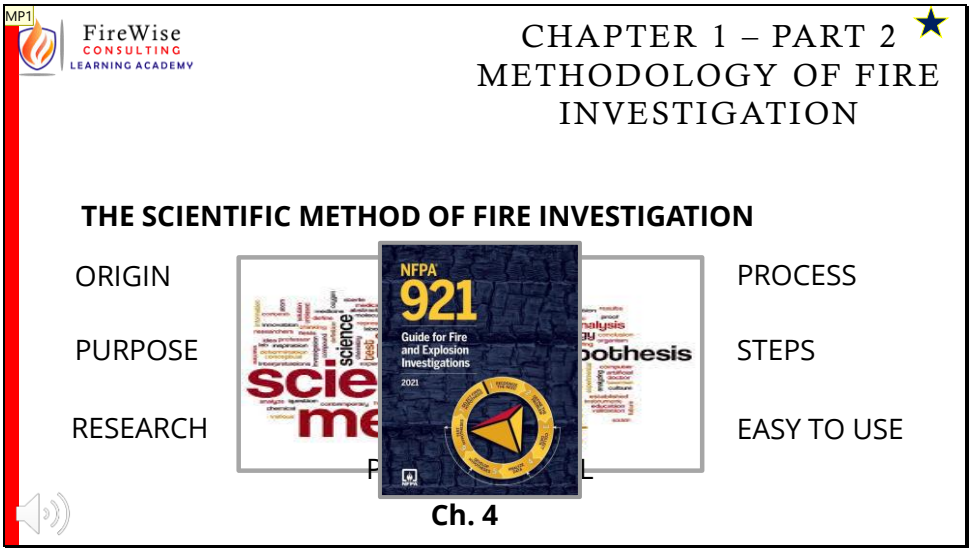
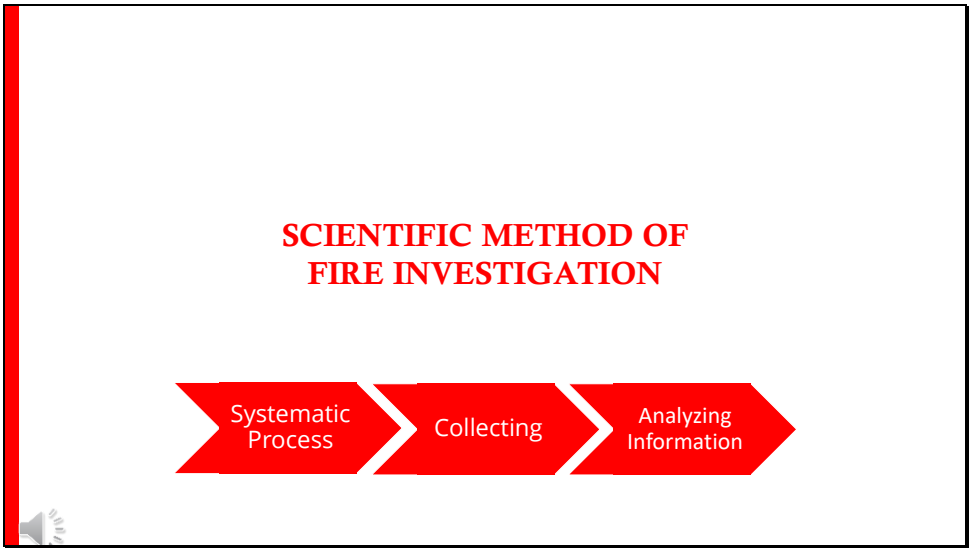
Slide 1



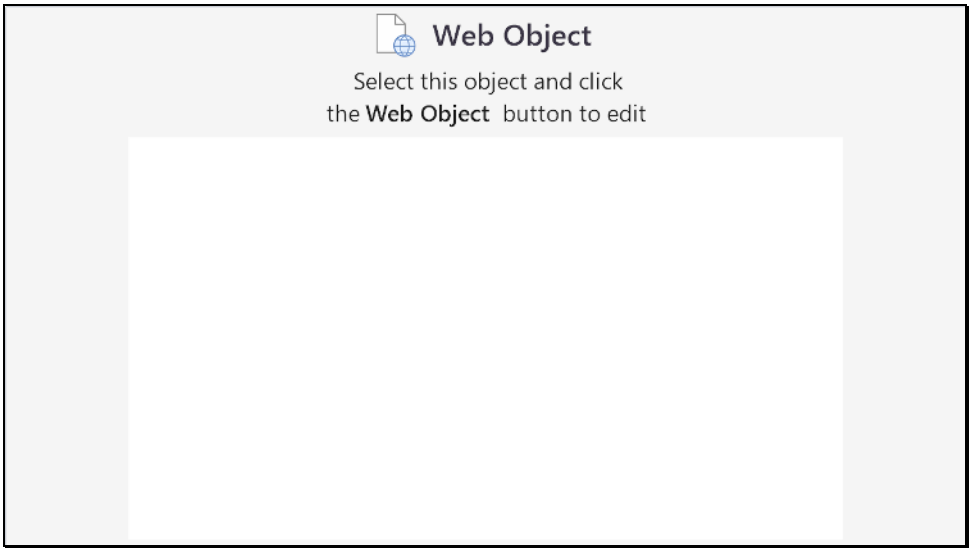
Welcome to **Part 2 of** Chapter **1** Methodology **of Fire Investigation** or as we like to call it “The Scientific Method of Fire Investigation”. If you are following us in NFPA 921 we’re covering chapter 4. In this chapter we will discuss:
The origins of the scientific method of fire investigation
The process of conducting investigations using the scientific method.
The purpose of the scientific method
The steps involved in the scientific method of fire investigation.
The scientific method as a form of organized research and thought.
That the scientific method is not difficult to learn or follow
And
A methodical approach like the scientific method is a powerful tool if used properly by the fire investigator

Slide 2



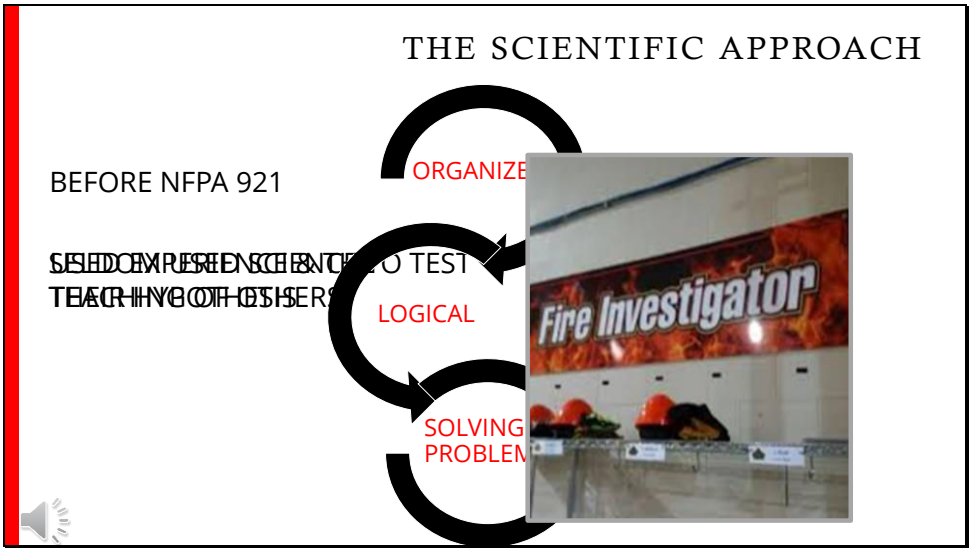
In the following video Dr. DeHaan describes the origins of the scientific method of fire investigation and explains that it is just a systematic method of collecting and analyzing information.

Slide 3



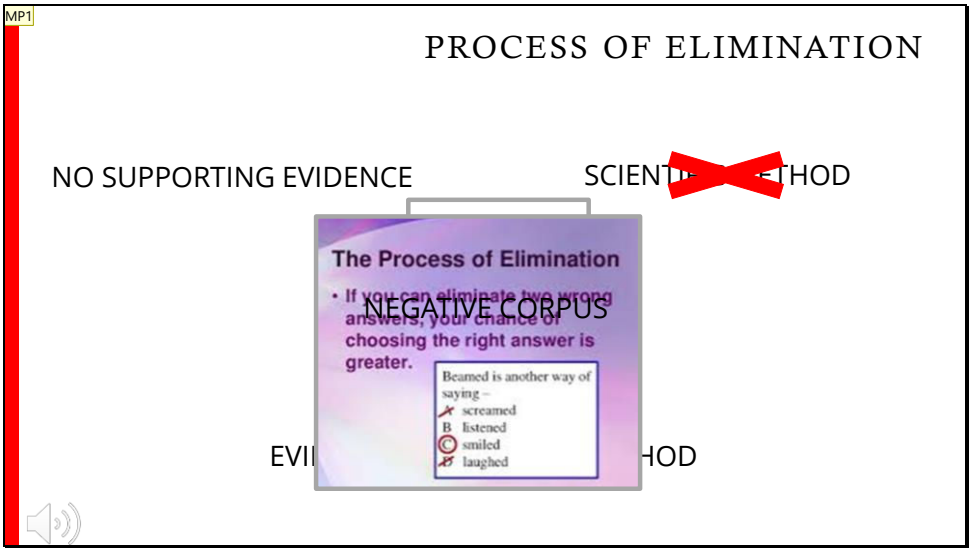
Dehaan Video 06 Scientific Method of fire investigation

Slide 4



The scientific approach to fire investigation is simply an organized and logical approach to solving a problem. However before NFPA 921 fire investigators usually relied on their experience and the teaching of others but seldom used science to test or determine their hypothesis

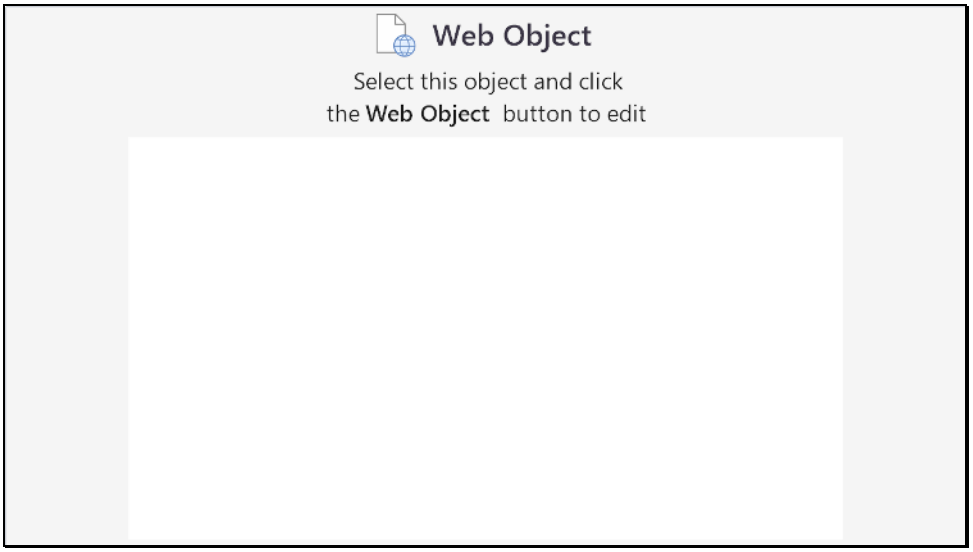
Slide 5



The process of elimination is not a bad thing and can be an integral part of the scientific method. But, if the fire investigator is making a determination for which they do not have supporting evidence that's not consistent with the scientific method. Whatever determination you're going to make in regards to the cause of fire, you have to have evidence to support it.

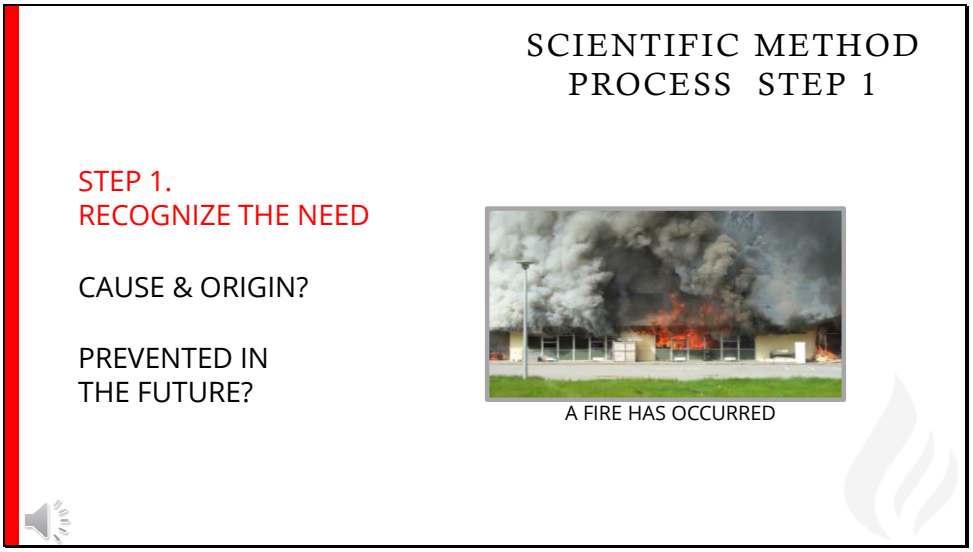
It is important for fire investigators to be aware of the term Negative Corpus. In the past investigators used the lack of supporting evidence for a fire as proof of an incendiary fire. If there was no other apparent causes then the fire "must" have been lit. This reasoning is not acceptable based on the scientific method of NFPA 921.

Slide 6



Dehaan Video #2

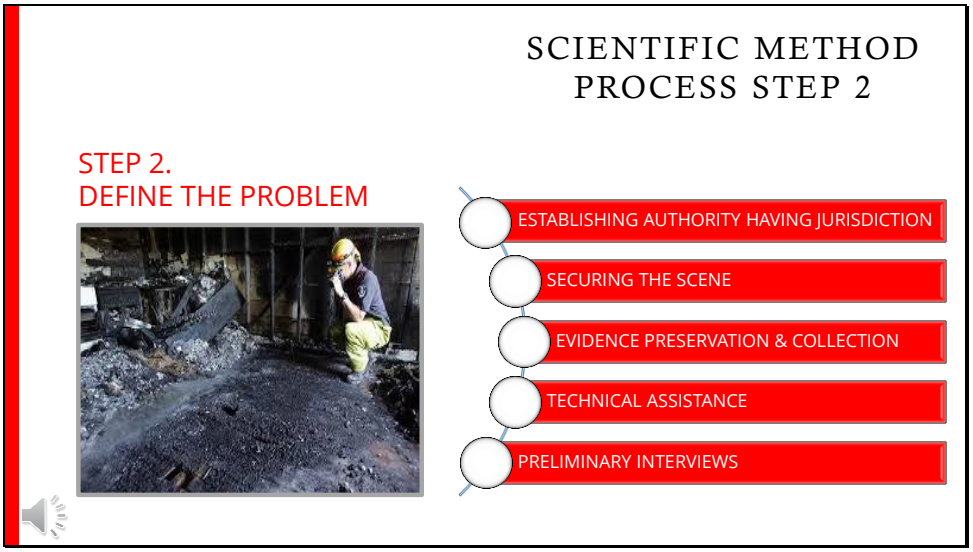
Slide 7



There are 7 steps used in applying the scientific method of fire investigation. They are:

Step 1 Recognize the need. Many jurisdictions are required by legislation to perform fire cause and origin investigations of every fire that occurs in their jurisdiction. When a fire occurs a fire investigator is assigned to investigate to determine the cause of the fire and report their findings. It is necessary not only to determine the cause and origin of the fire but also to identify if fires like this can be prevented in the future. Preventing fires may require changes in codes and standards, product design or other strategies.

Slide 8



Step 2 Define the problem. As soon as practical the investigator should attend the scene. By determining what has burned the fire investigator can anticipate what resources may be required to conduct the investigation. This may include establishing authority having jurisdiction, securing the scene, evidence preservation and collection, technical assistance from specialists and conducting preliminary interviews.

The determination process and location of the point/area of origin involves information derived from analysis of the physics and chemistry of the fire and witness statements.

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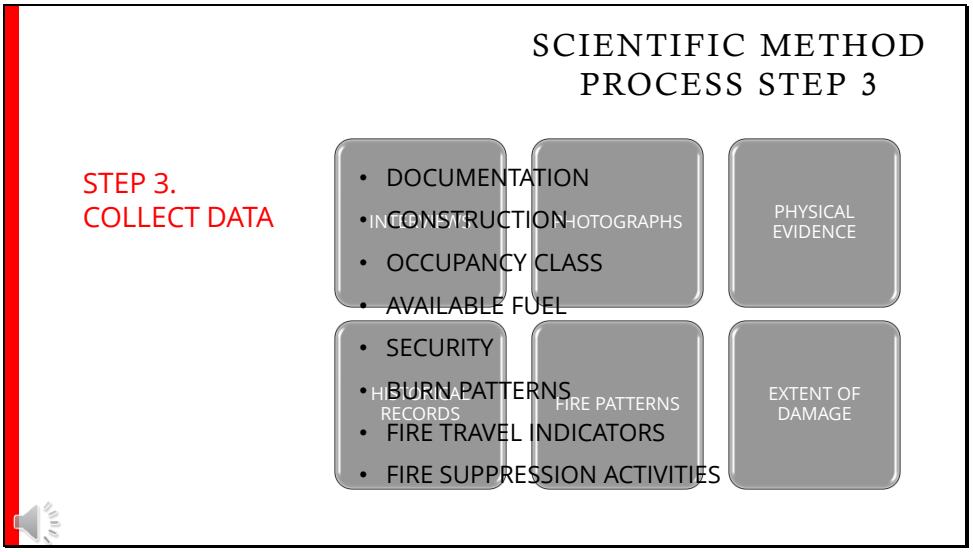

Step 3 Collect Data. Data is facts and statistics collected together for reference or analysis. Data can exist in a variety of forms like interviews,, historical records, photographs, fire patterns, physical evidence like appliances or furnishings and the extent of damage incurred by the fire. Data collection should include, but is not limited to things like documentation about the property, type of construction, occupancy classification, available fuel, security, burn patterns, fire travel indicators, fire suppression activities, and any other information that may assist in determining the cause of the fire.

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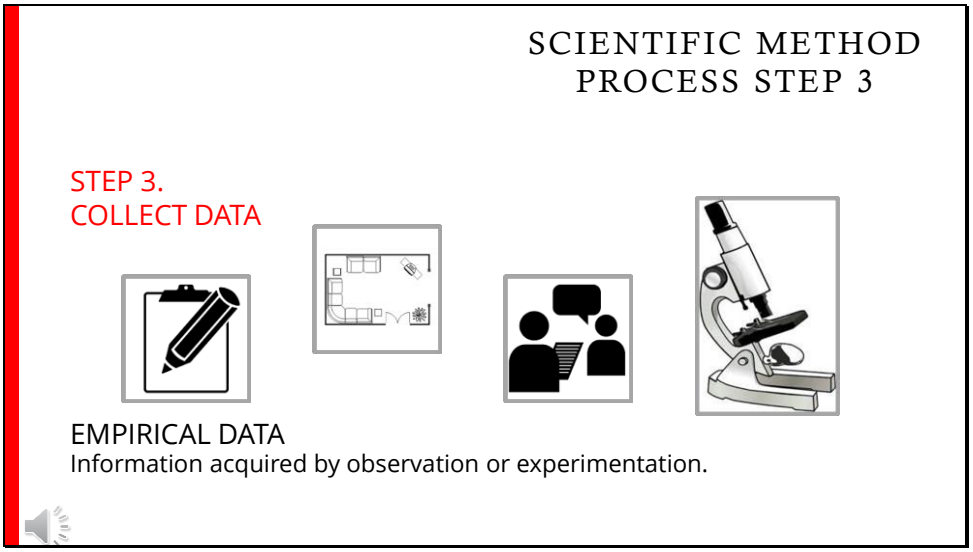
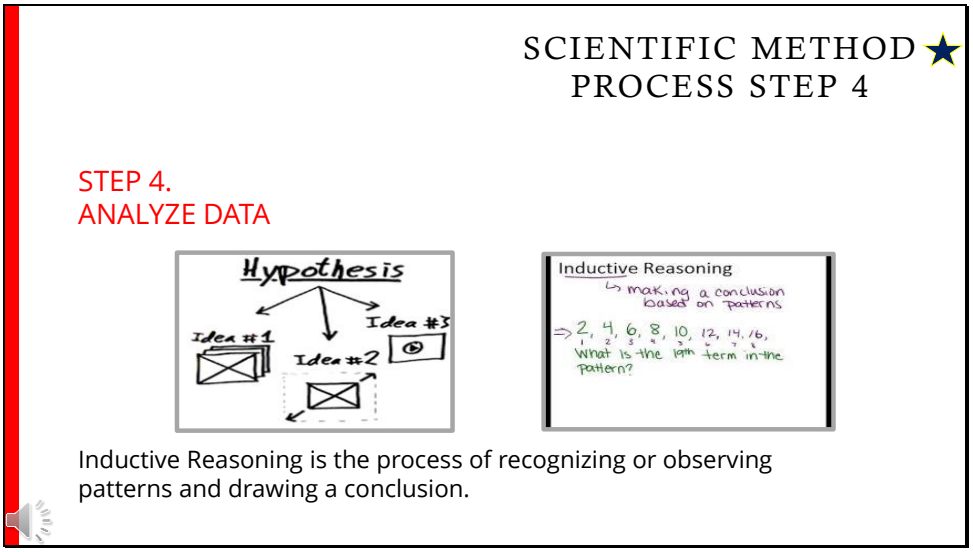


Data may also include notes, sketches, and drawings and interviews with responders and others at the scene or with individuals that have a vested interest in the event. Evidence may be collected and sent to a laboratory for analysis and the lab report becomes part of the data which will be closely analyzed.

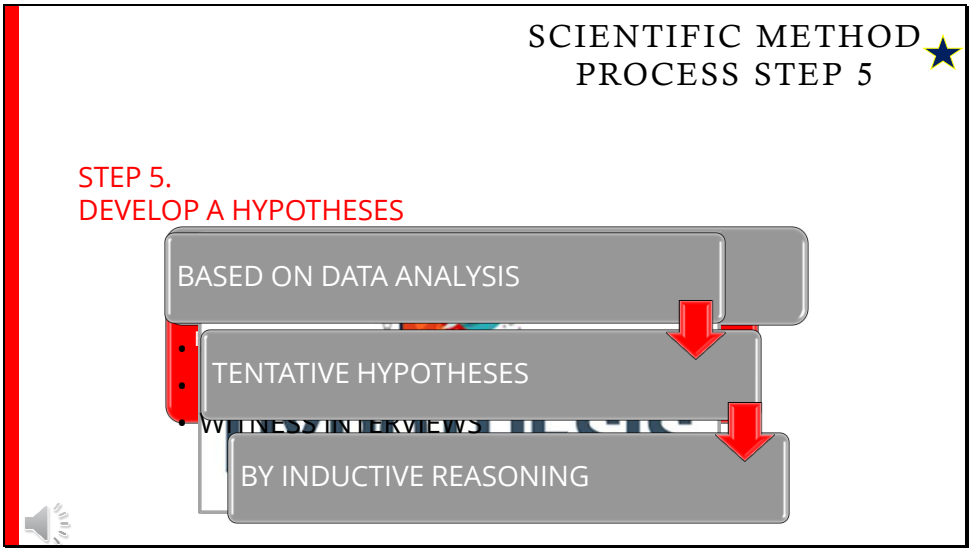
The data that is collected and will be analyzed is----- called empirical data. Empirical data is information acquired by observation or experimentation. This data is recorded and analyzed by fire investigators as part of the scientific method. The fire investigator must carefully document the collection of data that will ultimately be used to form the final hypothesis.

Slide 11



Step 4 Analyze Data. Once the data is collected it is thoroughly analyzed to determine a possible hypotheses for the cause of the fire. Fire investigators use inductive reasoning relying on their knowledge, training and experience to support or refute potential hypotheses. Inductive reasoning is the process of recognizing or observing patterns and drawing a conclusion.
Data that is based on speculation or is not directly related to the fire should be excluded.

Slide 12



Step 5 is “Develop a Hypothesis or Hypotheses”. Based on the available data, the fire investigator develops one or more hypotheses to explain the incident. A hypothesis has been defined as “a theory supported by the empirical data that the investigator has collected through observation and then developed into explanations for this event, which are based on the investigator’s knowledge, training, experience, and expertise.
Based on data analysis the investigator develops tentative hypotheses through inductive reasoning to explain the fire’s cause, origin, and development that is consistent with observations at the scene, physical evidence, and witness interviews.

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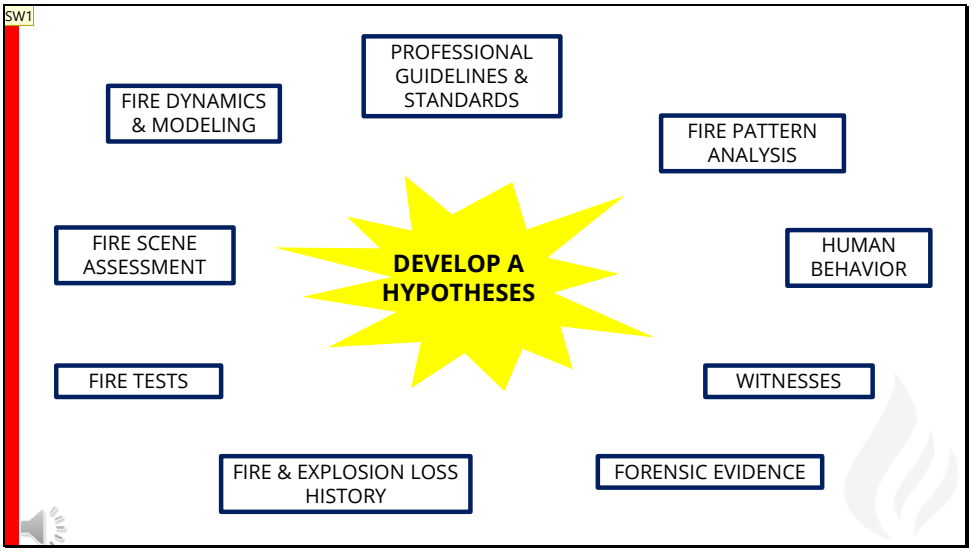

While developing the hypotheses the investigator considers such things as:

- The initial scene assessment
- Forensic evidence
- Fire dynamics and modeling
- Human behavior
- Professional guidelines and standards like NFPA 921
- Fire tests
- **Fire pattern analysis**
- Witnesses
- Fire or explosion loss history

Inductive reasoning is the logical process based on observation in which hypotheses are developed from factors believed true or found true most of the time which are combined to obtain a specific conclusion.

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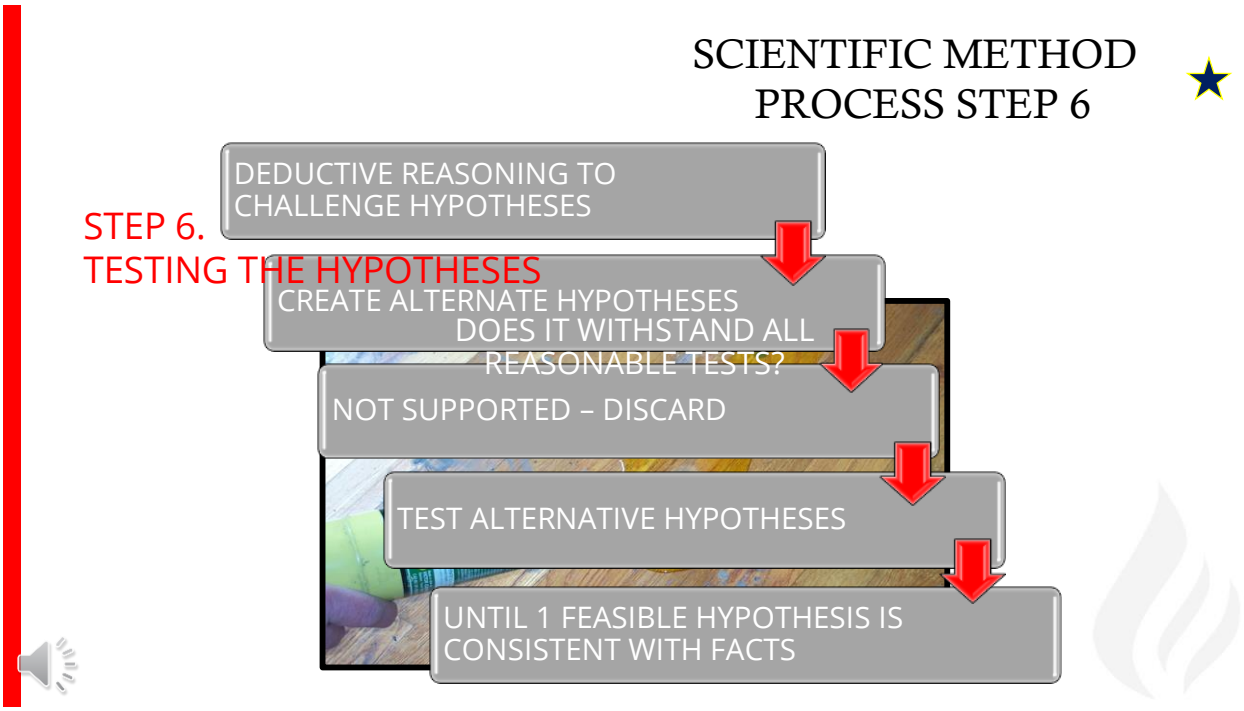

Step 6 Testing the Hypotheses. Testing the hypotheses involves deductive reasoning to eliminate all other reasonable origins of the fire or explosion. Deductive reasoning is when all known facts are used to challenge the final hypothesis. A critical feature of hypothesis testing is to create alternative hypothesis that can also be tested. By testing all hypotheses rigorously, those that cannot be conclusively eliminated must be considered viable. If the hypothesis cannot be supported, it should be discarded, and alternate hypotheses should be developed and tested. This may require the collection of new data or the reanalysis of existing data. The testing process needs to be continued until all feasible hypotheses have been tested and one is determined to be uniquely consistent with the facts.

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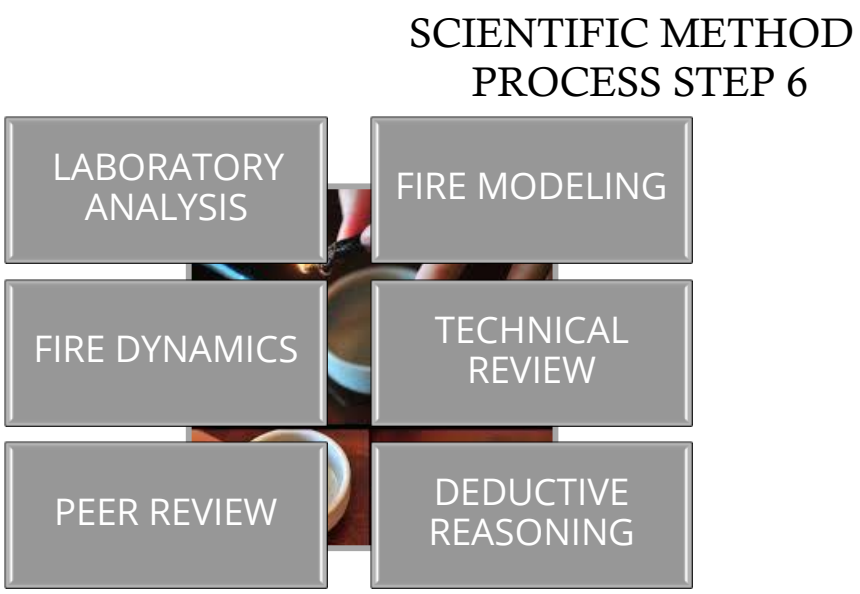

Testing a hypothesis can be done in many ways including but not limited to laboratory analysis, fire modeling, fire dynamics, technical review, peer review and deductive reasoning. Full scale modeling or testing may not be feasible in most cases but small scale tests performed by the fire investigator in the field can produce reliable data. For example the combustibility of a product that was located near the Point of Origin of the fire can be tested to determine ignitability simply by using a match or other ignition device as long as it is done in a safe manner. Often through deductive reasoning investigators use their knowledge and skills to test the hypothesis analytically.

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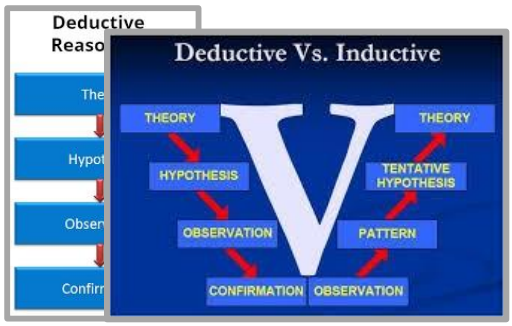
SCIENTIFIC METHOD PROCESS STEP 6



DEDUCTIVE REASONING USED TO TEST HYPOTHESES

INDUCTIVE REASONING USED TO FORM HYPOTHESES

Deductive reasoning, or deduction, is based on a theory and starts out with a general statement, or hypothesis, and examines the possibilities to reach a specific, logical conclusion. Deductive and Inductive reasoning have their place in the scientific method of fire investigation. Inductive reasoning is used to form hypotheses and Deductive reasoning is used to test hypotheses.

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SCIENTIFIC METHOD
PROCESS STEP 6

ANOTHER WAY TO INTERPRET?

ARE THERE FACTS THAT CONTRADICT?

IS YOUR INTERPRETATION MORE LIKELY?

CAN YOU PROVE IT?

DOES IT MAKE SENSE?

WHAT ARE THE WEAKNESSES?

It is important that when using the scientific method, testing the hypothesis should be designed to disprove the hypothesis.

WHAT ARGUMENTS MIGHT BE USED TO REFUTE?

Another way to test the hypothesis is by posing questions such as:

- Is there another way to interpret the data?
- Is your interpretation more likely?
- What are the weaknesses in the hypothesis?
- What arguments will someone else use to refute your hypothesis?
- Are there facts that contradict the hypothesis?
- Can you prove the hypothesis?
- Does it make sense?

It is important that when using the scientific method, testing the hypothesis should be designed to disprove the hypothesis.

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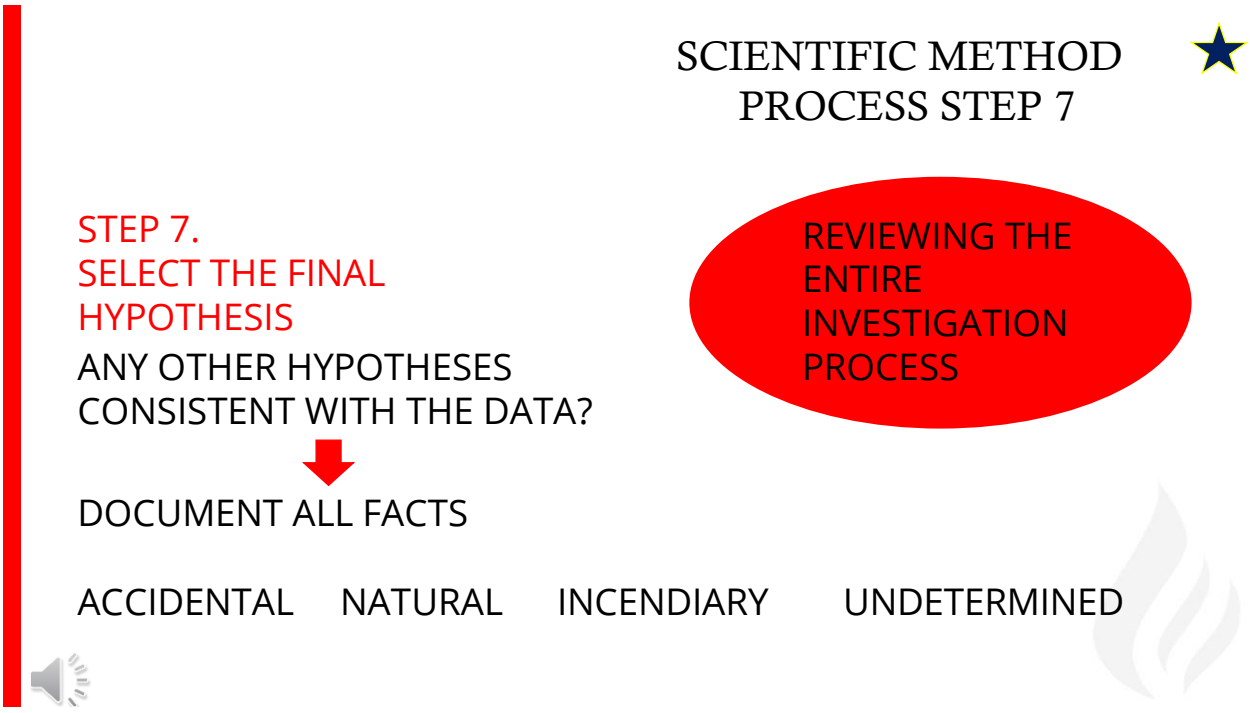

The final step or Step Seven in the scientific process is to Select the Final Hypothesis. This involves reviewing the entire investigation process to make sure all credible data has been considered and or eliminated. The investigator must determine if there are any other hypotheses that are consistent with the data. If all other reasonable hypotheses have been reliably tested and disproven the remaining hypothesis may be the appropriate final hypothesis in which case the fire cause can be identified as accidental, natural, or incendiary.

There will be cases where there is more than one hypothesis that is consistent with all known facts. The investigator must then document the facts and report that the cause of the fire is undetermined.

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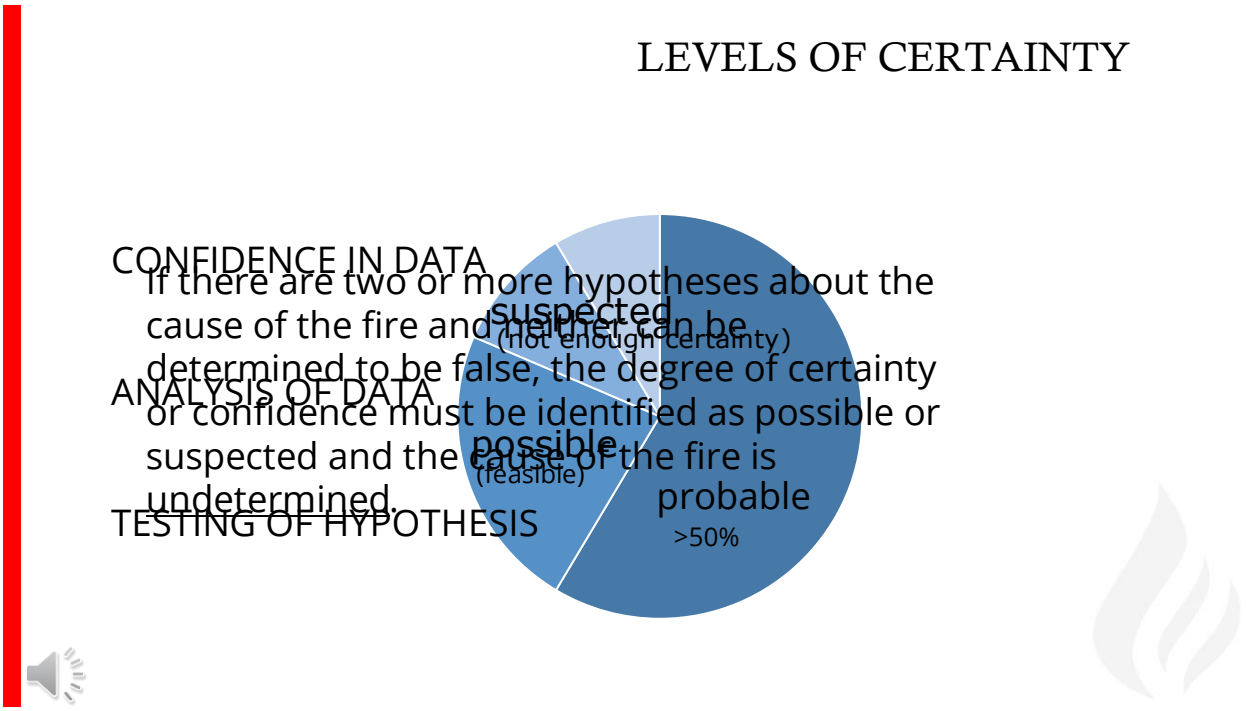

The level of certainty of the hypothesis describes how strongly one believes in that conclusion. There are three levels of certainty Probable, Possible and Suspected.

Probable is when it is more than 50% likely of being true.

Possible is when it is feasible and this term is often used when 2 hypothesis have the same level of certainty

Suspected is used when there is not enough certainty to be considered an expert opinion.

The level of certainty is determined by assessing the investigator's confidence in the data, in the analysis of that data, and testing of the hypothesis. That level of certainty will often determine the practical application of the opinion, especially in legal proceedings. If there are two or more hypothesis about the cause of the fire and neither can be determined to be false, the degree of certainty or confidence must be identified as possible or suspected and the cause of the fire is undetermined.

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Video

Slide 21

EXPECTATION BIAS

A CONCLUSION WITHOUT HAVING EXAMINED ALL RELEVANT DATA

PRECONCEIVED IDEAS

ONLY DATA THAT SUPPORTS PREVIOUSLY FORMED CONCLUSIONS

DISCARDING OTHER DATA

Expectation Bias is a phenomenon that occurs when investigators reach a conclusion without having examined or considered all of the relevant data. Instead of collecting and examining all of the data in a logical and unbiased manner to reach a scientifically reliable conclusion, the investigator uses preconceived ideas to dictate investigative processes, analyses, and, ultimately conclusions. Expectation bias can result in the use of only that data that supports the previously formed conclusion and often results in discarding data that does not support the original opinion. Investigators are strongly cautioned to avoid expectation bias by conducting all investigations with an open mind. Any preconceptions may consciously or unconsciously influence the outcome of the investigation.

There is a strong human tendency to interpret data in such a way that it is consistent with what you expect to find or see. In other words if you expect to find the cause of the fire was arson you probably will find evidence or at least interpret the evidence you find to support that conclusion.

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EXPECTATION BIAS

An example of how a fire investigator could fall into the trap of expectation bias follows.

In this case, the fire investigator was asked to conduct a fire investigation of a major shopping mall fire. He is unable to attend the scene that day so arranges to meet the local investigation team at the fire hall the next day prior to conducting the scene examination. His route to the fire hall takes him past the scene so he stops to have a quick look. He notices that the scene is secured by three police vehicles strategically located so the officers can see all sides of the building. He finds this somewhat unusual as he would normally expect to see security provided by a security company or perhaps a firefighter. He goes to the fire hall and is met by the local fire investigator and members of the police which includes a Staff Sargent, two detectives from the major crimes unit and two members of the identification section. Again, he finds this unusual as rarely has he seen that many police, especially senior members, in attendance at a fire investigation. The meeting opens with the police wanting to talk about historical events involving the owners and occupants of the building where the fire occurred.

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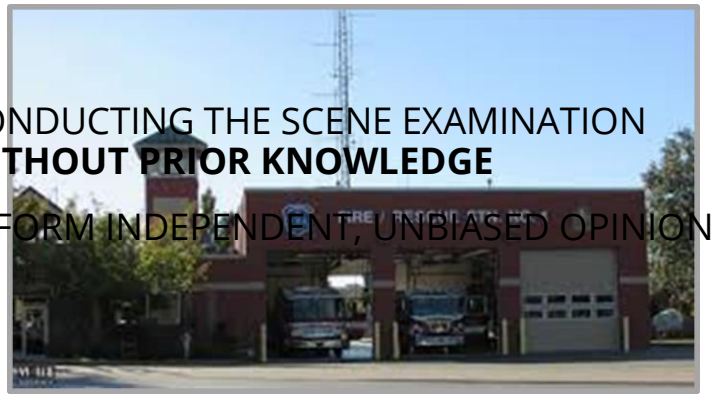
EXPECTATION BIAS



CONDUCTING THE SCENE EXAMINATION
WITHOUT PRIOR KNOWLEDGE

- FORM INDEPENDENT, UNBIASED OPINIONS

Expectation bias has lead to many fire cause determinations that were just wrong.

At that point the fire investigator stops the discussion explaining that he does not want to have any information prior to conducting the fire scene examination because it could create expectation bias. By conducting the scene examination without prior knowledge of events leading up to the fire he can form independent, unbiased opinions about the fire cause and origin. If he had listened to the police prior to conducting the scene examination he could be accused of reaching conclusions based on the information provided by the police rather than evidence found at the scene.

If the police had told him that they suspected arson the investigator could probably find evidence to support their theory. Most seasoned fire investigators will say that “they can find evidence of arson in any fire they investigate.” Expectation bias has lead to many fire cause determinations that were just wrong.

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Video

Slide 25

CONFIRMATION BIAS

SCIENTIFIC METHOD	• DESIGNED TO DISPROVE HYPOTHESIS
CONFIRMATION BIAS	• TRIES TO PROVE HYPOTHESIS

When using the scientific method, testing of hypothesis should be designed to disprove the hypothesis. Confirmation bias occurs when the investigator instead tries to prove the hypothesis. This can result in failure to consider alternate hypothesis. A hypothesis can be said to be valid only when rigorous testing has failed to disprove the hypothesis.

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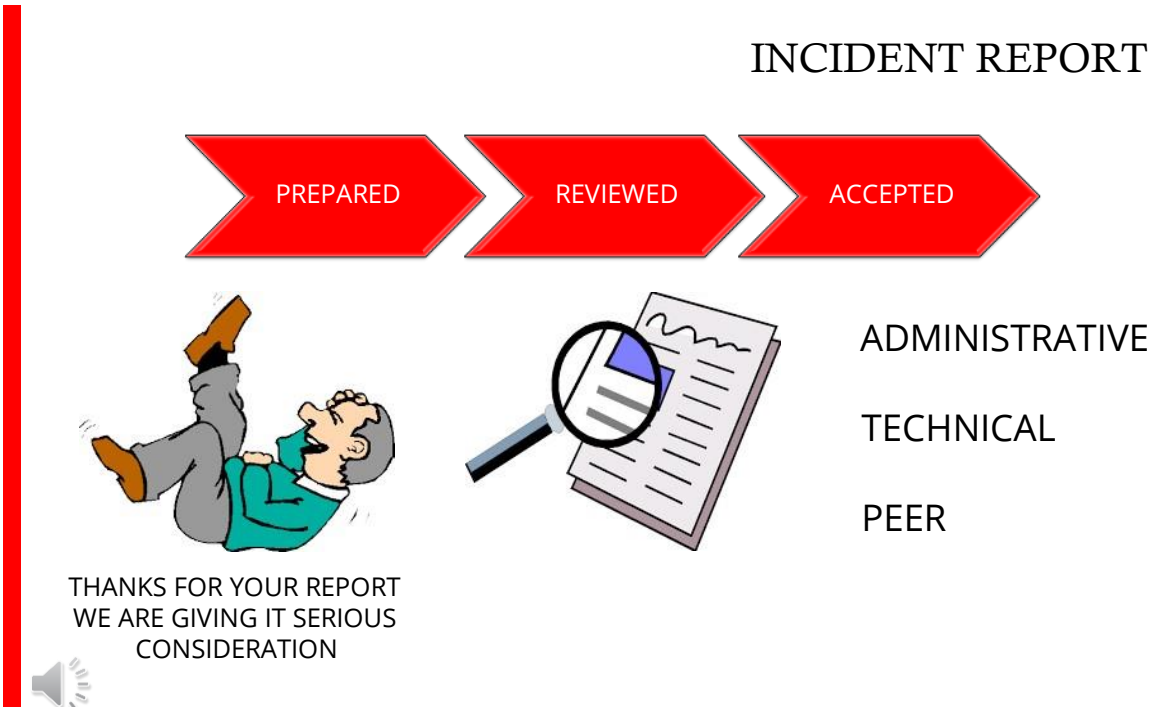

The fire investigation is not complete until the incident report has been prepared, reviewed and accepted. Accurately reporting the investigation findings is as important as any other step in the investigation process. Accuracy and thoroughness can add to the professional acceptance of the investigation.

There are different types of reviews that most incident reports go through. Internally the report may go through administrative, technical and peer reviews

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INCIDENT REPORT

ADMINISTRATIVE REVIEWS	TECHNICAL REVIEW	PEER REVIEW
• IN-HOUSE • MEETS PROCEDURES & FORMATS • SPELLING & GRAMMAR	• CRITIQUES FINDINGS • CHALLENGES DATA • QUESTIONS HYPOTHESIS	• SOMEONE WITH KNOWLEDGE & SKILLS • UN-BIASED • NOT A C0-WORKER

Administrative reviews are generally carried out in-house to ensure the product meets the organization's procedures and format. Administrative reviews also check for things like spelling and grammar but are not concerned with the technical contents of the report.

A technical review of the report critiques the investigator's work and findings. This evaluation is beneficial if it challenges the investigator's data and questions the hypothesis, but may be perceived as bias if the reviewer has a vested interest in the outcome of the investigation.

A peer review is conducted by someone who has the knowledge and skills to evaluate flaws in the process and procedures employed during the investigation. A peer review is unbiased because the reviewer has no interest in the outcome of the report. Objectivity is maintained if the reviewer is not a co-worker or part of the same organization as the investigator and has not been involved in the investigation.

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REPORT REVIEWS

CONDUCTED BY OUTSIDE AGENCIES

PARTIES TO LITIGATION MAY WANT TO REVIEW

CRITICAL REVIEWS

Report reviews can also be conducted by outside agencies. In many cases parties to litigation may want to review the reports but these will usually be performed differently than what was described here. In many cases they are critical reviews performed by people with a vested interest in the outcome of the legal proceeding.

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CHAPTER REVIEWS

- ORIGINS OF THE SCIENTIFIC METHOD
- IMPORTANCE OF REPORTS TO PROJECT PROFESSIONALISM
- RECOGNIZING THE NEED
- DEFINING THE PROBLEM
- COLLECTING DATA
- ANALYZING DATA
- DEVELOPING HYPOTHESES
- TESTING THE HYPOTHESES
- SELECTING THE FINAL HYPOTHESIS

In this chapter we discussed:

- The origins of the scientific method of fire investigation.
- The pitfalls of conclusions reached solely based on the process of elimination.
- The process of conducting investigations using the scientific method.
- The 7 steps involved in the scientific method of fire investigation.

Recognizing the need

Defining the problem

Collecting data

Analyzing the data

Developing hypotheses

Testing the hypotheses

Selecting the final hypothesis

The importance of how to question the hypothesis

Levels of certainty - Probable, Possible and Suspected, and that these levels of certainty do not meet the “Beyond a Reasonable Doubt” criteria required by the criminal courts.

Expectation bias and the pitfalls it can present

The importance of reports that can project the professionalism of the fire investigation.

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END OF CHAPTER 1 – PART 2

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That's the end of **Part 2 of Chapter 1** Methodology **of Fire Investigation**. You are now ready to move on to Chapter **2** which deals with Fire Science **for Fire Investigators** but please complete the quiz for Chapter **1 – Part 2** first.

If you have any questions now is a good time to contact your teacher.