Boiler Operations Accreditation Scheme

Learning Outcomes

(Version 10, July 2020)

Combustion Engineering Association

CEA
Combustion Engineering Association

CEA TG02 Boiler Operations Accreditation Scheme
Learning Outcomes
published by the Combustion Engineering Association July 2020

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Introduction

This document CEA TG02 is an appendix to the BOAS Handbook and contains the Leaning Outcomes for each of the different BOAS Categories of certification. It has the same status as the BOAS Handbook TG01 and will be kept up to date with changes to Legislation and boiler house best practice advice.

In case of any questions arising from the use of this material, please contact the CEA directly.

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Layout and organisation of BOAS Learning Outcomes

Over the many years of the BOAS scheme being available, several significant changes have been made, the most recent of these being the complete overhaul and review of the Learning Outcomes (LO).

Different BOAS Categories as they developed over the years had slightly different LO arrangements and layouts, but they were essentially addressing the same issues and outcomes. Common themes such as Health and Safety matters, environmental legislation, combustion principles, energy efficiency and fuels were all covered in similar ways, but with slight differences.

A major review in the first half of 2020 led to this new LO arrangement being created. It essentially still follows the list of training requirements laid down in

BG01 (Safe Operation of Steam Boilers)
BG02 (Safe Operation of Hot Water boilers)
BG11 (Safe Operation of Water Tube boilers)

but now split into 5 sections:

- Common themes for Operators and Managers across all Categories, sections 1-5;
- Category 1 specific themes – Hot Water Boilers sections 6-10;
- Category 2 specific themes – Fire tube steam Boilers sections 6-10;
- Category 3 specific themes – Water Tube Boilers sections 6-10;
- Category 5 specific themes – Coil type steam generators sections 6-10.

Fuel choice

Traditionally, BOAS has concentrated on conventional fossil fuels such as natural gas and oil, and these are still the predominant fuels in use today in the UK. There are, however, increasing numbers of plants using biogas, biomass, municipal waste and other solid fuels in all Categories of BOAS, especially in Energy from Waste (EfW) plants in Cat 3, and BOAS includes an element of training and assessment for solid fuel utilisation. This is covered in Annex 11, located at the end of Appendix 1.

Candidates who operate plant burning solid fuels must tell the Training Provider on their application form so that the correct Training session can be delivered, the correct Assessor can be assigned to the assessment, and the candidate can be awarded the correct endorsement to their BOAS certificate.

International BOAS (IBOAS)

For Cat 4, International BOAS (IBOAS) the Learning Outcomes are the same as for the relevant boiler Category above, but candidates will be examined on the technical contents of the relevant BG guidance note and will not be expected to know UK legislation.

In instances where the BOAS course is taught and examined in locations outside the United Kingdom it is recognised that certain parts of the syllabus as written, such as applicable United Kingdom legislation, may be inappropriate. In these instances the Training Provider shall offer IBOAS as an alternative. Any resulting changes must then be approved in writing

and in advance of the training by the examining body to ensure consistency of the taught material, examinations and examination standards; the examining body cannot modify the papers or the marking scheme on an ad hoc basis. The CEA shall be kept informed, in writing and in advance, of all changes and agreements. The CEA will have final approval of any changes, taking into account the recommendation(s) of the examining body.

The Assessors shall be adequately briefed of any changes and it is the responsibility of the examining body to ensure that this is performed. Any associated charges to be levied by the examining body, oral examiner(s) and the CEA for the preparation of such courses, together with payment terms, shall also be agreed in advance and in writing between the candidate's employer, the Training Provider, and the CEA.

Examination objectives:

Candidates are expected to be able to answer both written and oral questions based on the Learning Outcomes. The key objectives for each module are stated in this document and it is expected that they will form the core of the examination papers; although questions may be drawn from any part of the Learning Outcomes. Candidates are additionally expected to be able to relate the course to the plant at which they are working during the oral examination; it is not expected that this element will form part of the written questions.

Legend

In the tables below:

O = Operator requirements – things an operator and a manager of industrial hot water boilers should know and be able to discuss with an assessor.

M = Manager additional requirements – additional things a manager of industrial hot water boiler plant should know and be able to discuss with an assessor. Operators should be aware of these issues but will not be examined or assessed on them.

Appendix 1 – Common themes for Operators and Managers across all Categories

Special note – the notation '5O' relates to Learning Outcomes that are common themes only relevant to Operation of Coil Type Steam generators (Cat 5).

Section 1 – Safety & Legal

1	1		Be able to define the principal safety responsibilities of employers and employees, and understand the health and safety reporting procedure for the boiler house being operated, and compare to best practice.		
1	1.1		Describe an employee's principal responsibilities under HASAWA 1974 and subsidiary legislation	O	5O
1	1.2		Describe an employer's responsibilities under HASAWA 1974 and subsidiary legislation	O	5O
1	1.3		Describe the requirements of the Factories Act 1961 applicable to steam and pressurised hot water generating plant.	M	
1	1.4		Outline the process of performing risk assessments and their scope and frequency when applied to their installation	O	
1	1.5		Describe the health and safety reporting procedure for the boiler house being operated	O	5O
1	1.6		Compare the site operating procedures to best practice	O	5O
1	1.7		Explain where statutory and other legal advice and guidance may be found	O	5O
1	1.8		Explain the special legal status of an "Approved Code of Practice" (ACoP)	M	
1	1.9		Explain the requirements of Pressure Equipment Regulations (PER)	M	
1	1.10		Explain the requirements of the Pressure Systems Safety Regulations (2000) (PSSR) and how they are applied to the candidate's boiler operations.	M	
1	1.11		With respect to the PSSR, explain the meaning of the following terms:	O	
1	1.11	a)	what is meant by the term "Competent Person"	O	
1	1.11	b)	what is meant by the term "User / Owner"	O	
1	1.11	c)	what is meant by the terms "Written Scheme of Examination" (WSE) and "examination in accordance with a WSE"	O	
1	1.11	d)	what is meant by the term "imminent danger"	O	
1	1.12		Understand the importance of having pressure equipment inspected in accordance with a WSE under the PSSR	O	
1	1.13		Describe typical defects likely to be found as a result of examinations of pressure equipment such as boilers and generators	O	
1	1.14		State what action is to be taken if the Competent Person is of the opinion that the pressure system under examination will give rise to imminent danger	O	
1	1.15		State the actions that should be taken in response to the recommendations from the examination report	M	

1	1.16		Explain the requirements of the Reporting of Industrial Diseases and Dangerous Occurrence Regulations (RIDDOR) and how they are applied to the candidate's boiler operations	M	
1	1.17		Explain the term “Dangerous Occurrence” in the context of RIDDOR	O	
1	1.18		Describe under what circumstances an accident or Dangerous Occurrence should be reported and by whom.	O	
1	2		Know the principal waterside hazards and causal factors associated with industrial boilers and generators resulting from their operation.		
1	2.1		Explain the causes and effects of:		
1	2.1	a)	uncontrolled release of stored energy resulting from excess pressure	O	5O
1	2.1	b)	uncontrolled release of stored energy resulting from loss of water	O	
1	2.1	c)	uncontrolled release of stored energy resulting from deposition e.g. scale on the waterside of a boiler	O	
1	2.1	d)	flash steam caused by a sudden release of water at elevated pressure and temperature	O	5O
1	2.1	e)	flash steam caused by a cold fluid contacting a hot surface	O	5O
1	2.1	f)	excessive exhaust temperature in a boiler as an indicator of impending failure of the pressure envelope	O	5O
1	2.1	g)	excessive differential thermal expansion as a causal factor of the failure of the pressure envelope of a boiler	O	
1	2.1	h)	fatigue as a causal factor of the failure of the pressure envelope of a boiler or unfired pressure vessel	O	
1	2.1	i)	Excessive steam temperature: unexpected superheat, excessive superheat	O	5O
1	2.2		Be able to propose appropriate control measures for the principal hazards associated with the operation of industrial boilers	O	5O
1	2.3		State actions to be taken in the event of a dangerous occurrence or accident	O	5O
1	2.4		Outline the fundamental safety requirements applicable to industrial boiler houses and the consequences of failing to follow procedures in relation to:	O	5O
1	2.4	a)	Work at height	O	5O
1	2.4	b)	Slips and trips	O	5O
1	2.4	c)	Fuel storage and isolation	O	5O
1	2.4	d)	Electrical isolation	O	5O
1	2.4	e)	Safe systems of work in relation to plant normally at elevated pressure and temperature	O	5O
1	2.4	f)	The handling of chemicals	O	5O
1	2.4	g)	Ventilation to the boiler house	O	5O
1	2.4	h)	Confined spaces	O	5O
1	2.4	i)	Good housekeeping	O	5O
1	2.4	j)	Provision of adequate escape routes from a place of work	O	5O
1	2.4	k)	Pipe work and surfaces at elevated temperature	O	5O
1	2.4	l)	Thermal expansion of pipe work and the negative consequences of accommodating it incorrectly	M	
1	2.5		Describe the hazards associated with asbestos, the need to report it and the need for special training for persons working with asbestos	O	5O
1	2.6		Relate risk assessments, method statements and permits to work to the candidate's own plant	O	5O

1	2.7		Describe the hazards associated with leaks of fuel, exhaust gas, pressurised hot water and steam (saturated or superheated), the action taken to prevent injury to personnel in event of such a leak.	O	5O
1	2.8		Explain how the location of a boiler house affects its risk profile.	M	
1	3		Know the concepts underpinning general HSE guidance documents and British Standards to the candidate's work activities (this should be appropriate to the candidate's role and responsibility) and describe how they may be used.		
1	3.1		Show appropriate working knowledge of guidance applicable to boiler houses, such as:		
1	3.1	a)	HSG253 (The safe isolation of plant and equipment)	O	
1	3.1	b)	INDG436 (Safe management of industrial steam and hot water boilers)	O	
1	3.1	c)	HSG250 (Guidance on permit to work systems)	O	
1	3.1	d)	BS2486 (Treatment of water for steam boilers and water heaters)	O	
1	3.1	e)	BG guidance series	O	
1	3.2		Describe how HSE (and other) guidance documents may be used and quote their legal status	M	
1	3.3		Discuss the effect of de-manning on boiler plant operation and implications of the substitution of manning by instrumentation	M	
1	3.4		Discuss the limitations of the use of advice documents e.g. BG series for design and specification	M	
1	3.5		Explain the reasons for having written procedures	M	
1	4		Know the methods for preparing boilers and associated equipment for maintenance or other work such as statutory examination (in accordance with the PSSR)		
1	4.1		Explain the need for permits to work and the process for issuing a permit for work	O	
1	4.2		Explain the need for isolating equipment to be worked on	O	
1	4.3		Explain the isolations typically required and the precautions to be taken when isolating equipment	O	
1	4.4		Describe methods of isolation compliant with HSG253.	M	
1	4.5		State which boiler fittings and mountings are usually removed for inspections	M	
1	5		Know importance of logging observations, particularly defects, and understand the legal significance of omission of action with regard to safety related faults.		
1	5.1		Demonstrate understanding and importance of routine logs	O	5O
1	5.2		Give practical examples of items to be logged relating to industrial boiler / steam generator operations	O	5O
1	5.2	a)	Identity of operators	O	5O
1	5.2	b)	Daily routines	O	5O
1	5.2	c)	Weekly routines	O	5O
1	5.2	d)	Water treatment reports	O	5O
1	5.2	e)	Meter readings	O	5O
1	5.2	f)	Faults and alarms	O	5O
1	5.2	g)	Maintenance items	O	5O

1	5.2	h)	Works undertaken by external contractors	O	5O
1	5.2	i)	Observations, abnormal conditions and faults	O	5O
1	5.3		Explain the need for calibration of instrumentation and equipment used for test purposes.	O	5O
1	5.4		Give practical examples of conditions and equipment states that would be considered abnormal:	O	5O
1	5.4	a)	loss of fuel supply	O	5O
1	5.4	b)	loss of electrical supply	O	5O
1	5.4	c)	loss of water supply	O	5O
1	5.5		Discuss hazards that might result from a failure to address abnormal conditions	O	5O
1	5.6		Describe the actions to be taken for abnormal conditions	O	5O
1	6		Understand the importance of boiler protective devices and alarm systems and describe how alarms arise and are actioned.		
1	6.1		Explain the difference between a cut out device and a limiting device.	O	5O
1	6.2		Explain the meaning of the term “lockout” and who should attend plant that is in a lock out condition.	O	5O
1	6.3		Explain the meaning of the term “fail safe”	M	
1	6.4		Describe the main functions of protective devices and industrial alarm systems fitted to hot water or steam generation plant, ancillary equipment and distribution systems.	O	5O
1	6.4	a)	Low water limiter	O	5O
1	6.4	b)	High water limiter	O	5O
1	6.4	c)	Low pressure limiter	O	5O
1	6.4	d)	High pressure limiter	O	5O
1	6.4	e)	Safety valve	O	5O
1	6.4	f)	Low temperature limiter	O	5O
1	6.4	g)	High temperature limiter	O	5O
1	6.4	h)	Flow limiter	O	5O
1	6.4	i)	Burner lockout systems	O	5O
1	6.4	j)	Fire alarms	O	5O
1	6.4	k)	Gas alarms	O	5O
1	6.4	l)	Water quality alarm(s)	O	5O
1	6.5		Explain the requirements for calibration and certification of protective devices	O	5O
1	6.6		Describe the reasons why protective devices might fail to operate on demand.	O	5O
1	6.7		Describe the action(s) to be taken in the event of a failure of the protective devices fitted to a boiler or other relevant plant	O	5O
1	6.8		Describe the checks needed to confirm that automatic controls and protective devices have responded as intended	O	5O
1	6.9		Discuss the actions and precautions to be taken when responding to abnormal and alarm conditions	O	5O
1	6.10		Explain the necessity for responding promptly to alarm conditions	O	5O
1	6.11		Describe the actions to be taken and the on-site procedures to be followed in response to an alarm, both for the alarms fitted to the boiler and other alarms at the site and near misses (Dangerous Occurrences)	O	5O

1	6.12		Describe the alarm systems installed at the place of work, how frequently they are tested, and the test methods.	O	5O
1	6.13		Describe the procedures to be followed if the alarm systems are faulty or not to the current required standards	O	5O
1	7		Be able to describe in general and particular terms how oversight is exercised.		
1	7.1		Describe how staff competencies are assessed and maintained	O	
1	7.2		Explain how training and competence impacts professional responsibility	O	
1	7.3		Describe the need for and methods of exercising change management	M	
1	7.4		Describe the procedures to be followed in the event of equipment or the manning levels being changed	M	
1	7.5		Describe how plant is assessed in relation to safety, legislative compliance and its effective operation	M	

Section 2 – Fuel concepts

2	0	*NB: It is not intended that a boiler Operator or Manager should perform work on a fuel or combustion system; such work is the duty of an appropriately trained and competent person. The intended scope of this training syllabus is to ensure that a trained boiler Operator or Manager has a basic understanding of fuel and combustion safety, can operate their plant safely, recognise abnormal or unsafe conditions and take appropriate action(s). See Annex – section 11 for more information on solid fuels.*			
2	1		Know the relevant legislation relating to fuels used boilers		
2	1.1		State the legislation relating to fuels and combustion:	M	
2	1.1	a)	Natural Gas (Gas Safety Installation and Use) Regulations	M	
2	1.1	b)	Fuel oils (Sulphur Content of Liquid Fuels Regulations)	M	
2	1.2		Explain the meaning of the term “Gas Safe Register”	O	
2	1.3		Explain the requirements of the Factories Act 1961 in the context of who may work on plant located in a factory	O	
2	1.4		Explain the requirement for line diagrams of gas supply systems	O	
2	1.5		Explain where other legislation and guidance may be found	M	
2	2		Be able to list the principal characteristics of each fuel		
2	2.1		Explain the fundamental principles of fuel characterisation:		
2	2.1	a)	Calorific Value, nett and gross	M	
2	2.1	b)	Principle of flammability limits of fuel air mixtures	M	
2	2.1	c)	State the meaning and importance of ignition temperature of different fuel / air mixtures	M	
2	2.2		Relate specific characteristics to certain fuels:	O	
2	2.2	a)	Density of natural gas relative to air	O	
2	2.2	b)	Density of LPG relative to air	O	
2	2.2	c)	Flammability limits of natural gas	O	
2	2.2	d)	Flammability limits of LPG	O	
2	2.2	e)	Viscosity of liquid fuels	O	
2	2.3		Explain the effect of temperature on liquid fuels	O	
2	2.4		Explain the use of heating of liquid fuel stores and trace heating of fuel lines for residual grades of fuel oil	O	
2	2.5		Explain the importance of ensuring that the correct grade / type of liquid or solid fuel is used	O	

2	2.6		Explain how sulphur in oil is controlled by the Sulphur Content of Liquid Fuels Regulations	M	
2	3		Be able to describe the methods required for storing fuels		
2	3.1		Describe how common fuels are safely delivered and stored:	O	5O
2	3.1	a)	Gas networks and regulators	O	5O
2	3.1	b)	Oil storage and bunding - OFTEC BS5410	O	5O
2	3.1	c)	Gas tanks and gas cylinders (including safe separation)	O	5O
2	3.2		Understand the meaning of the term “auto ignition”	O	
2	4		Be able to explain the principal dangers to be guarded against when storing and using fuels, and the safe handling procedures necessary for a particular fuel		
2	4.1		Explain the environmental and safety risks associated with storing fuels on site:	O	
2	4.1	a)	Provision of leak detection and alarm systems	O	
2	4.1	b)	Location of oil tanks on a site	O	
2	4.1	c)	Location of gas and LPG cylinders at a boiler house	O	
2	4.2		Explain precautions to be taken when deliveries of liquid fuels (or gaseous such as LPG / CNG) occur	O	
2	4.3		Discuss safe handling techniques for fuels used on their sites	O	
2	5		Be able to describe fuel measurement techniques		
2	5.1		Describe how different fuels are measured in order to provide accurate data for efficiency calculations:	M	
2	5.1	a)	Natural gas metering, temperature and pressure correction	M	
2	5.1	b)	Oil deliveries and metering, strapping and ‘dipping’ tanks	M	

Section 3 – Draught and combustion

3	1		Be able to state the elementary principles of combustion and the basic chemical reactions in combustion of fuel		
3	1.1		State the basic requirements for combustion: fuel, oxidant and source of ignition	O	5O
3	1.2		Describe the composition of air in simple terms	O	5O
3	1.3		Give a simple explanation of forced draught systems	O	5O
3	1.4		Give a simple explanation of induced and balanced draught systems	M	
3	1.5		Explain the consequences of deficiency of air (rich combustion), and its effect on combustion and heat transfer – understand where in a furnace rich combustion may deliberately take place and why.	O	
3	1.6		Describe the factors which affect the exhaust temperature of a boiler	O	
3	1.7	a)	Discuss the reasons for adequate ventilation of boiler houses	O	
3	1.7	b)	Explain the potential consequences of inadequate ventilation	O	
3	1.8		Describe different forced ventilation systems and the consequences of failure of these systems	M	
3	1.9		Explain the meaning of “excess air”	O	
3	1.10		Describe the principles of primary, secondary and tertiary air	M	
3	1.11		Discuss the principles and advantages of preheated combustion air	M	
3	1.12		Explain the interpretation of CO_2 or O_2 as a measure of excess air	M	

3	1.13		Explain the use of (and need for calibration) of exhaust gas analysers	M	
3	1.14		Describe typical levels of oxygen and carbon dioxide in a boiler exhaust for their own installation	O	
3	1.15		Explain the consequences of too much and too little excess air (lean and rich combustion)	O	
3	1.16		Explain the purpose and benefits of oxygen trim systems	O	
3	1.17		Describe indicators of poor combustion (sensory or by instrument)	O	
3	1.18		Explain the causes and effects of fouling of the combustion side of a boiler	O	
3	1.19		Explain the reasons for and consequences of flame impingement.	O	
3	1.20		Discuss the importance of flame stability and change in flame pattern with turndown.	O	
3	1.21		Discuss the necessity for regular flame inspection and action(s) to be taken when abnormal conditions are observed.	O	5O
3	1.22		Describe the precautions to be taken when inspecting the flame	O	5O
3	1.23		Discuss the benefits of dual fuel burners	M	
3	1.24		Discuss the frequency of testing secondary fuels	O	
3	1.25		Explain the required qualifications for workers or contractors with specific relation to fuel systems and burners	O	
3	1.26		Explain why combustion plant needs to be maintained in accordance with the manufacturer's instructions.	O	
3	2		Understand the principles of operation of different burner types		
3	2.1		Explain the importance of pre-purge and post purge	O	5O
3	2.2		Explain the hazards associated with unqualified operation and adjustment of burners	O	5O
3	2.3		Explain the actions to be taken when a burner fails to fire	O	5O
3	2.4		Explain the reasons for formation of carbon monoxide	O	5O
3	2.5		Explain the principles of operation of pressure jet and rotary cup burner	M	
3	2.6		Explain what is meant by cycling, modulation and turndown, and how these affect efficiency	M	
3	2.7		Explain the fundamental concepts of low NOx burners	M	
3	2.8		Explain in simple terms different burner control systems and features which enhance fuel efficiency	M	
3	2.9		Explain the need for cleaning the cup on a rotary cup burner and the reasons why burner / site specific training is needed.	O	
3	3		Be able to state the significant safety hazards relating to combustion		
3	3.1		Describe the risks associated with:		
3	3.1	a)	effects of carbon monoxide poisoning	O	5O
3	3.1	b)	effects of exhaust gas poisoning	O	5O
3	3.1	c)	fuel leaks, with consequent risk of fire or explosion	O	5O
3	3.1	d)	failure of purge cycle	O	5O
3	3.1	e)	back burn	O	
3	3.1	f)	fireside explosion	O	5O
3	3.1	g)	poor combustion	O	5O
3	3.1	h)	interlock failure e.g. flue dampers / forced ventilation systems	O	5O

3	3.2		Discuss the provision and uses of safety devices and techniques such as:		
3	3.2	a)	flame failure devices	O	
3	3.2	b)	safety interlocks for fuel and ventilation	O	
3	3.2	c)	slam-shut valves	O	
3	3.2	d)	fusible links	O	
3	3.2	e)	fire detectors	O	
3	3.2	f)	smoke alarms	O	
3	3.2	g)	carbon monoxide detectors	O	
3	3.2	h)	flammable gas detectors	O	
3	3.2	i)	air purge (post & pre firing)	O	
3	3.2	j)	fuel proving	O	
3	3.2	k)	air proving	O	
3	3.2	l)	Emergency 'stop' location	O	
3	3.2	m)	Emergency Control Valves (gas installations)	O	
3	3.3		Be able to describe the main safety features of the boiler house at their site	O	
3	4		Be able to describe the combustion system in use at their own plant and the main features of this system		
3	4.1		Describe the combustion equipment at their plant	O	
3	4.2		Describe the main products of combustion and pollutants arising from their plant	O	
3	4.3		Describe the safety systems in place to prevent incidents relating to combustion issues at their plant	O	
3	4.4		Describe the typical readings they get from combustion analysis at their plant, and how those readings are obtained	M	
3	5		Be able to explain how chimneys work.		
3	5.1		Explain the importance of visual inspection of the chimney exhaust especially its integrity, smoke and the significance of 'pluming' during normal operation	O	5O
3	5.2		Describe different types of chimney and their materials of construction	M	
3	5.3		Explain the functions of a chimney, the conditions affecting draught and the control of draught	M	
3	5.4		Explain how draught is affected by chimney dimensions and temperature of gases	M	
3	5.5		Explain the term "differential pressure" in the context of draught	M	
3	5.6		Describe how differential pressure is measured	M	
3	5.7		Explain how the products of combustion may adversely affect a chimney	M	
3	5.8		Explain why materials for construction of flues / chimneys are important when using an economiser, condensing boiler or conditions where low temperatures may occur in an exhaust.	O	
3	6		Describe the various products of combustion and pollutants that can be produced by gas and oil fired boilers.		
3	6.1		List the main products of combustion from different fuels and the significant pollutants produced by each:	O	
3	6.1	a)	carbon dioxide	O	
3	6.1	b)	water	O	
3	6.1	c)	carbon monoxide	O	
3	6.1	d)	oxides of nitrogen (NOx)	O	

3	6.1	e)	oxides of sulphur (SOx)	O	
3	6.1	f)	dust / smoke / particulates	O	
3	6.1	g)	persistent organic pollutants (POP)	O	
3	7		Be able to discuss dew point and acid dew point		
3	7.1		Be able to explain the term dew point in relation to a boiler	O	
3	7.2		Be able to explain the term acid dew point in relation to a boiler	O	
3	7.3		Explain the effect of dew point on corrosion in exhausts and chimneys	O	
3	7.4		Explain the effect of acid dew point on corrosion in exhausts and chimneys	O	

Section 4 – Environment

4	1		Be able to identify relevant emissions legislation for boiler houses		
4	1.1		State the major legislation in the UK and EU for managing and controlling emissions from boiler plant	M	
4	1.1	a)	Clean Air Act	M	
4	1.1	b)	The Environmental Permitting (England and Wales) Regulations 2010	M	
4	1.1	c)	Pollution Prevention and Control (Scotland), Regulations 2000	M	
4	1.1	d)	The Pollution Prevention and Control Regulations (Northern Ireland) 2003	M	
4	1.1	e)	The Industrial Emissions Directive (2010/75/EU)	M	
4	1.1	f)	Large Combustion Plant Directive (LCPD, 2001/80/EC)	M	
4	1.1	g)	The 2013 non domestic building services compliance guide.	M	
4	1.1	h)	The Medium Combustion Plants Directive (2015/2193)	M	
4	1.2		Discuss legislation relevant to the candidate's own site.	M	
4	2		Be able to describe the causes and effects of air pollution from boiler houses		
4	2.1		Be able to show how emissions to air from boiler houses are measured and controlled	M	
4	2.2		Identify suitable equipment for taking a range of typical emissions measurements	M	
4	2.3		Describe the importance of calibration routines and consistent measurement techniques	M	
4	2.4		Explain the definition of dark smoke	O	
4	2.5		Explain the use of a Ringelmann chart and list the allowable exceptions for the emission of dark smoke	M	
4	3		Explain the fundamental dangers to human health of each of these major pollutants	O	
4	3.1	a)	NOx	O	
4	3.1	b)	SOx	O	
4	3.1	c)	Dust / smoke / soot	O	
4	3.1	d)	POP's	O	
4	3.1	e)	CO	O	
4	3.1	f)	CO_2	O	

4	4		Explain the fundamental dangers to the environment of each of the major pollutants above and the reasons for limiting emissions with respect to:	O	
4	4.1	a)	corrosion	O	
4	4.1	b)	acid rain	O	
4	4.1	c)	smog	O	
4	4.1	d)	climate change	O	
4	4.1	e)	greenhouse gases	O	
4	4.2		convert specific fuel consumption into CO_2 output	M	
4	4.3		Describe benefits of economical operation with respect to CO_2 and other emissions	M	
4	5		Know the main sources of other emissions from boiler houses and how they are managed		
4	5.1		Describe other sources of emissions from boiler houses:	M	
4	5.1	a)	Noise	M	
4	5.1	b)	Odours	M	
4	5.1	c)	Light pollution	M	
4	5.1	d)	Smoke	M	
4	5.1	e)	Fugitive emissions	M	
4	5.2		Describe means for controlling, minimising or eliminating these sources of emissions	M	
4	6		Know the main sources of waste arising from boiler houses and how they are managed		
4	6.1		Describe the sources of waste arising from a boiler house	O	5O
4	6.1	a)	Waste water flue gas condensate from flue / chimneys	O	
4	6.1	b)	Waste chemicals	O	5O
4	6.1	c)	Waste fuels	O	5O
4	6.1	d)	General and other rubbish	O	5O
4	6.2		Describe means for safe disposal, and minimising or eliminating these sources of waste	O	5O

Section 5 – Energy efficiency

5	1		Understand the fundamental concepts of boiler house efficiency	
5	1.1		Describe and compare what is meant by:	M
5	1.1	a)	combustion efficiency	M
5	1.1	b)	thermal efficiency	M
5	1.1	c)	plant efficiency	M
5	1.1	d)	direct and indirect efficiency calculations	M
5	1.2		State what indications there may be of a reduction in boiler efficiency	O
5	1.3		State what indications there may be of a reduction in plant efficiency	O
5	1.4		Describe simple checks and measures that may be undertaken to maintain boiler plant efficiency	O
5	1.5		Discuss the costs and efficiencies of different fuel types	M
5	1.6		Discuss the impact of poor operating regimes (all forms) on the efficiency of plant and its consequent operating costs.	M
5	2		Understand the principles of measuring boiler house efficiency	
5	2.1		Describe how visual observations can be employed to ensure that plant is being operated efficiently	O
5	2.2		Show how installed instruments can be used to maintain efficient operation	M
5	2.3		Describe the instruments provided at the place of work which may be used to determine overall boiler house efficiency	M
5	3		Be able to calculate boiler house efficiency in simple terms	
5	3.1		Take the measurements required to calculate a figure for direct and indirect efficiencies for boilers	M
5	3.2		Demonstrate an understanding of the importance of evaluation of trends in boiler house measurements	M
5	4		Know a variety of techniques that can be used to improve boiler house and generation efficiency	
5	4.1		Describe common energy recovery and energy saving features and techniques found in boiler houses:	
5	4.1	a)	economisers	M
5	4.1	b)	condensing technology	M
5	4.1	c)	air preheaters	M
5	4.1	d)	turndown ratios	M
5	4.1	e)	flue dampers	M
5	4.1	f)	correct chemical dosing	M

Section Annex – Solid fuels – many Category 3 courses and any Category 1 & 2 courses where solid fuels are used

Training Providers that do not offer any courses that require the assessment of solid fuel elements do not need to produce training materials for the topics covered in this annex.

11	1		Know the main characteristics of solid fuels	
11	1.1		State the main types of fuel and their characteristics	
11	1.1	a)	coal (different grades)	O
11	1.1	b)	wood chip	O
11	1.1	c)	wood pellet	O
11	1.1	d)	straw	O
11	1.1	e)	refuse derived fuel	O
11	1.1	f)	site specific fuels on a general basis	O
11	1.2		Explain the properties of the above fuels:	O
11	1.2	a)	calorific value	O
11	1.2	b)	water content of solid fuels and its variation	O
11	1.2	c)	Explain the impact of fluctuations in calorific value in a non-homogenous fuel	O
11	1.2	d)	Explain how moisture content of fuels impacts on its combustion and any additional steps necessary to burn fuels with high moisture content.	O
11	1.2	e)	variation of composition	O
11	1.3		Heterogeneity of solid fuels	O
11	1.4		Discuss the specific fuel fired at the candidate's site	O
11			Know the main hazards associated with solid fuels	
11	2.1		Discuss the hazards associated with:	
11	2.1	a)	dust explosion due to fuel degradation and over handling	O
11	2.1	b)	fire	O
11	2.1	c)	auto-ignition during storage	O
11	2.1	d)	digestion during storage (bio-mass fuels)	O
11	2.1	e)	generation and emission of toxic and flammable gases during storage	O
11	2.1	f)	inhalation of dusts and particulates emanating from solid fuels	O
11	2.1	g)	explosion caused by the addition of volatile agents to hot fuel	O
11	2.1	h)	risk of burn back from furnace into feed system	O
11	2.1	i)	machinery with moving parts	O
11	2.2		Discuss the hazards and control measures associated with the specific fuel fired at the candidate's site.	O
11	3		Explain the requirements for fuel delivery, storage and handling.	
11	3.1		Precautions to be observed during fuel deliveries and fuel handling	O
11	3.1	a)	Special handling requirements for friable bio-mass fuels	O
11	3.1	b)	Special requirements for municipal waste fuels	O
11	3.1	c)	types of bunkers and receivers for different types of solid fuel	O
11	3.1	d)	types of handling systems for different types of solid fuel	O
11	3.1	e)	Special considerations for long term storage.	O

11	3.2		Fuel isolation systems	O
11	3.3		Fire detection and suppression systems (boiler house and fuel handling systems).	O
11	3.4		Carbon monoxide and carbon dioxide detection systems in the boiler house and fuel storage areas.	O
11	3.5		Considerations with respect to fuel stores which may constitute an enclosed space.	O
11	3.6		Discuss the fuel delivery, storage and handling systems at the candidate's site.	O
11	4		Know types of combustion equipment and characteristics of combustion specific to solid fuels	
11	4.1		Discuss types of combustion system	O
11	4.1	a)	Fuel transfer system from storage to combustion	O
11	4.1	b)	Ignition systems	O
11	4.1	c)	Primary, secondary and tertiary air	O
11	4.1	d)	Draught control.	O
11	4.1	e)	Determination of completeness of combustion.	O
11	4.1	f)	Bottom ash removal systems.	O
11	4.1	g)	Fly ash removal systems.	O
11	4.1	h)	Give a simple explanation of how and why furnace pressure is maintained below atmospheric pressure where an induced draught fan is fitted	O
11	4.2		Discuss the combustion equipment installed at the candidate's site.	O
11	4.3		Explain the operating characteristics of solid fuel combustion equipment:	
11	4.3	a)	effect of poor fuel quality on combustion.	O
11	4.3	b)	ignition delay	O
11	4.3	c)	response to changes in steam load	O
11	4.3	d)	turndown	O
11	4.3	e)	sinking time	O
11	4.3	f)	application of solid fuel fired boilers to base load in combination with liquid / gaseous fuel boilers applied to transient load.	M
11	4.3	g)	necessity for and frequency of cleaning of boiler heating surfaces, flues and chimneys	O
11	4.3	h)	frequency of planned cleaning maintenance. Specifics of planned maintenance.	O
11	4.3	i)	redundancy requirements	O
11	4.3	j)	comparison with liquid and gaseous fuel fired boilers of equivalent rating	O
11	4.4		discuss the operating characteristics of the combustion equipment installed at the candidate's site.	O
11	5		Explain the emissions and waste profile of solid fuelled boilers	O
11	5.1	a)	Requirements for disposal of ash and other waste products.	O
11	5.1	b)	smoke / soot / dust	O
11	5.1	c)	Dust and particulates	O
11	5.1	d)	heavy metals	O
11	5.1	e)	Persistent Organic Pollutants (POP's),	O
11	5.1	f)	typical levels of carbon monoxide in the exhaust	O
11	5.1	g)	changes in emissions due to change in fuel grade / type.	O
11	5.1	h)	Any other emissions resulting from the burning of waste material	O
11	5.1	i)	Ash and other incombustibles	O

11	5.2		Discuss different methods of reducing emissions (all types of emissions)	M
11	5.3		Discuss the emissions and waste profile of the candidate's own site	O
11	6		Explain legal considerations specific to solid fuelled boilers and sources of specific guidance	O
11	6.1		Health and safety in biomass systems, design and operation guide (BG05 – a CEA publication)	O
11	6.2		HSE bulletin OPSTD 3-2012, risk of carbon monoxide release during the storage of wood pellets	O
11	6.3		requirements for burning "waste" as defined by the Waste Incineration Directive	O
11	6.4		Impact of smoke control zones (Clean Air Act) and Local Authority Air Quality Management Areas (AQMA).	O
11	6.5		Discuss the candidate's own site in relation to guidance and legal considerations	O
11	6.6		Industrial Emissions Directive, Waste Incineration Directive, Environmental Permitting Regulations, Medium Combustion Plant Directive, CEA BG11 – Water tube Boilers etc.	M

Appendix 2 – •Category 1 specific themes – Hot Water Boilers

Notes for Trainers and Assessors:

This syllabus is applicable to Operators and Managers with responsibility for hot water boilers which are either

- *Shell and tube hot water boilers subject to the requirements of the PSSR and normally operate at a temperature above 110^{o}C;or*
- *Industrial and large commercial shell and tube hot water boilers normally operating at <110^{o}C and sized >100kW each.*

It is recommended that an operational boiler will be available for demonstrating key points of the training.

Whilst current guidance is contained in INDG436 and BG02, there are many legacy sites which still have controls and operational systems suited to PM5 or PSG3. The Training Provider must take this into account when delivering the course but should also refer the candidates to the advice contained in the current guidance with respect to these legacy sites.

The core syllabus specifically excludes solid fuels - coal, biomass etc. as these are included in a separate module due to the number of significant differences which apply to solid fuel fired boilers. The relevant parts of the fuels Annex are required to be taught only for solid fuel BOAS courses and may be omitted otherwise. Trainers are however, free to include aspects of this module in the standard course if they feel that it aids their teaching.

Candidates may work with boilers that utilise liquid or gaseous bio-fuels which possess specific characteristics not shared with the more common hydrocarbon fuels. The Training Provider shall identify any candidates to whom this applies and adjust their teaching accordingly whilst otherwise covering the topic in an appropriate manner. It is expected that the oral examination rather than the written papers will cover this aspect of operation for applicable candidates.

Section 6 – Basic heat & heat transfer concepts

6	1		Understand and explain the terms and concepts in SI and Imperial units for heat, pressure, temperature, volume, energy.	
6	1.1	a)	Temperature	O
6	1.1	b)	Pressure	O
6	1.1	c)	Volume	O
6	1.1	d)	Energy	O
6	1.1	e)	Heat flow	O
6	1.2	a)	Define the relationship of heat, pressure and temperature when associated with boiler operation.	O
6	1.2	b)	Explain how to convert Imperial to SI measurements (and vice versa)	O
6	1.3	a)	Differentiate between 'gauge' and 'absolute' pressure	O
6	1.3	b)	For pressure gauges, convert between bar, psi and kPa	O
6	1.4		Explain these terms as applied to industrial boiler plant	O
6	1.4	a)	boiling point	O
6	1.4	b)	sensible heat	O
6	1.4	c)	latent heat	O
6	1.4	d)	differential temperature	O
6	1.4	e)	stratification	O
6	1.4	f)	saturation temperature and pressure	O
6	1.4	g)	density	O
6	1.4	h)	specific volume	O
6	1.4	i)	thermal expansion	O
6	1.4	j)	two phase fluids (liquid-vapour mixture)	O
6	1.5		Describe the effects of pressure on the boiling point of water and specific volumes of water and flash steam	O
6	1.6		Understand how an unwanted release of pressurised water at elevated temperature may result in the formation of flash steam	O
6	2		Understand and explain the conceptual functions of an industrial boiler	
6	2.1		Explain the functions of a boiler as	O
6	2.1	a)	an energy converter	O
6	2.1	b)	a heat exchanger	O
6	2.1	c)	a store of energy	O
6	2.2		State the principal modes of heat transfer within boilers (conduction, convection and radiation)	O
6	2.3		Explain the effect of thermal expansion on boilers and the negative effects of rapid thermal expansion	O
6	2.4		Discuss the importance of clean surfaces (fireside and waterside) in boilers and the effects of deposits impairing heat transfer (e.g. soot, scale and other fouling)	O
6	2.5		Explain the factors that may adversely affect the structural integrity of a boiler as a result of:	O
6	2.6	a)	over-pressure	O
6	2.6	b)	low water / low pressure condition	O
6	2.6	c)	water side fouling	O

6	2.6	d)	excessive firing rate	O
6	2.6	e)	cycling	O
6	2.6	f)	flame impingement	O
6	2.6	g)	corrosion	O
6	2.6	h)	cracks in the pressure vessel	O
6	2.7		Explain the following catastrophic failure modes applied to industrial hot water boilers:	
6	2.7	a)	furnace collapse not leading to explosion	O
6	2.7	b)	explosion due to furnace collapse	O
6	2.7	c)	explosion due to weld failure (all types)	O
6	2.8		Identify the precautions to be observed to maintain the structural integrity of industrial boilers	O

Section 7 – Feed water and boiler water analysis

7	1		Know the common impurities in raw water	
7	1.1		Describe the uses of the scientific terms and units used in water chemistry	
7	1.1	a)	pH	O
7	1.1	b)	tds and uS/cm	O
7	1.1	c)	ppm	O
7	1.1	d)	mg/l	O
7	1.2		State the main conditions of raw water that can have an adverse effect on boiler operation:	
7	1.2	a)	hardness	O
7	1.2	b)	alkalinity	O
7	1.2	c)	pH	O
7	1.2	d)	corrosive substances	O
7	1.2	e)	total dissolved solids (T.D.S.)	O
7	1.2	f)	phosphates	O
7	1.2	g)	suspended solids	O
7	1.2	h)	conductivity	O
7	1.2	h)	dissolved oxygen	O
7	2		Know the effect of impurities on boilers and boiler operation	
7	2.1		State the effect of pH changes on boiler water and the relationship between acidity, alkalinity and corrosion rate	O
7	2.2		State the causes and effects of scale in boilers	O
7	2.3		State the effect of oxygen in boiler water	O
7	3		Be able to describe common methods used for treating raw water and describe the water treatment system and testing procedure at the candidate's own plant.	
7	3.1		Describe the differences between raw water and boiler system water.	O
7	3.2		Explain the reasons for treating raw water	O
7	3.3		Describe different primary raw water treatment methods in basic terms and their relative advantages and disadvantages:	O

7	3.3	a)	base exchange softener	O
7	3.3	b)	reverse osmosis	O
7	3.3	c)	de-alkalisation / de-mineralisation	O
7	3.4		Describe the water treatment control methods (including common chemicals and the hazards they pose)	O
7	3.4	a)	oxygen control (thermal methods)	O
7	3.4	b)	oxygen control (chemical methods)	O
7	3.4	c)	pH control	O
7	3.5		Describe the water treatment plant and associated test regime used at their plant	O
7	3.6		Detail the importance of following instructions regarding treatment and water sampling	O
7	4		Understand methods for supplying, storing and chemical dosing of boiler water. Relate the terms and concepts to operation under normal and abnormal conditions.	
7	4.1		Specify which chemicals are used on the candidate's plant and what their purpose is	O
7	4.2		Discuss the safety requirements for storage, handling water treatment chemicals (COSHH, Manual Handling, PPE, etc)	O
7	4.8		Outline different methods of dosing, and location of dosing systems and injectors	M
7	5		Know the methods used to check the condition of boiler / system water. Know the actions needed to maintain an optimum condition of the water. Interpret the results of water tests and state conclusions.	
7	5.1		Describe the system for chemical dosing employed at the candidate's own plant.	O
7	5.2		Describe methods for taking water samples from hot water boiler system such that it is:	O
7	5.2	a)	safe	O
7	5.2	b)	accurate	O
7	5.3		Describe the actions to be taken if the permitted levels of impurities are exceeded.	O
7	5.4		Describe the actions to be taken if contamination of the system primary water occurs.	O
7	5.5		State the control and/or target levels for the water testing regimes that are used.	M
7	5.6		State the basic water testing regimes that are available and how to interpret results.	M
7	6		Know possible causes of and hazards due to scale formation within the boiler.	
7	6.1		State the reasons for scale formation in hot water boilers and how to avoid it	O
7	6.2		State the hazards and negative consequences associated with scale formation in hot water boilers	O
7	7		Know possible causes of and hazards due to corrosion formation within the boiler.	

7	7.1		State the reasons for corrosion formation in hot water boilers and how to avoid it	O
7	7.2		State the hazards and negative consequences associated with formation of corrosion in hot water boilers	O
7	7.3		State the reasons for microbiologically induced corrosion formation in hot water boilers and how to avoid it	O
7	7.4		State the legal maximum effluent discharge temperature to public sewer	O
7	7.5		Explain the application of a 'discharge consent' for the boiler house	M

Section 8 – Boilers and Auxiliaries

8	1		Be able to identify different hot water boiler types and methods of construction	
8	1.1		Identify different types of hot water boilers	
8	1.1	a)	shell boilers	O
8	1.1	b)	once through / coil boilers	O
8	1.1	c)	waste heat boilers	O
8	1.1	d)	combination boilers	O
8	1.2		Describe the specific type of boiler on their site and how it works	O
8	1.3		Explain the following terms:	O
8	1.3	a)	wet back	O
8	1.3	b)	dry back	O
8	1.3	c)	convective passes	O
8	1.3	d)	reversal cell	O
8	1.3	e)	turbulator / retarder	O
8	1.3	f)	stay bars	O
8	1.3	g)	tell tale	O
8	1.3	h)	two pass	O
8	1.3	i)	three pass	O
8	1.3	j)	steam cushion hot water boilers	O
8	1.3	k)	manway, head hole, hand hole, mud hole	O
8	1.3	l)	peaking (of longitudinal seam weld)	O
8	1.4		Explain the hazards associated with waterside failure of different types of boilers:	O
8	1.5		Compare and contrast different types of boilers	
8	1.5	a)	shell boilers	M
8	1.5	b)	waste heat boilers	M
8	1.5	c)	combination boilers	M
8	1.6		Discuss the relative amounts of stored energy in different boiler types	O
8	2		Know the main auxiliary items, fittings and mountings provided with a hot water boiler	
8	2.1		Identify and describe auxiliary plant items in common use and describe their function:	
8	2.1	a)	fans	O
8	2.1	b)	air heaters	O
8	2.1	c)	economisers	O

8	2.1	d)	circulating pumps	O
8	2.1	e)	condensing economisers	O
8	2.1	f)	thermal stores	O
8	2.1	g)	back end protection three way valves	O
8	2.2		Identify and describe features, fittings and mountings in common use on hot water boilers and describe their function and consequence of failure:	
8	2.2	a)	safety valve	O
8	2.2	b)	supply and flow control valves	O
8	2.2	c)	low pressure limiter	O
8	2.2	d)	air cocks	O
8	2.2	e)	temperature limiter (both low and high)	O
8	2.2	f)	pressure gauges	O
8	2.2	g)	drain valve	O
8	2.2	h)	high pressure limiter	O
8	2.2	i)	dosing lines	O
8	2.2	j)	vent line / valve	O
8	2.2	k)	temperature sensor for use with burner	O
8	2.2	l)	low loss headers	O
8	2.2	m)	shunt pumps,	O
8	2.2	n)	sample coolers	O
8	2.2	o)	flow limiter	O
8	2.2	p)	sinking time (with reference to steam cushioned boilers)	O
8	2.3		Discuss need for low water level / low pressure protection in hot water boilers (and consequences of inappropriate level / low pressure).	O
8	3		Understand the functions of basic hot water system equipment and hot water distribution systems	
8	3.1		Explain the role of basic hot water equipment fitted to hot water systems	
8	3.1	a)	isolation valves	O
8	3.1	b)	control valves in relation to heat emitters / exchangers	O
8	3.1	c)	pressurisation plants	O
8	3.1	d)	non return valves	O
8	3.1	e)	strainers	O
8	3.1	f)	low loss headers	O
8	3.1	g)	expansion vessels	O
8	3.1	h)	de-gassing unit	O
8	3.1	i)	circulation pumps	O
8	3.2		Explain why the PSSR does not cover low temperature hot water boilers. (LTHW)	M
8	3.3		Explain the term “high temperature hot water boilers” (HTHW) and precautions to be taken to ensure that relevant law is complied with.	M
8	3.4		Explain what is meant by the term "relevant fluid" in the context of LTHW and HTHW	M
8	3.5		Discuss the provisions of PUWER with respect to relevant hot water boilers	M
8	3.6		Explain the difference between sealed (closed) hot water systems and open vented hot water systems.	O

8	3.7		Explain the difference between primary circuits and secondary circuits within hot water systems.	O
8	3.8		Explain what is meant by anti flash margin	O
8	3.9		Explain safe practice when opening and closing manual valves on boilers and system lines (hot and cold)	O
8	3.10		Explain the function of safety valves fitted to boilers and parts of a system	O
8	3.11		Describe actions to be taken when safety valves act	O
8	3.12		Explain the function of an expansion vessel fitted to safety valve discharge pipework.	O
8	3.13		Describe the effect of a sudden decrease in pressure on a hot water boiler and its associated system.	O
8	3.14		Explain why the boiler circulating pump may be interlocked with the boiler / burner.	O
8	3.15		Describe the effect of air in hot water systems.	O
8	3.16		Explain how sealed hot water systems are protected against pressure increase.	O

Section 9 – Operation

9	1		Know the procedures for starting and stopping hot water boilers and bringing them on line	
9	1.1		Demonstrate the procedure for cold start and explain the factors affecting it:	
9	1.1	a)	pre-filling checks	O
9	1.1	b)	system inspection	O
9	1.1	c)	use of drains and air vents	O
9	1.1	d)	filling and venting	O
9	1.1	e)	Warming-up procedure for boilers.	O
9	1.1	f)	Thermal expansion during cold start	O
9	1.1	g)	Water system expansion	O
9	1.1	h)	Importance of minimising temperature differentials across the pressure parts (inlet and outlet of boiler connections, during cold start using RTS (return temperature safeguarding).	O
9	1.1	i)	precautions to be observed	O
9	1.2		Demonstrate how to raise pressure in the boiler:	O
9	1.2	a)	Rate of temperature / pressure rise	O
9	1.2	b)	Checking for leaks and defects	O
9	1.2	c)	Explain the need for manned operation during cold start	O
9	1.2	d)	Explain the need for flushing hot water systems before use	O
9	1.3		Explain the procedure for stopping and shutting down a hot water boiler	O
9	1.4		Discuss special precautions to be observed with boilers fitted with economisers (use of drains for purging or water flushing for cooling of elements, by-pass damper control etc.)	M

9	1.5		Describe a system of logging tests and the procedure for initiating action as a result of a test	M
9	2		Know the procedures for letting hot water into the distribution system and the associated hazards	
9	2.1		Demonstrate bringing a boiler on load:	O
9	2.1	a)	Valve opening procedures and sequence	O
9	2.1	b)	avoiding pump cavitation by venting the system	O
9	2.2		Explain the causes and effects of line erosion and corrosion leading to leakage and line rupture	O
9	2.3		Discuss load control and inter-action between multiple units when operating boilers in parallel	O
9	3		Be able to demonstrate normal and abnormal operations and actions when generating hot water with industrial hot water boilers.	
9	3.1		Describe normal operations:	O
9	3.1	a)	inspection of plant during operation	O
9	3.1	b)	reporting of defects and faults	O
9	3.1	c)	checking for fuel and combustion gas leaks	O
9	3.1	d)	testing of safety equipment and devices	O
9	3.2		Discuss poor operating regimes which may impact upon safety and efficient operation.	O
9	4		Be able to explain the procedures for inspections, maintenance and lay up of hot water boilers	
9	4.1		Describe arrangements for short term and long term laying up of plant:	
9	4.1	a)	Water wedging	O
9	4.1	b)	Nitrogen blankets	O
9	4.1	c)	Draining down	O
9	4.1	d)	water treatment chemicals management	O
9	4.2		Describe procedures used during banking up and factory shutdown periods	O
9	4.3		Describe the precautions required for entry into a confined space	O
9	4.4		Identify potential confined spaces at the candidate's place of work	O
9	4.5		Show a working knowledge of the requirements for liaison with Regulators and inspectors	M
9	4.6		Explain the procedures for safe isolation prior to carrying out repairs, modifications, or examinations	M
9	5		Understand the importance of record keeping and following manufacturer’s instructions	
9	5.1		Describe the record keeping arrangements at the site	O
9	5.2		Explain where to find information relating to the operation of the plant	O
9	5.3		Explain the importance of good record keeping and accurate recording of operational tasks	O
9	5.4		Discuss the procedures applicable at the site	O
9	5.5		Show a good understanding of a boiler house technical risk assessment	M
9	6		Be able to describe the supervision arrangement of the candidate's own plant and relate it to current guidance.	

9	6.1		Relate the law and guidance (BG02) to the candidate's own place of work; both systems of work and installed plant	O
9	6.2		Identify and explain the principles of hot water boiler automatic start-up and shutdown systems	M
9	6.3		Discuss the use of BMS / timeclock systems	M

Section 10 – Controls and instrumentation

10	1		Know the main legal requirements for hot boiler controls and instruments	
10	1.1		State the legal requirements for boiler instrumentation	
10	1.1	a)	Pressure gauge	O
10	1.1	b)	Pressure relief valve(s)	O
10	1.1	c)	Level limiter probe for HTHW or low pressure limiter for LTHW	O
10	1.1	d)	Pressure limiters	O
10			Know the types of control devices and control systems required on hot water boilers, and how and why they operate	
10	2.1		Identify and explain the control and measuring devices in common use on hot water boilers and describe their function and problems that may occur with them:	
10	2.1	a)	pressure sensors and gauges	O
10	2.1	b)	temperature sensors and gauges	O
10	2.1	c)	exhaust temperature sensors and gauges (how they can indicate water side problems)	O
10	2.1	d)	pressurisation units and link to boiler controls.	O
10	2.1	e)	boiler drain valve	O
10	2.1	f)	heat meters and fuel meters	O
10	2.2		Identify and describe the specific controls and instruments fitted on their hot water boiler	O
10	2.3		Describe checks for proving instruments and controls and the procedure for reporting defects	M

Appendix 3 – Category 2 specific themes – Fire tube steam Boilers

Notes for Trainers and Assessors:

This syllabus is applicable to Operators and Managers with responsibility for multitubular shell boilers which are directly fired, waste heat boilers and combination boilers (direct fired boilers with a waste heat section). It is essential that an operational steam boiler will be available for demonstrating key points of the training.

The core syllabus specifically excludes solid fuels - coal, biomass etc. as these are included in a separate module due to the number of significant differences which apply to solid fuel fired boilers. The relevant parts of the fuels Annex are required to be taught only for solid fuel BOAS courses and may be omitted otherwise. Trainers are however, free to include aspects of this module in the standard course if they feel that it aids their teaching.

Candidates may work with boilers that utilise liquid or gaseous bio-fuels which possess specific characteristics not shared with the more common hydrocarbon fuels. The Training Provider shall identify any candidates to whom this applies and adjust their teaching accordingly whilst otherwise covering the topic in an appropriate manner. It is expected that the oral examination rather than the written papers will cover this aspect of operation for applicable candidates.

Whilst current guidance is contained in INDG436 and BG01, there are many legacy sites which still have controls and operational systems suited to PM5 or PSG2. The Training Provider must take this into account when delivering the course but should also refer the candidates to the advice contained in the current guidance with respect to these legacy sites.

Each Section is split into several sub-sections and covers the Learning Outcomes for Operators and Managers of fire tube steam boiler installations.

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Section 6 – Basic heat & heat transfer concepts

6	1		Understand and explain the terms and concepts in SI and Imperial units for heat, pressure, temperature, volume, energy.	
6	1.1	a)	Temperature	O
6	1.1	b)	Pressure	O
6	1.1	c)	Volume	O
6	1.1	d)	Energy	O
6	1.1	e)	Heat flow	O
6	1.2	a)	Define the relationship of heat, pressure and temperature when associated with steam boiler operation.	O
6	1.2	b)	Explain how to convert Imperial to SI measurements (and vice versa)	O
6	1.3	a)	Differentiate between 'gauge' and 'absolute' pressure	O
6	1.3	b)	For pressure gauges, convert between bar, psi and kPa	O
6	1.4		Explain these terms as applied to industrial boiler plant	O
6	1.4	a)	boiling point	O
6	1.4	b)	sensible heat	O
6	1.4	c)	latent heat	O
6	1.4	d)	differential temperature	O
6	1.4	e)	differential pressure	O
6	1.4	f)	stratification	O
6	1.4	g)	saturation temperature and pressure	O
6	1.4	h)	density	O
6	1.4	i)	specific volume	O
6	1.4	j)	thermal expansion	O
6	1.4	k)	two phase fluids (liquid-vapour mixture)	O
6	1.4	l)	specific enthalpy	O
6	1.4	m)	superheat	O
6	1.4	n)	sub-cooling	O
6	1.4	o)	superheated steam	O
6	1.4	p)	saturated (dry) steam	O
6	1.4	q)	wet steam	O
6	1.4	r)	dryness fraction	O
6	1.4	s)	condensate	O
6	1.4	t)	flash steam	O
6	1.5		Describe the effects of pressure on the boiling point of water and specific volumes of water and steam	O
6	1.6		Describe the effects of change in pressure on steam velocity inside a boiler and in the distribution system	O
6	1.7		Explain the process of steam generation inside a boiler, including change in density with pressure and two phase nature of water when the burner is firing.	O
6	1.8		Explain why steam is used instead of other forms of heating system.	M
6	2		Understand and explain the conceptual functions of an industrial boiler	
6	2.1		Explain the functions of a boiler as	O
6	2.1	a)	an energy converter	O
6	2.1	b)	a heat exchanger	O
6	2.1	c)	a store of energy	O

6	2.2		State the principal modes of heat transfer within boilers (conduction, convection and radiation)	O
6	2.3		Explain the effect of thermal expansion on boilers and the negative effects of rapid thermal expansion	O
6	2.4		Discuss the importance of clean surfaces (fireside and waterside) in boilers and the effects of deposits impairing heat transfer (e.g. soot, scale and other fouling)	O
6	2.5		Explain the factors that may adversely affect the structural integrity of a boiler as a result of:	O
6	2.6	a)	over-pressure	O
6	2.6	b)	low water	O
6	2.6	c)	water side fouling	O
6	2.6	d)	excessive firing rate	O
6	2.6	e)	pressure cycling	O
6	2.6	f)	flame impingement	O
6	2.6	g)	corrosion	O
6	2.6	h)	cracks in the pressure vessel	O
6	2.6	i)	excessive TDS	O
6	2.7		Explain the following catastrophic failure modes applied to industrial steam boilers:	
6	2.7	a)	furnace collapse not leading to explosion	O
6	2.7	b)	explosion due to furnace collapse	O
6	2.7	c)	explosion due to weld failure (all types)	O
6	2.8		Identify the precautions to be observed to maintain the structural integrity of industrial boilers	O
6	2.9		Explain From and At rating	M
6	2.10		Explain the use of steam tables and standard notation	M
6	2.11		Interpret the basic elements of steam tables (the ability to perform complex calculations is not required).	M

Section 7 – Feed water and boiler water analysis

7	1		Know the common impurities in raw water	
7	1.1		Describe the uses of the scientific terms and units used in water chemistry	
7	1.1	a)	pH	O
7	1.1	b)	tds and uS/cm	O
7	1.1	c)	ppm	O
7	1.1	d)	mg/l	O
7	1.2		State the main conditions of raw water that can have an adverse effect on boiler operation:	
7	1.2	a)	hardness	O
7	1.2	b)	alkalinity	O
7	1.2	c)	pH	O
7	1.2	d)	corrosive substances	O
7	1.2	e)	total dissolved solids (T.D.S.)	O
7	1.2	f)	phosphates	O
7	1.2	g)	suspended solids	O

7	1.2	h)	conductivity	O
7	1.2	i)	dissolved oxygen	O
7	2		Know the effect of impurities on boilers and boiler operation	
7	2.1		State the effect of pH changes on boiler water and the relationship between alkalinity and corrosion rate	O
7	2.2		State the causes and effects of scale in boilers	O
7	2.3		State the effect of oxygen in boiler water	O
7	2.4		Understand the effects of contaminated condensate	O
7	3		Be able to describe common methods used for treating raw water and describe the water treatment system and testing procedure at the candidate's own plant.	
7	3.1		Describe the differences between raw water and boiler feed water.	O
7	3.2		Explain the reasons for treating raw water	O
7	3.3		Describe different primary raw water treatment methods in basic terms, their relative advantages and disadvantages and basic systems of checks performed on them:	O
7	3.3	a)	base exchange softener	O
7	3.3	b)	reverse osmosis	O
7	3.3	c)	de-alkalisation / de-mineralisation	O
7	3.4		Describe the water treatment control methods (including common chemicals and the hazards they pose)	O
7	3.4	a)	oxygen control (thermal methods)	O
7	3.4	b)	oxygen control (chemical methods)	O
7	3.4	c)	pH control	O
7	3.5		Describe the water treatment plant and associated test regime used at their plant	O
7	3.6		Detail the importance of following instructions regarding treatment and water sampling	O
7	3.7		Describe the actions to be taken in the event of failure (partial and total) of water treatment plant	
7	4		Understand methods for supplying, storing and chemical dosing of boiler water. Relate the terms and concepts to operation under normal and abnormal conditions.	
7	4.1		Describe the purpose of and operational regimes for hotwells:	O
7	4.1	a)	Monitoring requirements	O
7	4.1	b)	Recommended temperature regime for a hotwell	O
7	4.1	c)	Causes of too low or too high a temperature	O
7	4.1	d)	Negative consequences of too low a temperature	O
7	4.1	e)	Negative consequences of too high a temperature	O
7	4.1	f)	Effect of water temperature on oxygen levels in feed water	O
7	4.1	g)	Control of level	O
7	4.1	h)	Control of temperature	O
7	4.2		Discuss the safety requirements for storage, handling water treatment chemicals (COSHH, Manual Handling, PPE, etc)	O

7	4.3		Outline different methods of dosing, and location of dosing systems and injectors	M
7	4.4		Specify which chemicals are used on the candidate's plant and what their purpose is	O
7	4.5		Explain the hazards associated with common chemicals.	O
7	4.6		Discuss potential sources of contamination of condensate with their likely effects in the boiler	O
7	4.7		Explain methods of detecting condensate contamination	M
7	4.8		Describe different methods used for storing and supplying water for steam boilers and their relative merits and disadvantages	O
7	4.8	a)	Hot well	O
7	4.8	b)	De-aerator	O
7	4.9		Describe methods of controlling feed water and their relative benefits and disadvantages:	M
7	4.9	a)	on-off pumps	M
7	4.9	b)	variable speed pumps	M
7	4.9	c)	modulating control valves	M
7	4.9	d)	Individual pumps	M
7	4.9	e)	Duty-standby pump arrangements	M
7	4.9	f)	Pump farms	M
7	5		Know the methods used to check the condition of boiler water. Know the actions needed to maintain an optimum condition of the boiler water. Interpret the results of water tests and state conclusions.	
7	5.1		Describe the system for chemical dosing employed at the candidate's own plant.	O
7	5.2		Describe different methods that can be employed for chemical dosing.	M
7	5.3		Describe methods for taking water samples from steam boilers system such that it is:	O
7	5.3	a)	safe	O
7	5.3	b)	accurate	O
7	5.4		Describe the actions to be taken if the permitted levels of impurities are exceeded.	O
7	5.5		State the source of the control limits and / or target levels for the water testing regimes that are used (e.g. BG04 or other reference).	M
7	5.6		State the basic water testing regimes that are available and how to interpret results.	M
7	5.7		State the allowable levels of TDS in different types of boiler	O
7	5.8		Explain the consequences of inaccurate calibration / operation of TDS control systems	O
7	5.8	a)	too high	O
7	5.8	b)	too low	O
7	5.9		Show an awareness of the effect of temperature on uncompensated TDS control systems	O

7	5.10		Discuss manual and automatic blowdown techniques and the comparison between them in terms of effectiveness and efficiency	M
7	6		Know possible causes of and hazards due to scale formation within the boiler.	
7	6.1		State the reasons for scale formation in steam boilers and how to avoid it	O
7	6.2		State the hazards and negative consequences associated with scale formation in steam boilers	O
7	7		Know possible causes of and hazards due to corrosion formation within the boiler.	
7	7.1		State the reasons for corrosion formation in steam boilers and how to avoid it	O
7	7.2		State the hazards and negative consequences associated with formation of corrosion in steam boilers	O
7	8		Indicate manual and intermittent bottom blowdown valves and the manner of operating these.	
7	8.1		Describe the reasons for blowdown operations and the associated risks.	O
7	8.2		Describe the operation of blowdown valves, both manual and automatic.	O
7	8.3		Describe the potential hazards associated with blowdown systems and pipework	O
7	8.4		Understand the risks and control measures with regard to blowdown keys for sites where key manually operated/key actuated blowdown valves are fitted and used.	M
7	8.5		State the legal maximum effluent discharge temperature to public sewer	O
7	8.6		Explain the application of a ‘discharge consent’ for the boiler house	M
7	9		Know possible causes of and hazards due to carry-over.	
7	9.1		State the reasons for carry over from steam boilers and how to avoid it:	O
7	9.1	a)	foaming	O
7	9.1	b)	water level instability	O
7	9.1	c)	hunting of water level controls	O
7	9.2		State the effects and hazards of carry over on the boiler plant and the distribution system	O

Section 8 – Boilers and Auxiliaries

8	1		Be able to identify different steam boiler types and methods of construction	
8	1.1		Identify different types of steam water boilers	
8	1.1	a)	shell boilers	O
8	1.1	b)	once through / coil boilers	O
8	1.1	c)	waste heat boilers	O
8	1.1	d)	combination boilers	O
8	1.2		Describe the specific type of boiler on their site and how it works	O
8	1.3		Explain the following terms:	O
8	1.3	a)	wet back	O

8	1.3	b)	dry back	O
8	1.3	c)	convective passes	O
8	1.3	d)	reversal cell	O
8	1.3	e)	turbulator / retarder	O
8	1.3	f)	stay bars	O
8	1.3	g)	tell tale	O
8	1.3	h)	two pass	O
8	1.3	i)	three pass	O
8	1.3	j)	reverse flame boiler	O
8	1.3	k)	sinking time	O
8	1.3	l)	peaking (of longitudinal seam weld)	O
8	1.3	m)	manway, head hole, hand hole, mud hole	O
8	1.4		Explain the hazards associated with waterside failure of different types of boilers:	O
8	1.5		Compare and contrast different types of boilers	M
8	1.5	a)	shell boilers	M
8	1.5	b)	waste heat boilers	M
8	1.5	c)	combination boilers	M
8	1.6		Discuss the relative amounts of stored energy in different boiler types	O
8	2		Know the main auxiliary items, fittings and mountings provided with a steam boiler	
8	2.1		Identify and describe auxiliary plant items in common use and describe their function:	
8	2.1	a)	fans	O
8	2.1	b)	air heaters	O
8	2.1	c)	economisers	O
8	2.1	d)	superheaters	O
8	2.1	e)	feed tanks and feed pumps	O
8	2.1	f)	steam injectors	O
8	2.1	g)	feed water modulation	O
8	2.1	h)	blowdown vessels	O
8	2.2		Identify and describe features, fittings and mountings in common use on steam boilers and describe their function and consequence of failure:	
8	2.2	a)	safety valve	O
8	2.2	b)	crown valves	O
8	2.2	c)	gauge glasses	O
8	2.2	d)	air cocks	O
8	2.2	e)	vacuum relief / vent valves	O
8	2.2	f)	pressure gauges	O
8	2.2	g)	drain points	O
8	2.2	h)	high pressure limiter	O
8	2.2	i)	dosing lines	O
8	2.2	j)	blowdown valves	O
8	2.2	k)	sparge lines and associated equipment	O
8	2.2	l)	dosing lines	O
8	2.2	m)	feed water connections	O
8	2.2	n)	sample coolers	O

8	2.2	o)	spill back lines protecting feed pumps and economisers	O
8	2.3		Discuss need for low water level protection in steam boilers	O
8	3		Understand the functions of basic steam system equipment and steam distribution systems	
8	3.1		Explain the role of basic steam equipment fitted to steam systems	
8	3.1	a)	isolation valves	O
8	3.1	b)	control valves	O
8	3.1	c)	pressure reduction valves	O
8	3.1	d)	non return valves	O
8	3.1	e)	strainers	O
8	3.1	f)	steam traps	O
8	3.1	g)	safety valves located within steam distribution systems	O
8	3.1	h)	steam separators	O
8	3.1	i)	surplussing valves	O
8	3.2		Explain why steam moves around a distribution system and the effect of this movement on the steam	O
8	3.3		Explain why condensate forms in steam systems and the reasons for collection and return of condensate to the boiler house	O
8	3.4		Discuss heat loss from steam lines and the formation of condensate	O
8	3.5		Explain what is meant by sub-cooling of condensate	O
8	3.6		Explain the effect of insulation on condensate formation rates	O
8	3.7		Discuss the effect of non-condensable gases in steam lines	O
8	3.8		Show awareness of steam hammer and water hammer events and suitable preventative and corrective actions	O
8	3.9		Explain safe practice when opening and closing manual valves on boilers and system lines (hot and cold)	O
8	3.10		Explain the function of safety valves	O
8	3.11		Describe actions to be taken when safety valves act	O
8	3.12		Discuss the potential negative consequences of unexpected steam release to atmosphere	O
8	3.13		Describe the effect of a sudden decrease in pressure on a steam boiler and its associated system.	O
8	3.14		Describe the effect of air in steam systems.	O
8	3.15		Explain the effect of gravity on condensate	M
8	3.16		Discuss the principles of steam line design including pressure rating and maximum bulk velocity	M
8	3.17		Explain the effect of pressure changes / excessive demand on line velocities	M
8	3.18		Describe the function of a pressure reducing valve and the reasons for their use.	O
8	3.19		Explain the mechanisms by which steam hammer and water hammer events occur	M

Section 9 – Operation

9	1		Know the procedures for starting and stopping steam boilers and bringing them on line	
9	1.1		Demonstrate the procedure for cold start and explain the factors affecting it:	
9	1.1	a)	pre-filling checks	O
9	1.1	b)	system inspection	O
9	1.1	c)	use of drains and air vents	O
9	1.1	d)	filling and venting	O
9	1.1	e)	warming-up procedure for boilers.	O
9	1.1	f)	thermal expansion during cold start	O
9	1.1	g)	change of water level with temperature	O
9	1.1	h)	Importance of minimising temperature differentials across the pressure parts during cold start	O
9	1.1	i)	precautions to be observed	O
9	1.2		Demonstrate how to raise pressure in the boiler:	O
9	1.2	a)	initial checks	O
9	1.2	b)	Stratification and the use of manual blow-down to assist circulation	O
9	1.2	c)	Checking for leaks and defects	O
9	1.2	d)	Controlling the rate of temperature / pressure rise to acceptable rates	O
9	1.2	e)	Gauge glass checks	O
9	1.2	f)	Explain the need for manned operation during cold start	O
9	1.3		Explain how water level controls are proved (the evaporation test) and explain any additional requirements / tests needed for level controls mounted in external chambers and tests for direct mounted controls	O
9	1.4		Discuss special precautions to be observed with boilers fitted with economisers or superheaters (use of drains for purging or water flushing for cooling of elements, by-pass damper control etc.)	M
9	1.5		Describe a system of logging tests and the procedure for initiating action as a result of a test	M
9	1.6		Explain the procedure for stopping and shutting down a boiler	O
9	1.7		Explain the procedure for starting a warm boiler with residual heat following a short lay-up	O
9	2		Know the procedures for letting steam into the distribution system and the associated hazards	
9	2.1		Demonstrate bringing a boiler on load:	O
9	2.1	a)	valve opening procedures and sequence	O
9	2.1	b)	condensate loading	O
9	2.1	c)	screw-down non-return valve operation	O
9	2.1	d)	avoiding pump cavitation	O
9	2.1	e)	avoiding steam hammer	O
9	2.1	f)	avoiding vacuum forming	O
9	2.1	g)	precautions against waterlogging	O
9	2.1	h)	wire draw of valves	
9	2.2		Explain the causes and effects of line erosion and corrosion leading to line rupture	O

9	2.3		Discuss load control and inter-action between multiple units when operating boilers in parallel	O
9	2.4		Explain precautions to be taken in draining the system down-stream of the crown valve, checking of traps and drains, and warming-up of piping systems	O
9	2.5		Explain the cause and effect of priming	O
9	3		Be able to demonstrate normal and abnormal operations and actions when steaming	
9	3.1		Describe normal operations:	O
9	3.1	a)	Inspection of plant during operation	O
9	3.1	b)	reporting of defects and faults	O
9	3.1	c)	Checking for fuel and combustion gas leaks	O
9	3.1	d)	Testing of safety equipment and devices	O
9	3.1	e)	Checking water level gauges, water alarms and flame failure equipment	O
9	3.1	f)	Blowdown procedures and precautions to be taken	O
9	3.2		Discuss poor operating regimes which may impact upon safety and efficient operation in general and specifically:	O
9	3.2	a)	failure of an automatic blowdown system	O
	3.2	b)	activation of a condensate quality alarm	O
9	4		Be able to explain the procedures for inspections, maintenance and lay up of steam boilers	
9	4.1		Describe arrangements for short term and long term laying up of plant:	
9	4.1	a)	Water wedging	O
9	4.1	b)	Nitrogen blankets	O
9	4.1	c)	Draining down	O
9	4.1	d)	water treatment chemicals management	O
9	4.2		Describe procedures used during banking up and factory shutdown periods	O
9	4.3		Describe the precautions required for entry into a confined space	O
9	4.4		Identify potential confined spaces at the candidate's place of work	O
9	4.5		Show an appropriate working knowledge of the requirements for liaison with regulators and inspectors	O
9	4.6		Explain the procedures for safe isolation prior to carrying out repairs, modifications, or examinations	M
9	5		Understand the importance of record keeping and following manufacturer’s instructions	
9	5.1		Describe the record keeping arrangements at the site	O
9	5.2		Explain where to find information relating to the operation of the plant	O
9	5.3		Explain the importance of good record keeping and accurate recording of operational tasks	O
9	5.4		Discuss the procedures applicable at the site	O
9	5.5		Show a good understanding of a boiler house technical risk assessment	M
9	6		Be able to describe the supervision arrangement of the candidate's own plant and relate it to current guidance.	
9	6.1		Relate BG01 to the candidate's own place of work; both systems of work and installed plant	O

Section 10 – Controls and instrumentation

10	1		Know the main legal requirements for steam boilers	
10	1.1		State the legal requirements for boiler instrumentation:	
10	1.1	a)	pressure gauge c/w marked line	O
10	1.1	b)	safety valve	O
10	1.1	c)	efficient low water alarm (low water limiter and alarm system)	O
10	1.1	d)	sight glass (with guard if tubular)	O
10	1.1	e)	main stop valve	O
10	1.1	f)	name plate	O
10	1.1	g)	distinctive number where there is more than one boiler	O
10			Know the types of control devices and control systems required on steam boilers, and how and why they operate	
10	2.1		Identify and explain the control and measuring devices in common use on steam boilers and describe their function and problems that may occur with them:	
10	2.1	a)	pressure sensors and gauges	O
10	2.1	b)	meaning of the marking(s) on pressure gauges	O
10	2.1	c)	exhaust temperature sensors and gauges (how they can indicate water side problems)	O
10	2.1	d)	sight glasses and level shown in them	O
10	2.1	e)	level indicated inside a boiler by measuring devices including cut out and limiting devices	O
10	2.1	f)	pressure indicated inside a boiler by measuring devices including cut out and limiting devices	O
10	2.1	g)	heat and fuel meters	O
10	2.2		Identify and describe the specific controls and instruments fitted on their boiler	O
10	2.3		Describe checks for proving instruments and controls and the procedure for reporting defects	O
10	3		State the requirements for operation with respect to guidance for:	
10	3.1	a)	Gauge glass blowdown	O
10	3.1	b)	Evaporation test	O
10	3.1	c)	Flame failure device test (non-high integrity types)	O

Appendix 4 – Category 3 specific themes – Water Tube Boilers

Notes for Trainers and Assessors:

The primary aim of the BOAS course is to bring candidates' knowledge and experience to the point whereby they are professionally recognised as being able to operate their boilers safely, efficiently and effectively.

Access to a fully operational water tube steam boiler plant is required as an essential part of the training and assessment process for this Category of BOAS. New Cat 3 candidates will normally be assessed on site at the boiler house.

Whilst current guidance is contained in INDG436 and BG11, there are many legacy sites which still have controls and operational systems suited to PM5 or other guidance. The Training Provider must take this into account when delivering the course but should also refer the candidates to the advice contained in the current guidance with respect to these legacy sites.

The core syllabus specifically excludes solid fuels - coal, biomass etc. as these are included in a separate module due to the number of significant differences which apply to solid fuel fired boilers. The relevant parts of the fuels Annex are required to be taught only for solid fuel BOAS courses and may be omitted otherwise. Trainers are however, free to include aspects of this module in the standard course if they feel that it aids their teaching.

Candidates may work with boilers that utilise liquid or gaseous bio-fuels possessing specific characteristics not shared with the more common hydrocarbon fuels. The Training Provider should seek to identify any Operators to whom this applies and adjust their teaching accordingly whilst otherwise covering the topic in an appropriate manner. It is expected that the oral examination rather than the written papers will cover this aspect of operation for applicable candidates.

Section 6 – Basic heat & heat transfer concepts

6	1		Understand and explain the terms and concepts in SI and Imperial units for heat, pressure, temperature, volume, energy.	
6	1.1	a)	Temperature	O
6	1.1	b)	Pressure	O
6	1.1	c)	Volume	O
6	1.1	d)	Energy	O
6	1.1	e)	Heat flow	O
6	1.2	a)	Define the relationship of heat, pressure and temperature when associated with boiler operation.	O
6	1.2	b)	Explain how to convert Imperial to SI measurements (and vice versa)	O
6	1.3	a)	Differentiate between 'gauge' and 'absolute' pressure	O
6	1.3	b)	For pressure gauges, convert between bar, psi and kPa	O
6	1.4		Explain these terms as applied to industrial boiler plant	O
6	1.4	a)	boiling point	O
6	1.4	b)	latent heat	O
6	1.4	c)	superheat	O
6	1.4	d)	differential temperature	O
6	1.4	e)	differential pressure	O
6	1.4	f)	stratification	O
6	1.4	g)	saturation temperature and pressure	O
6	1.4	h)	density	O
6	1.4	i)	specific volume	O
6	1.4	j)	specific heat capacity	O
6	1.4	k)	thermal expansion	O
6	1.4	l)	two phase fluids (liquid-vapour mixture)	O
6	1.4	m)	specific enthalpy	O
6	1.4	n)	sensible heat	O
6	1.4	o)	sub-cooling	O
6	1.4	p)	superheated steam	O
6	1.4	q)	saturated (dry) steam	O
6	1.4	r)	wet steam	O
6	1.4	s)	dryness fraction	O
6	1.4	t)	condensate	O
6	1.4	u)	flash steam	O
6	1.5		Describe the effects of pressure on the boiling point of water and specific volumes of water and steam	O
6	1.6		Describe the effects of operating a boiler on its internal water level.	O
6	1.7		Describe the effects of change in pressure on steam velocity inside a boiler and in the distribution system	O
6	1.8		Explain the process of steam generation inside a boiler, including change in density with pressure and two phase nature of water when the burner is firing.	O
6	1.9		Explain why steam is used instead of other forms of heating system.	M
6	2		Understand and explain the conceptual functions of an industrial boiler	

6	2.1		Explain the functions of a boiler as	O
6	2.1	a)	an energy converter	O
6	2.1	b)	a heat exchanger	O
6	2.1	c)	a store of energy	O
6	2.2		State the principal modes of heat transfer within boilers (conduction, convection and radiation)	O
6	2.3	a)	Explain the effect of thermal expansion on boilers and the negative effects of rapid thermal expansion	O
6	2.3	b)	Explain the effect of thermal expansion on superheaters, economisers, air-heaters and support feet. How this expansion is accommodated.	
6	2.4		Discuss the importance of clean surfaces (fireside and waterside) in boilers and the effects of deposits impairing heat transfer (e.g. soot, scale and other fouling)	O
6	2.5		Explain the factors that may adversely affect the structural integrity of a boiler as a result of:	O
6	2.5	a)	over-pressure	O
6	2.5	b)	low water	O
6	2.5	c)	water side fouling	O
6	2.5	d)	excessive firing rate	O
6	2.5	e)	pressure cycling	O
6	2.5	f)	flame impingement	O
6	2.5	g)	corrosion and pitting (all forms)	O
6	2.5	h)	cracks in the pressure envelope	O
6	2.5	i)	excessive TDS	O
6	2.5	j)	tube failure	O
6	2.5	k)	creep	O
6	2.5	l)	fatigue: corrosion fatigue; mechanical fatigue; thermo-mechanical fatigue	O
6	2.5	m)	erosion / abrasion of pressure parts	O
6	2.5	n)	fretting	O
6	2.5	o)	stress corrosion cracking	O
6	2.5	p)	graphitisation	
6	2.5	q)	fireside fouling	O
6	2.5	r)	fireside corrosion	O
6	2.6		Explain how the factors listed in 6.2.5 above can relate to the risk of:	O
6	2.6	a)	fireside explosion	O
6	2.6	b)	waterside explosion	O
6	2.7		Identify the precautions to be observed to maintain the structural integrity of industrial boilers	O
6	2.8		Explain the use of steam tables and standard notation	M
6	2.9		Interpret the basic elements of steam tables (the ability to perform complex calculations is not required).	M

Section 7 – Feed water and boiler water analysis

7	1		Know the common impurities in raw water	
7	1.1		Describe the uses of the scientific terms and units used in water chemistry	
7	1.1	a)	pH	O
7	1.1	b)	tds and uS/cm	O
7	1.1	c)	ppm	O
7	1.1	d)	mg/l	O
7	1.2		State the main conditions of raw water that can have an adverse effect on boiler operation:	
7	1.2	a)	hardness (including different types of hardness)	O
7	1.2	b)	alkalinity	O
7	1.2	c)	pH	O
7	1.2	d)	corrosive substances	O
7	1.2	e)	total dissolved solids (T.D.S.)	O
7	1.2	f)	phosphates	O
7	1.2	g)	suspended solids	O
7	1.2	h)	conductivity	O
7	1.2	i)	dissolved oxygen	O
7	2		Know the effect of impurities on boilers and boiler operation	
7	2.1		State the effect of pH changes on boiler water and the relationship between alkalinity and corrosion rate	O
7	2.2		State the causes and effects of scale in boilers	O
7	2.3		State the effect of oxygen in boiler water	O
7	2.4		Understand the effects of contaminated condensate	O
7	3		Be able to describe common methods used for treating raw water and describe the water treatment system and testing procedure at the candidate's own plant.	
7	3.1		Describe the differences between raw water and boiler feed water.	O
7	3.2		Explain the reasons for treating raw water	O
7	3.3		Describe different primary raw water treatment methods in basic terms and their relative advantages and disadvantages:	O
7	3.3	a)	base exchange softener	O
7	3.3	b)	reverse osmosis	O
7	3.3	c)	de-alkalisation / de-mineralisation / de-gassing	O
7	3.3	d)	lime soda softeners	O
7	3.3	e)	evaporators	O
7	3.3	f)	electrodeionisation	O
7	3.4		Describe the water treatment control methods (including common chemicals and the hazards they pose)	O
7	3.4	a)	oxygen control (thermal methods)	O
7	3.4	b)	oxygen control (chemical methods)	O
7	3.4	c)	pH control	O

7	3.4	d)	Silica monitoring and control	O
7	3.5		Detail the importance of following instructions regarding treatment and water sampling	O
7	4		Understand methods for supplying, storing and chemical dosing of boiler water. Relate the terms and concepts to operation under normal and abnormal conditions.	
7	4.1		Describe operational regimes for hot wells and de-aerators	O
7	4.1	a)	Monitoring requirements	O
7	4.1	b)	Recommended temperature regime for a hotwell and a de-aerator	O
7	4.1	c)	Causes of too low or too high a temperature	O
7	4.1	d)	Negative consequences of too low a temperature	O
7	4.1	e)	Negative consequences of too high a temperature	O
7	4.1	f)	Effect of water temperature on oxygen levels in feed water	O
7	4.1	g)	Control of level	O
7	4.1	h)	Control of temperature	O
7	4.2		Discuss the safety requirements for storage, handling water treatment chemicals (COSHH, Manual Handling, PPE, etc)	O
7	4.3		Outline different methods of dosing, and location of dosing systems and injectors	M
7	4.4		Specify which chemicals are used on the candidate's plant and what their purpose is	O
7	4.5		Discuss potential sources of contamination of condensate with their likely effects in the boiler	O
7	4.6		Explain the hazards associated with common chemicals.	O
7	4.7		Explain methods of detecting condensate contamination	M
7	4.8		Describe different methods used for storing and supplying water for steam boilers and their relative merits and disadvantages	O
7	4.8	a)	Hot well	O
7	4.8	b)	De-aerator	O
7	4.9		Describe methods of controlling feed water and their relative benefits and disadvantages:	M
7	4.9	a)	on-off pumps	M
7	4.9	b)	variable speed pumps	M
7	4.9	c)	modulating control valves	M
7	4.9	d)	Individual pumps	M
7	4.9	e)	Duty-standby pump arrangements	M
7	4.9	f)	Pump farms	M
7	4.10		Describe the relationship of boiler size and feed water temperature to feed water pump and control systems.	
7	5		Know the methods used to check the condition of boiler water. Know the actions needed to maintain an optimum condition of the boiler water. Interpret the results of water tests and state conclusions.	

7	5.1		Describe the system for chemical dosing employed at the candidate's own plant.	O
7	5.2		Describe different methods that can be employed for chemical dosing.	M
7	5.3		Describe methods for taking water samples from steam boilers system such that it is:	O
7	5.3	a)	safe	O
7	5.3	b)	accurate	O
7	5.4		Describe the actions to be taken if the permitted levels of impurities are exceeded.	O
7	5.5		State the source of the control limits and / or target levels for the water testing regimes that are used (e.g. BS2486 or other reference).	M
7	5.6		State the basic water testing regimes that are available and how to interpret results.	M
7	5.7		State the allowable levels of TDS in different types of boiler and different operating pressures	M
7	6		Know possible causes of and hazards due to scale formation within the boiler.	
7	6.1		State the reasons for scale formation in steam boilers and how to avoid it	O
7	6.2		State the hazards and negative consequences associated with scale formation in steam boilers	O
7	6.3		State the hazards and negative consequences associated with carry over and deposit formation in superheaters	O
7	7		Know possible causes of and hazards due to corrosion formation within the boiler.	
7	7.1		State the reasons for corrosion formation in steam boilers and how to avoid it	O
7	7.2		State the hazards and negative consequences associated with formation of corrosion in steam boilers	O
7	8		Indicate manual and intermittent / continuous blowdown valves and the manner of operating these.	
7	8.1		Describe the reasons for blowdown operations and the associated risks.	O
7	8.2		Describe the operation of blowdown valves, both manual and automatic.	O
7	8.3		Describe the potential hazards associated with blowdown systems and pipework	O
7	8.4		State the legal maximum effluent discharge temperature	O
7	8.5		Explain the consequences of inaccurate calibration of TDS control systems	O
7	8.5	a)	too high	O
7	8.5	b)	too low	O
7	8.6		Discuss manual and automatic blowdown techniques and the comparison between them in terms of effectiveness and efficiency	M
7	8.7		Explain the application of a ‘discharge consent’ for the boiler house	M
7	8.8		Understand the risks and control measures with regard to blowdown keys for sites where key manually operated/key actuated blowdown valves are fitted and used.	M

7	8.9		Show an awareness of the effect of temperature on uncompensated TDS control systems	M
7	9		Know possible causes of and hazards due to priming and carry-over.	
7	9.1		State the reasons for priming and carry over from steam boilers and how to avoid it:	O
7	9.1	a)	foaming	O
7	9.1	b)	water level instability	O
7	9.1	c)	hunting of water level controls	O
7	9.2		State the effects and hazards of carry over on the superheater, the distribution system and steam users (turbine)	O

Section 8 – Boilers and Auxiliaries

8	1		Be able to identify different steam boiler types and methods of construction	
8	1.1		Identify different types of steam boilers	
8	1.1	a)	water tube boilers	O
8	1.1	a)	shell boilers	O
8	1.1	b)	once through / coil boilers	O
8	1.1	c)	waste heat boilers	O
8	1.1	d)	combination boilers	O
8	1.2		Describe the specific type of boiler on their site and how it works	O
8	1.3		Explain the following terms:	O
8	1.3	a)	water drum / mud drum / lower header	O
8	1.3	b)	steam drum and associated drum internals including steam dryers, feed water/chemical distribution pipes, feed water preheaters and attemperator coils and instrumentation connections	O
8	1.3	c)	superheater	O
8	1.3	d)	economiser	O
8	1.3	e)	soot blower	O
8	1.3	f)	riser tube	O
8	1.3	g)	down comer tube	O
8	1.3	h)	air pre-heater	O
8	1.3	i)	attemperator and de-superheater	O
8	1.4		Explain the hazards associated with waterside failure of different types of boilers:	O
8	1.5		Compare and contrast different types of boilers	
8	1.5	a)	Water tube boilers and shell smoke tube boilers	M
8	1.5	b)	waste heat boilers – heat recovery steam generators	M
8	1.5	c)	combination boilers – waste heat boilers / heat recovery steam generators with supplementary and auxiliary firing	M
8	1.6		Discuss the relative amounts of stored energy in different boiler types	O
8	2		Know the main auxiliary items, fittings and mountings provided with a steam boiler	
8	2.1		Identify and describe auxiliary plant items in common use and describe their function:	
8	2.1	a)	fans	O

8	2.1	b)	air heaters	O
8	2.1	c)	economisers	O
8	2.1	d)	superheaters	O
8	2.1	e)	feed tanks and feed pumps	O
8	2.1	f)	steam injectors	O
8	2.1	g)	feed water modulation	O
8	2.1	h)	blowdown vessels	O
8	2.1	i)	Drum attemperators and feed water pre-heaters	O
8	2.1	j)	Spray attemperators and de-superheaters	O
8	2.2		Identify and describe features, fittings and mountings in common use on steam boilers and describe their function and consequence of failure:	
8	2.2	a)	safety valves on superheater, steam drum and economiser	O
8	2.2	b)	main superheated steam outlet valve and start up vent	O
8	2.2	c)	gauge glasses	O
8	2.2	d)	air cocks	O
8	2.2	e)	vacuum relief / vent valves	O
8	2.2	f)	pressure gauges	O
8	2.2	g)	drain points	O
8	2.2	h)	high pressure limiter	O
8	2.2	i)	dosing lines	O
8	2.2	j)	blowdown valves	O
8	2.2	k)	sparge lines and associated equipment	O
8	2.2	l)	dosing lines	O
8	2.2	m)	feed water connections	O
8	2.2	n)	sample coolers	O
8	2.2	o)	spill back lines protecting feed pumps and economisers	O
8	2.2	p)	discuss the advantages and disadvantages of differing methods of soot cleaning – soot blowers, rapping systems, sonic cleaning, shot cleaning etc..	O
8	2.3		Discuss the need for low water level protection in steam boilers	O
8	3		Understand the functions of basic steam system equipment and steam distribution systems	
8	3.1		Explain the role of basic steam equipment fitted to steam systems	
8	3.1	a)	isolation valves	O
8	3.1	b)	control valves	O
8	3.1	c)	de-superheater and pressure reduction stations	O
8	3.1	d)	non return valves	O
8	3.1	e)	strainers	O
8	3.1	f)	steam traps	O
8	3.1	g)	safety valves located within steam distribution systems	O
8	3.1	h)	steam separators	O
8	3.1	i)	surplussing valves	O
8	3.2		Explain why steam moves around a distribution system and the effect of this movement on the steam	O
8	3.3		Explain why condensate forms in steam systems and the reasons for collection and return of condensate to the boiler house	O
8	3.4		Discuss heat loss from steam lines and the formation of condensate	O
8	3.5		Explain what is meant by sub-cooling of condensate	O

8	3.6		Explain the effect of insulation on condensate formation rates	O
8	3.7		Discuss the effect of non-condensable gases in steam lines	O
8	3.8		Show awareness of steam hammer and water hammer events and suitable preventative and corrective actions	O
8	3.9		Explain safe practice when opening and closing manual valves on boilers and system lines (hot and cold)	O
8	3.10		Explain the function of safety valves	O
8	3.11		Describe actions to be taken when safety valves act	O
8	3.12		Discuss the potential negative consequences of unexpected steam release to atmosphere	O
8	3.13		Describe the effect of a sudden decrease in pressure on a steam boiler and its associated system.	O
8	3.14		Describe the effect of air in steam systems.	O
8	3.15		Explain the effect of gravity on condensate	M
8	3.16		Discuss the principles of steam line design including pressure rating and maximum bulk velocity	M
8	3.17		Explain the effect of pressure changes/excessive demand on line velocities	M
8	3.18		Describe the function of a pressure reducing valve and the reasons for their use.	O
8	3.19		Explain the mechanisms by which steam hammer and water hammer events occur	M

Section 9 – Operation

9	1		Know the procedures for starting and stopping steam boilers and bringing them on line	
9	1.1		Demonstrate the procedure for cold start and explain the factors affecting it:	
9	1.1	a)	pre-filling checks	O
9	1.1	b)	system inspection	O
9	1.1	c)	use of drains and air vents	O
9	1.1	d)	filling and venting	O
9	1.1	e)	warming-up procedure for boilers.	O
9	1.1	f)	thermal expansion during cold start	O
9	1.1	g)	change of water level with temperature	O
9	1.1	h)	Importance of minimising temperature differentials across the pressure parts during cold start	O
9	1.1	i)	precautions to be observed	O
9	1.2		Demonstrate how to raise pressure in the boiler:	O
9	1.2	a)	initial checks	O
9	1.2	b)	the importance of natural circulation, how this improves as temperature rises and where appropriate the use of manual blow-down to assist natural circulation	O
9	1.2	c)	Checking for leaks and defects	O
9	1.2	d)	Controlling the rate of temperature / pressure rise to acceptable rates	O
9	1.2	e)	Gauge glass checks	O

9	1.2	f)	Explain the need for manned operation during cold start	O
9	1.3		Explain how water level controls are proved (evaporation test or other method) and explain any additional requirements / tests needed for level controls / limiters mounted external to the steam drum and tests for direct mounted controls / limiters	O
9	1.4		Discuss special precautions to be observed with boilers fitted with economisers or superheaters (use of drains for purging or water flushing for cooling of elements, by-pass damper control etc.)	O
9	1.5		Discuss the use of superheater start up vent, manual blow-down/header drains and air cocks to assist circulation and rate of pressure rise	O
9	1.6		Discuss action(s) to be taken in the event of failure to stabilize the combustion	O
9	1.7		Describe a system of logging tests and the procedure for initiating action as a result of a test	M
9	1.8		Explain the procedure for stopping and shutting down a boiler	O
9	1.9		Explain the procedure for starting a warm boiler with residual heat following a short lay-up	O
9	1.10		Describe actions to be taken in the event of a failure of protective devices or an emergency	O
9	2		Know the procedures for letting steam into the distribution system and the associated hazards	
9	2.1		Demonstrate bringing a boiler on load:	O
9	2.1	a)	Valve opening procedures and sequence	O
9	2.1	b)	condensate loading	O
9	2.1	c)	screw-down non-return valve operation	O
9	2.1	d)	avoiding pump cavitation	O
9	2.1	e)	avoiding steam hammer	O
9	2.1	f)	avoiding vacuum forming	O
9	2.1	g)	precautions against waterlogging	O
9	2.2		Discuss load control and the inter-action between multiple boilers when operating in parallel.	O
9	2.3		Discuss valve opening sequences when bring on load	O
9	2.4		Explain the causes and effects of line erosion and corrosion leading to line rupture	O
9	2.5		Discuss load control and inter-action between multiple units when operating boilers in parallel	O
9	2.6		Discuss testing of safety equipment and devices (on boilers with more than one safety valve where there is a specific order of operation i.e. with superheater safety valve).	O
9	2.7		Explain precautions to be taken in draining the system down-stream of the crown valve, checking of traps and drains, and warming-up of piping system	O
9	2.8		Explain the cause and effect of priming	O
9	3		Be able to demonstrate normal and abnormal operations and actions when steaming	
9	3.1		Describe normal operations:	O
9	3.1	a)	Maintenance of operational parameters such as level and pressure	O
9	3.1	b)	Inspection of plant during operation	O
9	3.1	c)	reporting of defects and faults	O

9	3.1	d)	Checking for fuel and combustion gas leaks	O
9	3.1	e)	Testing of safety equipment and devices	O
9	3.1	f)	Checking water level gauges, water alarms and flame failure equipment	O
9	3.1	g)	Blowdown procedures and precautions to be taken	O
9	3.2		Discuss poor operating regimes which may impact upon safety and efficient operation in general and specifically:	O
9	3.2	a)	failure of an automatic blowdown system	O
9	3.2	b)	activation of a condensate quality alarm	O
9	4		Be able to explain the procedures for inspections, maintenance and lay up of steam boilers	
9	4.1		Describe arrangements for short term and long term laying up of plant:	
9	4.1	a)	Water wedging	O
9	4.1	b)	Nitrogen blankets	O
9	4.1	c)	Draining down	O
9	4.1	d)	water treatment chemicals management	O
9	4.2		Describe procedures used during banking up and factory shutdown periods	O
9	4.3		Discuss inspection on plant whilst not in operation	O
9	4.4		Describe the precautions required for entry into a confined space	O
9	4.5		Identify potential confined spaces at the candidate's place of work	O
9	4.6		Show a working knowledge of the requirements for liaison with Regulators and inspectors	M
9	4.7		Explain the procedures for safe isolation prior to carrying out repairs, modifications, or examinations	M
9	5		Understand the importance of record keeping and following manufacturer’s instructions	
9	5.1		Describe the record keeping arrangements at the site	O
9	5.2		Explain where to find information relating to the operation of the plant	O
9	5.3		Explain the importance of good record keeping and accurate recording of operational tasks	O
9	5.4		Discuss the procedures applicable at the site	O
9	5.5		Discuss the use of target figures as an indication of boiler thermal losses and overall plant performance. Importance of noting trends in logged instrument readings as an aid in diagnosing problems	O
9	5.6		Show a good understanding of a boiler house technical risk assessment	M
9	6		Be able to describe the supervision arrangement of the candidate's own plant and relate it to current guidance.	
9	6.1		Relate current guidance to the candidate's own place of work; both systems of work and installed plant	O

10	1		Know the main legal requirements for steam boilers	
10	1.1		State the legal requirements for boiler instrumentation:	
10	1.1	a)	pressure gauge c/w marked line	O
10	1.1	b)	safety valve	O
10	1.1	c)	efficient low water alarm (low water limiter and alarm system)	O
10	1.1	d)	sight glass	O
10	1.1	e)	main superheated / saturated steam stop valve	O
10	1.1	f)	name plate	O
10	1.1	g)	distinctive number where there is more than one boiler	O
10			Know the types of control devices and control systems required on steam boilers, and how and why they operate	
10	2.1		Identify and explain the control and measuring devices in common use on steam boilers and describe their function and problems that may occur with them:	
10	2.1	a)	pressure sensors and gauges	O
10	2.1	b)	meaning of the marking(s) on pressure gauges	O
10	2.1	c)	exhaust temperature sensors and gauges (how they can indicate water side problems)	O
10	2.1	d)	sight glasses and level shown in them	O
10	2.1	e)	level indicated inside a boiler by measuring devices including cut out and limiting devices	O
10	2.1	f)	pressure indicated inside a boiler by measuring devices including cut out and limiting devices	O
10	2.1	g)	heat and fuel meters	O
10	2.2		Identify and describe the specific controls and instruments fitted on their boiler	O
10	2.3		Describe checks for proving instruments and controls and the procedure for reporting defects	M
10	3		State the requirements for operation with respect to guidance for:	
10	3.1	a)	Gauge glass blowdown	O
10	3.1	b)	Level limiter and control tests	O
10	3.1	c)	Pressure limiting devices	O
10	3.1	d)	Safety valves	O
10	3.1	e)	Flame failure device test (non-high integrity types)	O

Appendix 5 – Category 5 specific themes – Coil type steam generators

Each Section is split into several sub-sections and covers the Learning Outcomes for Operators and Managers of Coil Type Steam Generator installations.

Whilst current guidance is contained in INDG436 and BG01, there are many legacy sites which still have controls and operational systems suited to PM5 or other guidance. The Training Provider must take this into account when delivering the course but should also refer the candidates to the advice contained in the current guidance with respect to these legacy sites.

Operator requirements – things an operator of a steam generator should know. Examination will be by multiple choice paper.

Engineer/Manager additional requirements – additional things a manager of steam generator plant should know and be able to discuss with an assessor. Operators should be aware of these issues but will not be examined or assessed on them. Managers will be required to take written examinations and attend an oral interview.

Section 6 – Basic heat & heat transfer concepts

6	1		Understand and explain the terms and concepts in SI and Imperial units for heat, pressure, temperature, volume, energy.	
6	1.1	a)	Temperature	O
6	1.1	b)	Pressure	O
6	1.1	c)	Volume	O
6	1.1	d)	Energy	O
6	1.1	e)	Heat flow	O
6	1.2	a)	Define the relationship of heat, pressure and temperature when associated with steam generator operation.	O
6	1.2	b)	Explain how to convert Imperial to SI measurements (and vice versa)	O
6	1.3	a)	Differentiate between 'gauge' and 'absolute' pressure	O
6	1.3	b)	For pressure gauges, convert between bar, psi and kPa	O
6	1.4		Explain these terms as applied to industrial boiler plant	O
6	1.4	a)	boiling point	O
6	1.4	b)	sensible heat	O
6	1.4	c)	latent heat	O
6	1.4	d)	differential temperature	O
6	1.4	e)	differential pressure	O
6	1.4	f)	stratification	O
6	1.4	g)	saturation temperature and pressure	O
6	1.4	h)	density	O
6	1.4	i)	specific volume	O
6	1.4	j)	thermal expansion	O
6	1.4	k)	two phase fluids (liquid-vapour mixture)	O
6	1.4	l)	specific enthalpy	O
6	1.4	m)	superheat	O
6	1.4	n)	sub-cooling	O
6	1.4	o)	superheated steam	O
6	1.4	p)	saturated (dry) steam	O
6	1.4	q)	wet steam	O
6	1.4	r)	dryness fraction	O
6	1.4	s)	condensate	O
6	1.4	t)	flash steam	O
6	1.5		Describe the effects of pressure on the boiling point of water and specific volumes of water and steam	O
6	1.6		Describe the effects of change in pressure on steam velocity inside a steam generator and in the distribution system	O
6	1.7		Explain the process of steam generation inside a steam generator, including change in density with pressure and two phase nature of water when the burner is firing.	O
6	1.8		Explain why steam is used instead of other forms of heating system.	M
6	2		Understand and explain the conceptual functions of an industrial steam generator	
6	2.1		Explain the functions of a steam generator as	O
6	2.1	a)	an energy converter	O

6	2.1	b)	a heat exchanger	O
6	2.1	c)	a store of energy	O
6	2.2		State the principal modes of heat transfer within steam generators (conduction, convection and radiation)	O
6	2.3		Explain the effect of thermal expansion on steam generators and the negative effects of rapid thermal expansion	O
6	2.4		Discuss the importance of clean surfaces (fireside and waterside) in steam generators and the effects of deposits impairing heat transfer (e.g. soot, scale and other fouling)	O
6	2.5		Explain the factors that may adversely affect the structural integrity of a steam generator as a result of:	O
6	2.6	a)	over-pressure	O
6	2.6	b)	low water	O
6	2.6	c)	water side fouling	O
6	2.6	d)	excessive firing rate	O
6	2.6	e)	pressure cycling	O
6	2.6	f)	flame impingement	O
6	2.6	g)	corrosion	O
6	2.6	h)	cracks in the pressure vessel	O
6	2.6	i)	excessive TDS	O
6	2.7		Explain the following catastrophic failure modes applied to industrial steam generators:	
6	2.7	a)	collapse not leading to explosion	O
6	2.7	b)	explosion due to collapse	O
6	2.7	c)	explosion due to weld failure (all types)	O
6	2.8		Identify the precautions to be observed to maintain the structural integrity of industrial steam generators	O
6	2.9		Explain From and At rating	M
6	2.10		Explain the use of steam tables and standard notation	M
6	2.11		Interpret the basic elements of steam tables (the ability to perform complex calculations is not required).	M

Section 7 – Feed water and steam generator water analysis

7	1		Know the common impurities in raw water	
7	1.1		Describe the uses of the scientific terms and units used in water chemistry	
7	1.1	a)	pH	O
7	1.1	b)	tds and uS/cm	O
7	1.1	c)	ppm	O
7	1.1	d)	mg/l	O
7	1.2		State the main conditions of raw water that can have an adverse effect on steam generator operation:	
7	1.2	a)	hardness	O
7	1.2	b)	alkalinity	O
7	1.2	c)	pH	O
7	1.2	d)	corrosive substances	O
7	1.2	e)	total dissolved solids (T.D.S.)	O

7	1.2	f)	phosphates	O
7	1.2	g)	suspended solids	O
7	1.2	h)	conductivity	O
7	1.2	i)	dissolved oxygen	O
7	2		Know the effect of impurities on steam generators and steam generator operation	
7	2.1		State the effect of pH changes on steam generator water and the relationship between alkalinity and corrosion rate	O
7	2.2		State the causes and effects of scale in steam generators	O
7	2.3		State the effect of oxygen in steam generator water	O
7	2.4		Understand the effects of contaminated condensate	O
7	3		Be able to describe common methods used for treating raw water and describe the water treatment system and testing procedure at the candidate's own plant.	
7	3.1		Describe the differences between raw water and steam generator feed water.	O
7	3.2		Explain the reasons for treating raw water	O
7	3.1		Describe different primary raw water treatment methods in basic terms and their relative advantages and disadvantages:	O
7	3.1	a)	base exchange softener including the use of brine tanks, simplex and duplex systems, regeneration	O
7	3.1	b)	reverse osmosis	O
7	3.1	c)	de-alkalisation / de-mineralisation	O
7	3.2		Describe the water treatment control methods (including common chemicals and the hazards they pose)	O
7	3.2	a)	oxygen control (thermal methods)	O
7	3.2	b)	oxygen control (chemical methods)	O
7	3.2	c)	pH control	O
7	3.3		Describe the water treatment plant and associated test regime used at their plant	O
7	3.4		Detail the importance of following instructions regarding treatment and water sampling	O
7	4		Understand methods for supplying, storing and chemical dosing of steam generator water. Relate the terms and concepts to operation under normal and abnormal conditions.	
7	4.1		Describe operational regimes for hot wells:	O
7	4.1	a)	Monitoring requirements	O
7	4.1	b)	Recommended temperature regime for a hot well	O
7	4.1	c)	Causes of too low or too high a temperature	O
7	4.1	d)	Negative consequences of too low a temperature	O
7	4.1	e)	Negative consequences of too high a temperature	O
7	4.1	f)	Effect of water temperature on oxygen levels in feed water	O
7	4.1	g)	Control of level	O
7	4.1	h	Control of temperature	O
7	4.2		Discuss the safety requirements for storage, handling water treatment chemicals (COSHH, Manual Handling, PPE, etc)	O

7	4.3		Outline different methods of dosing, and location of dosing systems and injectors	M
7	4.4		Specify which chemicals are used on the candidate's plant and what their purpose is	O
7	4.5		Explain the hazards associated with common chemicals.	O
7	4.6		Discuss potential sources of contamination of condensate with their likely effects in the steam generator	O
7	4.7		Explain methods of detecting condensate contamination	M
7	4.8		Describe different methods used for storing and supplying water for steam generators and their relative merits and disadvantages	O
7	4.8	a)	Hot well	O
7	4.8	b)	De-aerator	O
7	4.9		Describe methods of controlling feed water and their relative benefits and disadvantages:	M
7	4.9	a)	on-off pumps	M
7	4.9	b)	variable speed pumps	M
7	4.9	c)	modulating control valves	M
7	4.9	d)	Individual pumps	M
7	4.9	e)	Duty-standby pump arrangements	M
7	4.9	f)	Pump farms	M
7	5		Know the methods used to check the condition of steam generator water. Know the actions needed to maintain an optimum condition of the steam generator water. Interpret the results of water tests and state conclusions.	
7	5.1		Describe the system for chemical dosing employed at the candidate's own plant.	O
7	5.2		Describe different methods that can be employed for chemical dosing.	M
7	5.3		Describe methods for taking water samples from steam generators system such that it is:	O
7	5.3	a)	safe	O
7	5.3	b)	accurate	O
7	5.4		Describe the actions to be taken if the permitted levels of impurities are exceeded.	O
7	5.5		State the source of the control limits and / or target levels for the water testing regimes that are used (e.g. BG04 or other reference).	M
7	5.6		State the basic water testing regimes that are available and how to interpret results.	M
7	5.7		State the allowable levels of TDS in different types of boiler	M
7	6		Know possible causes of and hazards due to scale formation within the steam generator.	
7	6.1		State the reasons for scale formation in steam generators and how to avoid it	O
7	6.2		State the hazards and negative consequences associated with scale formation in steam generators	O
7	7		Know possible causes of and hazards due to corrosion formation within the steam generator.	

7	7.1		State the reasons for corrosion formation in steam generators and how to avoid it	O
7	7.2		State the hazards and negative consequences associated with formation of corrosion in steam generators	O
7	73		Explain “slug” dosing and generator corrosion protection	O
7	8		Indicate manual and intermittent/continuous blowdown valves and the manner of operating these.	
7	8.1		Describe the reasons for blowdown operations and the associated risks.	O
7	8.2		Describe the operation of blowdown valves, both manual and automatic.	O
7	8.3		Describe the potential hazards associated with blowdown systems and pipework	O
7	8.4		State the legal maximum effluent discharge temperature	O
7	8.5		Explain the consequences of inaccurate calibration of TDS control systems	O
7	8.5	a)	too high	O
7	8.5	b)	too low	O
7	8.6		Discuss manual and automatic blowdown techniques and the comparison between them in terms of effectiveness and efficiency	M
7	8.7		Explain the application of a ‘discharge consent’ for the boiler house	M
7	8.8		Understand the risks and control measures with regard to blowdown keys	M
7	8.9		Show an awareness of the effect of temperature on uncompensated TDS control systems	M
7	9		Know possible causes of and hazards due to carry-over.	
7	9.1		State the reasons for carry over from steam generators and how to avoid it:	O
7	9.1	a)	foaming	O
7	9.1	b)	water level instability	O
7	9.1	c)	hunting of water level controls	O
7	9.2		State the effects and hazards of carry over on the steam generator plant and the distribution system	O

Section 8 – Boilers and Auxiliaries

8	1		Be able to identify different steam boiler types and methods of construction	
8	1.1		Identify different types of steam boilers	
8	1.1	a)	shell boilers	O
8	1.1	b)	once through / coil boilers	O
8	1.1	c)	waste heat boilers	O
8	1.1	d)	combination boilers	O
8	1.2		Describe the specific type of steam generator on their site and how it works	O
8	1.2	a)	Vertical	O

8	1.2	b)	Horizontal	O
8	1.3		Explain the use of semi-closed receivers	O
8	1.4		Explain the hazards associated with waterside failure of once through / coil boilers and semi-closed receivers	O
8	1.4	a)	coil failure	M
8	1.4	b)	explosion due to over pressure	M
8	1.4	c)	explosion due to other failure of an unfired pressure vessel	M
8	1.6		Discuss the relative amounts of stored energy in different boiler types	O
8	2		Know the main auxiliary items, fittings and mountings provided with a steam generator	
8	2.1		Identify and describe auxiliary plant items in common use and describe their function:	
8	2.1	a)	fans	O
8	2.1	b)	air heaters	O
8	2.1	c)	economisers	O
8	2.1	d)	superheaters	O
8	2.1	e)	feed tanks and feed pumps	O
8	2.1	f)	steam injectors	O
8	2.1	g)	feed water modulation	O
8	2.1	h)	blowdown vessels	O
8	2.2		Identify and describe features, fittings and mountings in common use on steam generators and describe their function and consequence of failure:	
8	2.2	a)	safety valve	O
8	2.2	b)	crown valves	O
8	2.2	c)	coil fill valve	O
8	2.2	d)	air cocks	O
8	2.2	e)	vacuum relief / vent valves	O
8	2.2	f)	pressure gauges	O
8	2.2	g)	drain valve / sludge cock	O
8	2.2	h)	high pressure limiter	O
8	2.2	i)	dosing lines	O
8	2.2	j)	blowdown valves	O
8	2.2	k)	sparge lines and associated equipment	O
8	2.2	l)	dosing lines	O
8	2.2	m)	feed water connections	O
8	2.2	n)	sample coolers	O
8	2.2	o)	spill back lines protecting feed pumps and economisers	O
8	2.3		Discuss need for low water level protection in steam generators	O
8	3		Understand the functions of basic steam system equipment and steam distribution systems	
8	3.1		Explain the role of basic steam equipment fitted to steam systems	
8	3.1	a)	isolation valves	O
8	3.1	b)	control valves	O
8	3.1	c)	pressure reduction valves	O
8	3.1	d)	non return valves	O
8	3.1	e)	strainers	O

8	3.1	f)	steam traps	O
8	3.1	g)	safety valves located within steam distribution systems	O
8	3.1	h)	steam separators	O
8	3.1	i)	surplussing valves	O
8	3.2		Explain why steam moves around a distribution system and the effect of this movement on the steam	O
8	3.3		Explain why condensate forms in steam systems	O
8	3.4		Discuss heat loss from steam lines and the formation of condensate	O
8	3.5		Explain what is meant by sub-cooling of condensate	O
8	3.6		Explain the effect of insulation on condensate formation rates	O
8	3.7		Discuss the effect of non-condensable gases in steam lines	O
8	3.8		Show awareness of steam hammer and water hammer events and suitable preventative and corrective actions	O
8	3.9		Explain safe practice when opening and closing manual valves on boilers and system lines (hot and cold)	O
8	3.10		Explain the function of safety valves	O
8	3.11		Describe actions to be taken when safety valves act	O
8	3.12		Discuss the potential negative consequences of unexpected steam release to atmosphere	O
8	3.13		Describe the effect of a sudden decrease in pressure on a steam generator and its associated system.	O
8	3.14		Describe the effect of air in steam systems.	O
8	3.15		Explain the effect of gravity on condensate	M
8	3.16		Discuss the principles of steam line design including pressure rating and maximum bulk velocity	M
8	3.17		Explain the effect of pressure changes/excessive demand on line velocities	M
8	3.18		Describe the function of a pressure reducing valve and the reasons for their use.	O
8	3.19		Explain the mechanisms by which steam hammer and water hammer events occur	M

Section 9 – Operation

9	1		Know the procedures for starting and stopping steam generators and bringing them on line	
9	1.1		Demonstrate the procedure for cold start and explain the factors affecting it:	
9	1.1	a)	pre-filling checks	O
9	1.1	b)	system inspection	O
9	1.1	c)	use of drains and air vents	O
9	1.1	d)	filling and venting	O
9	1.1	e)	warming-up procedure for steam generators.	O
9	1.1	f)	thermal expansion during cold start	O
9	1.1	i)	precautions to be observed	O
9	1.2		Demonstrate how to raise pressure in the steam generator:	O
9	1.2	a)	initial checks	O

9	1.2	b)	Checking for leaks and defects	O
9	1.2	c)	Controlling the rate of temperature / pressure rise to acceptable rates	O
9	1.2	f)	Explain when manned operation is necessary	O
9	1.3		Explain coil blowdown tests	O
9	1.4		Discuss special precautions to be observed with steam generators fitted with superheaters (use of drains for purging or water flushing for cooling of elements, by-pass damper control etc.)	M
9	1.5		Describe a system of logging tests and the procedure for initiating action as a result of a test	M
9	1.6		Explain the procedure for stopping and shutting down a steam generator	O
9	1.7		Explain the procedure for starting a warm steam generator with residual heat following a short lay-up	O
9	2		Know the procedures for letting steam into the distribution system and the associated hazards	
9	2.1		Demonstrate bringing a steam generator on load:	O
9	2.1	a)	Valve opening procedures and sequence	O
9	2.1	b)	condensate loading	O
9	2.1	c)	screw-down non-return valve operation	O
9	2.1	d)	avoiding pump cavitation	O
9	2.1	e)	avoiding steam hammer	O
9	2.1	f)	avoiding vacuum forming	O
9	2.1	g)	precautions against waterlogging	O
9	2.2		Explain the causes and effects of line erosion and corrosion leading to line rupture	O
9	2.3		Discuss load control and inter-action between multiple units when operating steam generators in parallel	O
9	2.4		Explain precautions to be taken in draining the system down-stream of the crown valve, checking of traps and drains, and warming-up of piping system	O
9	2.5		Explain the cause and effect of carry over	O
9	3		Be able to demonstrate normal and abnormal operations and actions when steaming	
9	3.1		Describe normal operations:	O
9	3.1	a)	Inspection of plant during operation	O
9	3.1	b)	reporting of defects and faults	O
9	3.1	c)	Checking for fuel and combustion gas leaks	O
9	3.1	d)	Testing of safety equipment and devices	O
9	3.1	e)	Checking equipment	O
9	3.1	f)	Blowdown procedures and precautions to be taken	O
9	3.2		Discuss poor operating regimes which may impact upon safety and efficient operation in general and specifically:	O
9	3.2	a)	failure of an automatic blowdown system	O
9	3.2	b)	activation of a condensate quality alarm	O
9	4		Be able to explain the procedures for inspections, maintenance and lay up of steam generators	
9	4.1		Describe arrangements for short term and long term laying up of plant:	

9	4.1	a)	Water wedging	O
9	4.1	b)	Nitrogen blankets	O
9	4.1	c)	Draining down	O
9	4.1	d)	water treatment chemicals management	O
9	4.2		Describe procedures used during banking up and factory shutdown periods	O
9	4.3		Describe the precautions required for entry into a confined space	O
9	4.4		Identify potential confined spaces at the candidate's place of work	O
9	4.5		Show a working knowledge of the requirements for liaison with Regulators and inspectors	M
9	4.6		Explain the procedures for safe isolation prior to carrying out repairs, modifications, or examinations	M
9	5		Understand the importance of record keeping and following manufacturer's instructions	
9	5.1		Describe the record keeping arrangements at the site	O
9	5.2		Explain where to find information relating to the operation of the plant	O
9	5.3		Explain the importance of good record keeping and accurate recording of operational tasks	O
9	5.4		Discuss the procedures applicable at the site	O
9	5.5		Show a good understanding of a boiler house technical risk assessment	M
9	6		Be able to describe the supervision arrangement of the candidate's own plant and relate it to current guidance.	
9	6.1		Relate BG01 to the candidate's own place of work; both systems of work and installed plant	O
9	6.2		Identify and explain the principles of steam generator automatic start-up and shutdown systems	M
9	6.3		Discuss the use of BMS / timeclock systems	M

Section 10 – Controls and instrumentation

10	1		Know the main legal requirements for steam boilers	
10	1.1		State the legal requirements for boiler instrumentation:	
10	1.1	a)	pressure gauge c/w marked line	O
10	1.1	b)	safety valve	O
10	1.1	c)	efficient low water alarm (low water limiter and alarm system)	O
10	1.1	d)	sight glass (with guard if tubular)	O
10	1.1	e)	main stop valve	O
10	1.1	f)	name plate	O
10	1.1	g)	distinctive number where there is more than one boiler	O
10			Know the types of control devices and control systems required on steam steam generators, and how and why they operate	

10	2.1		Identify and explain the control and measuring devices in common use on steam generators and describe their function and problems that may occur with them:	
10	2.1	a)	pressure sensors and gauges	O
10	2.1	b)	meaning of the marking(s) on pressure gauges	O
10	2.1	c)	exhaust temperature sensors and gauges (how they can indicate water side problems)	O
10	2.1	g)	measuring devices including cut out and limiting devices	O
10	2.1	h)	pressure indicated inside a steam generator by measuring devices including cut out and limiting devices	O
10	2.1	i)	heat and fuel meters	O
10	2.2		Identify and describe the specific controls and instruments fitted on their steam generator	O
10	2.3		Describe checks for proving instruments and controls and the procedure for reporting defects	M
10	3		State the requirements for operation with respect to guidance for:	
10	3.1		Flame failure device test (non-high integrity types)	O

Appendix 6 – Syllabus and Examination development and implementation procedures

The credibility of the BOAS scheme depends critically on the appropriateness of the syllabus and learning Outcomes, and the robustness of the examination process.

This Appendix sets out the procedures whereby the Learning Outcomes and written examination papers are developed, controlled and issued.

The responsibilities of the various parties involved including the scheme owner (the CEA), its Officers, and the Assessors in regards to these are set out below.

The training syllabuses for the scheme are defined by the CEA in consultation with its delivery partners, the scheme Assessors and the Training Providers/Trainers.

Step by step procedures are defined which are designed to ensure that the quality and integrity of the scheme are maintained.

The CEA makes the final decision on approval for issue and use of all Learning Outcomes and examination papers.

1.1 - Learning Outcomes

The Learning Outcomes are based around industry recognised standards, COPs etc.

Syllabuses and Learning Outcomes exist for three categories of boiler system. These are defined in the main text of the BOAS handbook and these are identified as:

- Cat 1
- Cat 2
- Cat 3
- Cat 5

Each syllabus or set of Learning Outcomes defines the range of knowledge and skills that are needed by a candidate in order for them to demonstrate competency at the level set by the BOAS for the relevant category of boiler system.

1.1.1 Responsibilities

The CEA owns the Learning Outcomes.

The Assessors and Training Providers/Trainers are committed to supporting the development of BOAS including the Learning Outcomes.

The CEA monitor technical and regulatory developments that may impact on the best practice for the operation of boiler systems covered by the BOAS scheme.

The CEA BOAS Working Group decide when development of Learning Outcomes is required and initiate the process.

1.1.2 Development Process

1. To lead a Learning Outcomes development project the CEA will appoint a suitably qualified and experienced member as the Learning Outcomes Developer (LOD). The LOD will be responsible for ensuring that all the steps in the development procedure occur.

2. The LOD will review the existing scope of the relevant Learning Outcomes and the current versions of industry recognised standards, COPs etc.

3. The LOD will consult with other suitably qualified and experienced CEA members and relevant bodies such as the HSE.

4. Based on this review the LOD will identify areas for inclusion or adjustment (in the case of existing Learning Outcomes).

5. The LOD will prepare a draft of the new or revised Learning Outcomes and submit this to the CEA.

6. The CEA will arrange for a technical review to be carried out by one or more of their members who have not been involved in the development of the Learning Outcomes.

7. The CEA will either approve the Learning Outcomes for use or return them to the LOD for revisions and to deal with any issues found during a review.

NOTE: The CEA will repeat the review/revision steps until they are satisfied to approve the Learning Outcomes for use.

8. At the time of approval of Learning Outcomes the CEA will also set a date from which their use will be mandatory. In setting this date the CEA will give due consideration to such factors as; the urgency of reflecting changes in best practice, the time required for examination papers to be reviewed and revised, and the time required for Trainers/Training Providers to adjust training course content and training materials.

1.1.3 Implementation Process

New Learning Outcomes will be incorporated into the BOAS handbook as soon as practicable after final CEA approval. Training providers will be consulted in order to set a realistic date for any changes required to training materials, and the CEA will announce a date from which time all CEA approved BOAS training courses will use the new or revised Learning Outcomes.

Copies of old Learning Outcomes will be kept by the CEA for 5 years.

1.2 - Examination Papers

There are two aspects to maintaining the credibility of the BOAS with regards to its written examinations:

1. They must test the range of knowledge defined by the relevant Learning Outcomes so they must neither be too narrow in their focus nor stray beyond the defined scope.
2. They must not be seen as predictable and although it may be unlikely that a candidate will remember the details of question papers between their initial assessment and any subsequent 5 yearly renewal but there is a clear risk that, where papers must be re-sat by a candidate in order to pass an assessment, they will aim to learn to a specific exam paper.

The target number of sets of papers has been set at three and the CEA is responsible for ensuring that there are sufficient alternative sets of examination papers for each and every category.

Periodically, usually in coincidence with the adoption of new Learning Outcomes, new sets of examination papers will be required. The CEA is responsible for commissioning the development of sets of examination papers as and when required.

1.2.1 Responsibilities

The CEA own the examination papers; the intellectual property of the wording of the exam questions and their rationales (model answers) belongs to the CEA.

The CEA's BOAS Working Group decide when development of examination papers is required and initiate the process. Development of examination papers may be triggered by:

- the need to maintain a level of three alternative sets of examination papers per category, or
- the issue of new or revised Learning Outcomes.

The CEA is responsible for the final approval of all examination papers prior to their adoption.

The CEA will maintain a register and master copy of current approved examination papers with full revision control. The CEA will ensure that only the current approved examination papers are used by Training Providers.

1.2.2 Development Process

1. To lead the development process the CEA will appoint a suitably qualified and experienced member (Examination Developer - ED).

2. The ED will review the scope of the relevant Learning Outcomes and any existing examination papers and the associated 'model answers'.

3. Based on this review they will identify areas to be examined in questions and that will enable a candidate's breadth and depth of knowledge of the Learning Outcomes content to be determined.

4. The number of questions of each type in each paper within a set is defined by the structure of sets of examination papers. The ED will create and outline of each examination paper defining the area(s) of knowledge to be tested in each question.

5. The ED will liaise with suitably experienced and qualified CEA members and with their assistance develop wording for each question and in parallel a 'rationale' for each question setting out the expected response(s) and model answers.

6. A draft of each examination paper developed will be submitted to the CEA along with a marking schedule and the proposed model answers.

7. The CEA will arrange for a technical review to be carried out by one or more of their members not involved in the development of the paper. This will result in either a request for revisions or approval to trial the paper.

8. Each examination paper will be trialled with candidates who have completed a training course in the relevant category. This enables the accessibility and clarity of wording to be assessed. It also enables the practicality of completion of the examination within the allotted time span to be assessed; Assessors will take account of this in carrying out assessments in this situation.

9. The findings of a trial will be reported to the CEA.

10. The CEA will either approve an examination paper for use or return it to the ED for revisions to deal with any issues found during a trial. After any revisions the CEA will determine whether a further trial is required prior to their approval of the paper for use.

1.2.3 Implementation Process

New examination papers will be incorporated into the Assessment process as soon as practicable after final CEA approval.

The CEA will announce a date from which time all new examination papers will be used and will request all Trainers to destroy all old examination papers and will supply copies of the new papers in good time for the first training course following the implementation date for the new examination papers.

Copies of old examination papers and the associated 'model answers' will be kept by the CEA for 5 years.

Changes from Version 9 to version 10

All Learning Outcomes for all Categories have been overhauled and improved.

Learning Outcomes for Common themes sections 1-5 are now common across all Categories of BOAS.

Additional LOs for solid fuel principles included.

Learning Outcomes for ‘boiler specific’ themes sections 6-10 are separated into different Categories.

Old App 1 moved to App 6

Document reference CEA TG02 version 10

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