



**Australian Government**

# **PUAFIR606A Apply principles of combustion and fire dynamics to fire scene investigation**

**Release 2**

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### **Modification History**

| <b>Release</b> | <b>TP Version</b> | <b>Comments</b>                        |
|----------------|-------------------|----------------------------------------|
| 2              | PUA12 V2          | Layout adjusted. No changes to content |
| 1              | PUA00 V8.1        | Primary release on TGA                 |

### **Unit Descriptor**

This unit covers the competency required to apply the principles of fire science and fire dynamics to a fire scene investigation. It includes chemistry of combustion, fire physics and behaviour.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of publication.

### **Application of the Unit**

Application of this unit is relevant to the work of a specialist fire investigator.

It focuses on the skills and knowledge required to apply the principles of fire science and fire behaviour when investigating a fire incident.

### **Licensing/Regulatory Information**

Not applicable.

### **Pre-Requisites**

Not applicable.

### **Employability Skills Information**

This unit contains employability skills.

## Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a Unit of Competency.

Performance Criteria describe the required performance needed to demonstrate achievement of the element. Where ***bold italicised*** text is used, further information is detailed in the Range Statement. Assessment of performance is to be consistent with the Evidence Guide.

## Elements and Performance Criteria

| ELEMENT                                                                      | PERFORMANCE CRITERIA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Apply principles of fire chemistry in fire behaviour                      | 1.1 States of matter, changes and impact on combustion are explained<br>1.2 Chemical reactions, basic chemical structures, bonds and energy are defined<br>1.3 Process of chemical reaction and oxidation is explained<br>1.4 Organic and inorganic compounds are distinguished<br>1.5 Hydrocarbons and how they are constructed are explained<br>1.6 Pyrolysis is defined<br>1.7 <b>Chemistry of combustion</b> in solids, liquids and gases is explained<br>1.8 Vapour density and its impact on fire spread is assessed<br>1.9 Different <b>fuel types</b> are identified and fuel loads are assessed<br>1.10 Difference between exothermic and endothermic reactions is explained |
| 2. Demonstrate knowledge of the physics of fire and impact on fire behaviour | 2.1 <b>Methods of heat transfer</b> are explained<br>2.2 <b>Theory of heat release</b> is outlined<br>2.3 Stages of fire development in structures are identified and outlined<br>2.4 <b>Stages of fire development in a compartment</b> are identified and detailed<br>2.5 Concepts of flashover and backdraught, and their signs and symptoms are outlined<br>2.6 Effect of <b>fuel load</b> on fire behaviour is explained<br>2.7 <b>Deflagration and detonation</b> are outlined<br>2.8 <b>Types of ignition</b> are outlined                                                                                                                                                     |

## Required Skills and Knowledge

This describes the essential skills and knowledge and their level, required for this unit.

### Required Skills

- apply scientific methodology to determine fire cause
- apply theory of principles of fire chemistry and physics to develop hypothesis based on fire scene evidence

- identify unrelated fire science evidence (finger prints, forced entry, signs of burglary, tool marks)
- take notes
- undertake a risk analysis of a fire scene including consideration of electrical hazards, hazardous materials, physical hazards and environmental hazards

### **Required Knowledge**

- auto-ignition temperature
- chemistry and properties of flammable and combustible liquids
- chemistry of pyrolysis
- classes of fire
- compartment fire development and fire spread, including flashover and backdraught
- data interpretation
- deflagration
- detonation
- drying oils, chemicals, vegetable matter, friction
- effect of oxygen concentration
- effects of flammable liquids on a fire scene
- expected combustion products of different fuels
- extinguishing theory and methods
- fire gases
- fire point
- flame types (which may include associated temperature ranges, diffused, laminar, pre-mixed, surface, ground and crown wildfires, turbulent)
- flammability limits
- flammable products and gases
- flashpoint
- heat release rate
- ignition energy
- ignition sources
- physics of heat transfer including radiant, convection, conducted and impact of fire spread
- products of combustion (carbonaceous and unburnt pyrolysis products)
- radiant heat flux
- safe work practices
- significance of flashpoint in terms of fire scene
- spontaneous combustion
- types of combustion
- wildfire development (surface, ground and crown fires)
- vapour density

## Evidence Guide

### **Critical aspects for assessment and evidence required to demonstrate competency in this unit**

Assessment must confirm the ability to:

- apply relevant laws, legislation, codes of practice and national standards to fire investigation
- identify and assess ignition sources
- demonstrate understanding of compartment fire behaviour and wildfire behaviour and fire spread at an investigation scene
- assess fuel type and fuel load at investigation scene
- assess impact of vapour density on fire spread
- apply relevant physical and chemical principles to fire investigation
- integrate knowledge of fire chemistry, fire behaviour and science into forming and testing working hypotheses for fire origin and cause
- validate fire investigation conclusions using scientific principles.

### **Consistency in performance**

Competency should be demonstrated across a range of workplace and/or simulated situations.

### **Context of and specific resources for assessment**

#### **Context of assessment**

Competency should be assessed in the workplace and in a simulated workplace environment.

#### **Specific resources for assessment**

Access is required to:

- case studies and workplace scenarios to capture the range of causes likely to occur for which evidence needs to be gathered and managed.

### **Guidance information for assessment**

Assessment methods suitable for valid and reliable assessment of this unit may include a combination of:

- case studies
- demonstration
- observation
- questioning
- scenarios
- authenticated evidence from the workplace.

## Range Statement

The Range Statement relates to the Unit of Competency as a whole. It allows for different work environments and situations that may affect performance. ***Bold italicised*** wording in the Performance Criteria is detailed below.

|                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><i>Chemistry of combustion</i></b> includes:           | <ul style="list-style-type: none"> <li>• Combustion products of common fuels</li> <li>• Fire extinguishment theory</li> <li>• Flammable vapours</li> <li>• Ignition temperatures (flashpoint, fire point, auto-ignition temperature or flame point and explosive limits)</li> <li>• Interrelationship between fuel size, quantity, arrangement, moisture content, weather and topography on wildfire development and behaviour</li> <li>• Non-piloted auto-ignition</li> <li>• Spontaneous combustion (drying oils, chemicals, vegetable matter, friction)</li> <li>• States of matter (solids, liquids, gases)</li> <li>• Toxicity of combustion gases</li> <li>• Types of combustion (incipient, smouldering and flaming)</li> </ul> |
| <b><i>Fuel types</i></b> may include:                     | <ul style="list-style-type: none"> <li>• Class A solid carbonaceous materials</li> <li>• Class B flammable liquids</li> <li>• Class C flammable gases</li> <li>• Class D combustible metals such as sodium, potassium, calcium, magnesium, aluminium dust, zinc dust, titanium dust</li> <li>• Class E fires involving energised electrical equipment</li> <li>• Class F fires involving cooking oil and fat</li> <li>• Sclerophyll, grass, scrub and pine fuels in wildfires</li> </ul>                                                                                                                                                                                                                                               |
| <b><i>Methods of heat transfer</i></b> include:           | <ul style="list-style-type: none"> <li>• Conduction</li> <li>• Convection</li> <li>• Direct flame impingement</li> <li>• Radiation</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b><i>Theory of heat release</i></b> includes:            | <ul style="list-style-type: none"> <li>• Heat flux</li> <li>• Heat release rate</li> <li>• Temperature</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b><i>Stages of fire development in a compartment</i></b> | <ul style="list-style-type: none"> <li>• Ignition</li> <li>• Growth</li> <li>• Flashover</li> <li>• Fully developed</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

|                                                        |                                                                                                                                                                               |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                        | <ul style="list-style-type: none"><li>• Decay</li></ul>                                                                                                                       |
| <b><i>Fuel load</i></b> may include:                   | <ul style="list-style-type: none"><li>• Arrangement</li><li>• Moisture content</li><li>• Quantity</li><li>• Type</li></ul>                                                    |
| <b><i>Deflagration and detonation</i></b> may include: | <ul style="list-style-type: none"><li>• Dust and vapour explosion</li><li>• Mechanical explosion</li><li>• Solid explosion</li></ul>                                          |
| <b><i>Types of ignition</i></b> may include:           | <ul style="list-style-type: none"><li>• Chemical/reaction</li><li>• Friction/mechanical</li><li>• Flame/heat</li><li>• Self ignition</li><li>• Spark/arc/electrical</li></ul> |

## Unit Sector(s)

Not applicable.