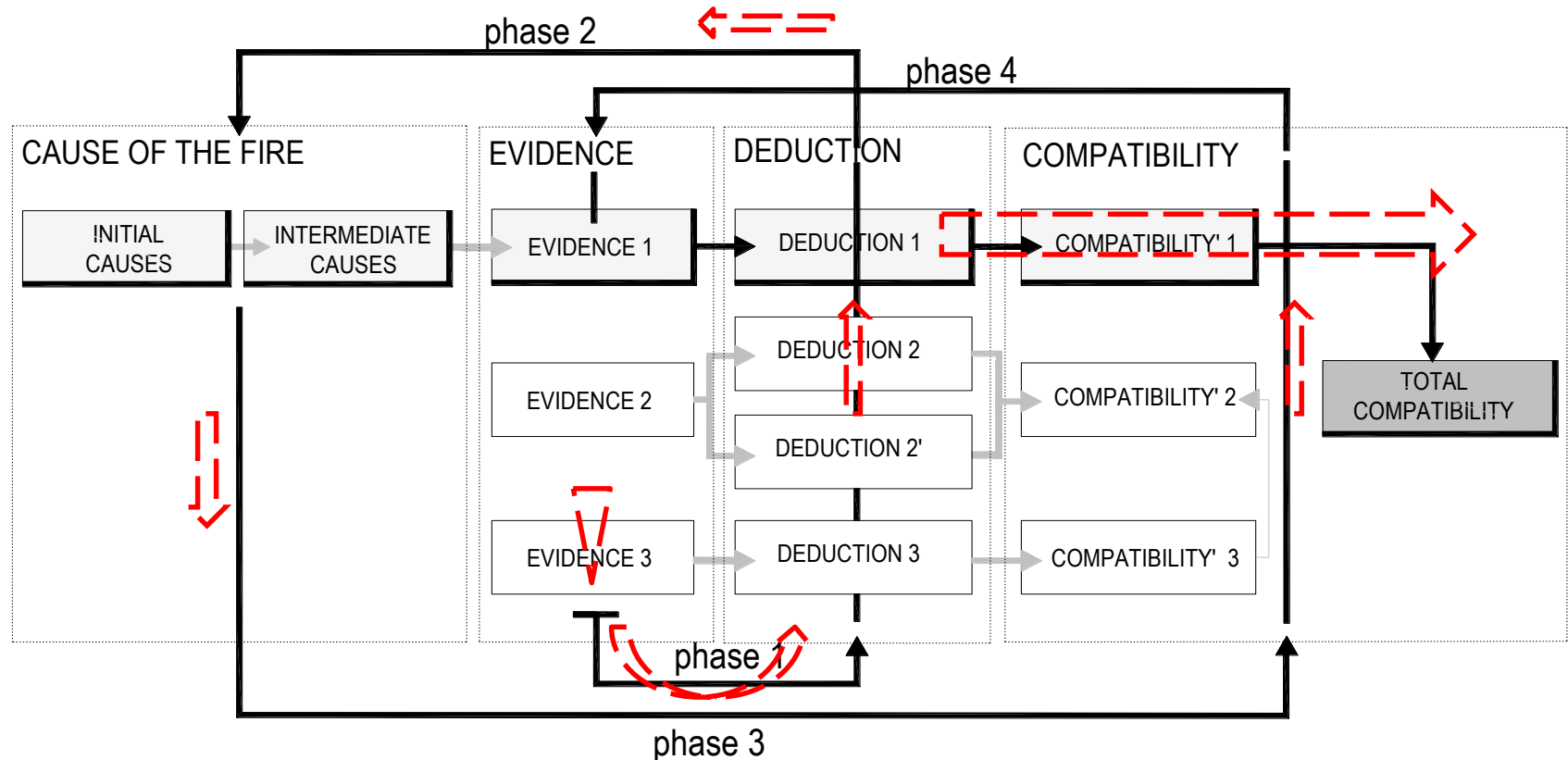
Diagram Perrow

Causative link and responsibility profiles



The **first control** that the investigator have to do is *linear* and consequential. Causes leads to evidences, deductions and compatibility verification of compatibilities. From each evidence one or more deduction may originate, sometimes antithetical, to evaluate throught a judgment on compatibility.

Causative link and responsibility profiles



The **second control** is *circular and starts from evidences*. Divided in 4 phases, it verify if:

- the evidence is compatible with the deduction (phase 1);
- the deduction is acceptable and consequent to the causes (phase 2);
- causes that have features of compatibility with what established (phase 3);
- total compatibility is connected to evidences and to a linear control (phase 4).