Hydrogen Skills Alliance

Hydrogen Skills Framework

Contents

Production Roles

	Theme	Knowledge Statement	Chemical/Process Engineer/ Hydrogen Process Engineer	Process Control Technician	Process Operator	Process Safety Professional
			Engineer	Technical & Trade		Specialists & Quality/H&S
		HYDROGEN INDUSTRY				
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.	✓	✓	✓	✓
2	**Hydrogen Industry** Background on hydrogen production, storage, distribution and use	Understand the global need for the hydrogen transition and how it can be produced, stored, and transported, and its benefits/uses in the energy mix (including environmental impact and safety considerations).	✓	✓	✓	✓
3	**Hydrogen Industry** Recognition of hydrogen and waste product interchangeability in other industries	Understand how hydrogen and any associated waste products in its production process (e.g. oxygen and carbon) can be repurposed and provided to use cases (i.e. chemical processes) in other industries.	✓	✓	✓	✓
		HAZARDS, RISK AND CONTROLS				
4	**Hazards, Risks and Controls** Risks and hazards	Understand the difference between risks and hazards and how to identify them; Simple (Dynamic) to Advanced Haz-Op and predictive analysis.	✓	✓	✓	✓
5	**Hazards, Risks and Controls** Hydrogen Properties	Understand the processes required to convert gases into others and indicators of the interchangeability of various gases (in terms of heating or calorific value). Understand hydrogen's chemical properties, its forms (gas & liquid), structure, volumetric and energy density, how it differs from other gases, how it interacts with other materials, and its property risks (including how it affects handling, e.g. odourless, leaks quietly, rises quickly due to lightness).	✓	✓	✓	✓
6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).	✓	✓	✓	✓

7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).	✓	✓	✓	✓
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.	✓	✓	✓	✓
9	**Hazards, Risks and Controls** Identifying and managing hydrogen; substance interaction (hydrogen embrittlement)	Understand how hydrogen may interact with steel, plastics or composite materials at a molecular level to cause embrittlement of materials and the testing required to address this (e.g. fracture mechanics testing for components to evaluate crack propagation). Understand the materials that can be used to reduce the risk of hydrogen hazards (e.g. corrosion, loss of containment, flammability, and explosion).	✓	✓	✓	✓
10	**Hazards, Risks and Controls** Identifying and managing other hazards associated with hydrogen generation, storage, transportation and use	Understand the domino effects of hydrogen hazards affecting others in the neighbourhood or from the neighbourhood impacting the hydrogen operations.	✓	✓	✓	✓
11	**Hazards, Risks and Controls** Identification of appropriate control measures for managing hydrogen	Understand the control measures required for managing hydrogen; access control, personal exposure and protective equipment, gas monitoring, ventilation, controlled spaces & zoning (including area zoning), control of temporary ignition, tools and equipment, emergency protocols.	✓	✓	✓	✓
12	**Hazards, Risks and Controls** Oversight of control measures for hydrogen processes	Understand how to program and monitor control measures in a system undertaking a chemical process with hydrogen so that the process occurs safely and efficiently.	✓	✓	✓	
13	**Hazards, Risks and Controls** Storing hydrogen for transportation using cryogenic materials	Understand how to use cryogenics or related systems to maintain hydrogen in a stable form for transportation.	✓	✓	✓	
14	**Hazards, Risks and Controls** Protocols for decommissioning hydrogen installations	Understand the decommissioning, decontamination and dismantling of equipment processes (including knowledge of purging methods and the use of inert gases).	✓	✓	✓	✓

LEGISLATION & REGULATION						
15	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in an operational role	Understand the statutory authorities that regulate the industry, including ATEX, Management of H&S Regs & ACOP L21, COSHH & ACOP L5. COMAH L111* and DSEAR & ACOP L138* Health & Safety @ Work Act 1974 Gas Safety (Installation & Use) Regulations 1998* Gas Safety (Management) Regulations 1996* Awareness of the Pressure Systems Safety Regulations 2000 Awareness of the Pressure Equipment (Safety) Regulations 2016 The Control of Substances Hazardous to Health Regulations 2002* Compliance with the Dangerous Substances and Explosive Atmosphere Regulations 2002* Compliance with The Control of Substances Hazardous to Health Regulations 2002* Transport of Dangerous Goods (Safety Advisers) Regulations 1999 **(Transport & Distribution)** Provision and Use of Work Equipment Regulations 1992 **(Transport & Distribution)**	✓	✓	✓	✓
16	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in a managerial role	Compliance with the Management of Health and Safety @ Work Regulations 1999 Awareness of the SEVESO Directive 1982 - Control of Major Accident Hazards Regulations 2015 Compliance with the Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulation 1996 (ATEX) *	✓	✓	✓	✓
PROCESS SAFETY, DESIGN AND CONTEXTUALISED KNOWLEDGE						
17	**Process Safety** Management of incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including training and competence assessment of staff to carry out their role safely (Control of Contractors - HSG 159 & INDG 368), and ensuring compliance with Process Safety Performance Indicators - HSG 254. Understand how to conduct safety audits (Asset Integrity) and management reviews.	✓			✓
18	**Process Safety** Incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including Permit to Work - HSG250; Safe Systems of Work - HSG 253 (Safe Isolations). Understand safety critical equipment and safety critical tasks.	✓	✓	✓	✓
19	**Process Safety** Incident management	Understand relevant Major Accident Scenario protocols, Safe Systems of Work - HSG 253 (Safe Isolations), Emergency Preparedness - HSG 191.	✓	✓	✓	✓

(* not required for all roles)

20	**Process Safety** Monitoring, testing and maintaining hydrogen equipment	Understand how to monitor, measure and test maintenance equipment in a hydrogen process to ensure functionality (e.g. checking vessels for signs of fracture, cracks, leakage).	✓	✓	✓	✓
21	**Hydrogen design** Reading and interpreting technical drawings with hydrogen equipment	Understand how to interpret technical drawings of systems or components incorporating hydrogen (inc. plans, diagrams, drawings, graphs and tables), accurately apply standards or regulations and understand the material implications and hazardous area requirements.	✓	✓	✓	✓
22	**Hydrogen Production** Fuel cells	Understand the different types of hydrogen fuel cell's; their functions, components, chemical and electrical processes, and advantages/ disadvantages relative to other fuel cells that impact the contexts they are utilised in (e.g. operating measure, waste, temperatures). (Fuel cells can include: proton exchange membrane (PEM), molten carbonate (MCFC), phosphoric acid (PAFC), solid oxide (SOFC), and alkaline (AFC) fuel cells.)	✓			
23	**Hydrogen Production** Fuel cells – Operating and maintaining fuel cells	Understand how to identify fuel cells that have degraded and arrange for/undertake unit replacement.	✓	✓		✓
24	**Hydrogen Production** Cooling systems	Understand the cooling systems required in hydrogen production plants, such as electrolysers, their benefits and how they operate.	✓	✓	✓	✓
25	**Hydrogen Production** Electrolysis, biofuels, photolysis	Understand the production processes available to undertake hydrogen production, their processes, and the technology they require, such as the water quality and H2 purity requirements required for electrolysis, as well as the processes required to ensure access to these.	✓	✓	✓	✓
26	**Hydrogen Production** SMR (steam methane reforming)	Understand the technological process required to produce hydrogen through steam methane reforming and natural gas.	✓	✓	✓	✓
27	**Hydrogen Production** Coal gasification	Understand the technological process required to produce hydrogen through coal gasification.	✓	✓	✓	✓
28	**Hydrogen Production:** Co-firing in natural gas and hydrogen fuelled gas turbines	Understand the operations and processes in co-firing power plants where hydrogen and natural gas may be burned simultaneously in specific proportions.	✓	✓	✓	✓
29	**Hydrogen storage** Compressed hydrogen	Understand how hydrogen can be converted into a compressed gas form, its material properties, and the activities required to store it in this state. Understand the process of loading compressed hydrogen into road transportation.	✓	✓	✓	✓
30	**Hydrogen storage** Liquid hydrogen	Understand how hydrogen can be converted into a liquid form, its material properties, and the activities required to store it in this state.	✓	✓	✓	✓

31	**Hydrogen storage** Conversion to hydrogen carriers	Understand how hydrogen can be converted into other chemical compounds as a carrier (e.g. ammonia, methane), the selected compound's material properties, and the activities required to store it in this state, including safety considerations for these hazardous chemicals.	✓	✓	✓	✓
32	**Hydrogen system maintenance** Inspect, maintain and modify hydrogen vehicles	Understand how to apply inspection and maintenance procedures to hydrogen fuel cell electric vehicles, including safely depowering and inspection of H2 gas cylinders, as well as any modifications that may be required for these systems.				
33	**Hydrogen system maintenance** Integrating hydrogen equipment	Understand how to integrate components sourced from various suppliers so that they function as intended within a single system. In hydrogen contexts this may include integrating fuel cells into electric vehicles (whether they are built to purpose or involving the certification, homologation and retrofitting of powertrains into an existing vehicle) or integrating subassemblies into an electrolyser.	✓	✓	✓	
34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.	✓	✓	✓	✓

Transmission Roles

			OCCUPATION	OCCUPATION	OCCUPATION	OCCUPATION	OCCUPATION	OCCUPATION
	Theme	Knowledge Statement	Engineer	Technical & Trade			Specialists & Quality/H&S	
	HYDROGEN INDUSTRY							
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.						
2	**Hydrogen Industry** Background on hydrogen production, storage, distribution and use	Understand the global need for the hydrogen transition and how it can be produced, stored, and transported, and its benefits/uses in the energy mix (including environmental impact and safety considerations).						
3	**Hydrogen Industry** Recognition of hydrogen and waste product interchangeability in other industries	Understand how hydrogen and any associated waste products in its production process (e.g. oxygen and carbon) can be repurposed and provided to use cases (i.e. chemical processes) in other industries.						
	HAZARDS, RISK AND CONTROLS							
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6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).						

7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).						
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.						
9	**Hazards, Risks and Controls** Identifying and managing hydrogen; substance interaction (hydrogen embrittlement)	Understand how hydrogen may interact with steel, plastics or composite materials at a molecular level to cause embrittlement of materials and the testing required to address this (e.g. fracture mechanics testing for components to evaluate crack propagation). Understand the materials that can be used to reduce the risk of hydrogen hazards (e.g. corrosion, loss of containment, flammability, and explosion).						
10	**Hazards, Risks and Controls** Identifying and managing other hazards associated with hydrogen generation, storage, transportation and use	Understand the domino effects of hydrogen hazards affecting others in the neighbourhood or from the neighbourhood impacting the hydrogen operations.						
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13	**Hazards, Risks and Controls** Storing hydrogen for transportation using cryogenic materials	Understand how to use cryogenics or related systems to maintain hydrogen in a stable form for transportation.						
14	**Hazards, Risks and Controls** Protocols for decommissioning hydrogen installations	Understand the decommissioning, decontamination and dismantling of equipment processes (including knowledge of purging methods and the use of inert gases).						

LEGISLATION & REGULATION								
15	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in an operational role	Understand the statutory authorities that regulate the industry, including ATEX, Management of H&S Regs & ACOP L21, COSHH & ACOP L5. COMAH L111* and DSEAR & ACOP L138* Health & Safety @ Work Act 1974 Gas Safety (Installation & Use) Regulations 1998* Gas Safety (Management) Regulations 1996* Awareness of the Pressure Systems Safety Regulations 2000 Awareness of the Pressure Equipment (Safety) Regulations 2016 The Control of Substances Hazardous to Health Regulations 2002* Compliance with the Dangerous Substances and Explosive Atmosphere Regulations 2002* Compliance with The Control of Substances Hazardous to Health Regulations 2002* Transport of Dangerous Goods (Safety Advisers) Regulations 1999 **(Transport & Distribution)** Provision and Use of Work Equipment Regulations 1992 **(Transport & Distribution)**						
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(* not required for all roles)

19	**Process Safety** Incident management	Understand relevant Major Accident Scenario protocols, Safe Systems of Work - HSG 253 (Safe Isolations), Emergency Preparedness - HSG 191.						
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33	**Hydrogen system maintenance** Integrating hydrogen equipment	Understand how to integrate components sourced from various suppliers so that they function as intended within a single system. In hydrogen contexts this may include integrating fuel cells into electric vehicles (whether they are built to purpose or involving the certification, homologation and retrofitting of powertrains into an existing vehicle) or integrating subassemblies into an electrolyser.						
34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.						

Transport & Distribution Roles

	Theme	Knowledge Statement	Chemical/Process Engineer/ Hydrogen Process Engineer	Pipeline integrity specialist
			Engineer	Specialists & Quality/H&S
		HYDROGEN INDUSTRY		
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.	✓	✓
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(* not required for all roles)

16	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in a managerial role	Compliance with the Management of Health and Safety @ Work Regulations 1999 Awareness of the SEVESO Directive 1982 - Control of Major Accident Hazards Regulations 2015 Compliance with the Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulation 1996 (ATEX) *	✓	✓
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34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.	✓	✓

Storage Roles

	Theme	Knowledge Statement	Chemical/ Process Engineer/ Hydrogen Process Engineer	Process Control Technician	Process Operator	Storage Technician	Pipeline integrity specialist	Process Safety Professional
			Engineer	Technical & Trade		Technical & Trade	Specialists & Quality/ H&S	
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1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.	✓	✓	✓	✓	✓	✓
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HAZARDS, RISK AND CONTROLS								
4	**Hazards, Risks and Controls** Risks and hazards	Understand the difference between risks and hazards and how to identify them; Simple (Dynamic) to Advanced Haz-Op and predictive analysis.	✓	✓	✓	✓	✓	✓
5	**Hazards, Risks and Controls** Hydrogen Properties	Understand the processes required to convert gases into others and indicators of the interchangeability of various gases (in terms of heating or calorific value). Understand hydrogen's chemical properties, its forms (gas & liquid), structure, volumetric and energy density, how it differs from other gases, how it interacts with other materials, and its property risks (including how it affects handling, e.g. odourless, leaks quietly, rises quickly due to lightness).	✓	✓	✓	✓	✓	✓
6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).	✓	✓	✓	✓	✓	✓

7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).	✓	✓	✓		✓	✓
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.	✓	✓	✓	✓	✓	✓
9	**Hazards, Risks and Controls** Identifying and managing hydrogen; substance interaction (hydrogen embrittlement)	Understand how hydrogen may interact with steel, plastics or composite materials at a molecular level to cause embrittlement of materials and the testing required to address this (e.g. fracture mechanics testing for components to evaluate crack propagation). Understand the materials that can be used to reduce the risk of hydrogen hazards (e.g. corrosion, loss of containment, flammability, and explosion).	✓	✓	✓	✓	✓	✓
10	**Hazards, Risks and Controls** Identifying and managing other hazards associated with hydrogen generation, storage, transportation and use	Understand the domino effects of hydrogen hazards affecting others in the neighbourhood or from the neighbourhood impacting the hydrogen operations.	✓	✓	✓	✓	✓	✓
11	**Hazards, Risks and Controls** Identification of appropriate control measures for managing hydrogen	Understand the control measures required for managing hydrogen; access control, personal exposure and protective equipment, gas monitoring, ventilation, controlled spaces & zoning (including area zoning), control of temporary ignition, tools and equipment, emergency protocols.	✓	✓	✓	✓	✓	✓
12	**Hazards, Risks and Controls** Oversight of control measures for hydrogen processes	Understand how to program and monitor control measures in a system undertaking a chemical process with hydrogen so that the process occurs safely and efficiently.	✓	✓	✓		✓	✓
13	**Hazards, Risks and Controls** Storing hydrogen for transportation using cryogenic materials	Understand how to use cryogenics or related systems to maintain hydrogen in a stable form for transportation.	✓	✓	✓	✓	✓	
14	**Hazards, Risks and Controls** Protocols for decommissioning hydrogen installations	Understand the decommissioning, decontamination and dismantling of equipment processes (including knowledge of purging methods and the use of inert gases).	✓	✓	✓	✓	✓	✓

LEGISLATION & REGULATION								
15	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in an operational role	Understand the statutory authorities that regulate the industry, including ATEX, Management of H&S Regs & ACOP L21, COSHH & ACOP L5. COMAH L111* and DSEAR & ACOP L138* Health & Safety @ Work Act 1974 Gas Safety (Installation & Use) Regulations 1998* Gas Safety (Management) Regulations 1996* Awareness of the Pressure Systems Safety Regulations 2000 Awareness of the Pressure Equipment (Safety) Regulations 2016 The Control of Substances Hazardous to Health Regulations 2002* Compliance with the Dangerous Substances and Explosive Atmosphere Regulations 2002* Compliance with The Control of Substances Hazardous to Health Regulations 2002* Transport of Dangerous Goods (Safety Advisers) Regulations 1999 **(Transport & Distribution)** Provision and Use of Work Equipment Regulations 1992 **(Transport & Distribution)**	✓	✓	✓	✓	✓	✓
16	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in a managerial role	Compliance with the Management of Health and Safety @ Work Regulations 1999 Awareness of the SEVESO Directive 1982 - Control of Major Accident Hazards Regulations 2015 Compliance with the Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulation 1996 (ATEX) *	✓			✓	✓	✓
PROCESS SAFETY, DESIGN AND CONTEXTUALISED KNOWLEDGE								
17	**Process Safety** Management of incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including training and competence assessment of staff to carry out their role safely (Control of Contractors - HSG 159 & INDG 368), and ensuring compliance with Process Safety Performance Indicators - HSG 254. Understand how to conduct safety audits (Asset Integrity) and management reviews.	✓				✓	✓
18	**Process Safety** Incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including Permit to Work - HSG250; Safe Systems of Work - HSG 253 (Safe Isolations). Understand safety critical equipment and safety critical tasks.	✓	✓	✓	✓	✓	✓
19	**Process Safety** Incident management	Understand relevant Major Accident Scenario protocols, Safe Systems of Work - HSG 253 (Safe Isolations), Emergency Preparedness - HSG 191.	✓	✓	✓	✓	✓	✓

(* not required for all roles)

20	**Process Safety** Monitoring, testing and maintaining hydrogen equipment	Understand how to monitor, measure and test maintenance equipment in a hydrogen process to ensure functionality (e.g. checking vessels for signs of fracture, cracks, leakage).	✓	✓	✓	✓	✓	✓
21	**Hydrogen design** Reading and interpreting technical drawings with hydrogen equipment	Understand how to interpret technical drawings of systems or components incorporating hydrogen (inc. plans, diagrams, drawings, graphs and tables), accurately apply standards or regulations and understand the material implications and hazardous area requirements.	✓	✓	✓	✓	✓	✓
22	**Hydrogen Production** Fuel cells	Understand the different types of hydrogen fuel cell's; their functions, components, chemical and electrical processes, and advantages/ disadvantages relative to other fuel cells that impact the contexts they are utilised in (e.g. operating measure, waste, temperatures). (Fuel cells can include: proton exchange membrane (PEM), molten carbonate (MCFC), phosphoric acid (PAFC), solid oxide (SOFC), and alkaline (AFC) fuel cells.)	✓					
23	**Hydrogen Production** Fuel cells – Operating and maintaining fuel cells	Understand how to identify fuel cells that have degraded and arrange for/undertake unit replacement.	✓	✓		✓	✓	✓
24	**Hydrogen Production** Cooling systems	Understand the cooling systems required in hydrogen production plants, such as electrolysers, their benefits and how they operate.	✓	✓	✓	✓		✓
25	**Hydrogen Production** Electrolysis, biofuels, photolysis	Understand the production processes available to undertake hydrogen production, their processes, and the technology they require, such as the water quality and H2 purity requirements required for electrolysis, as well as the processes required to ensure access to these.	✓	✓	✓	✓		✓
26	**Hydrogen Production** SMR (steam methane reforming)	Understand the technological process required to produce hydrogen through steam methane reforming and natural gas.	✓	✓	✓	✓		✓
27	**Hydrogen Production** Coal gasification	Understand the technological process required to produce hydrogen through coal gasification.	✓	✓	✓	✓		✓
28	**Hydrogen Production:** Co-firing in natural gas and hydrogen fuelled gas turbines	Understand the operations and processes in co-firing power plants where hydrogen and natural gas may be burned simultaneously in specific proportions.	✓	✓	✓	✓		✓
29	**Hydrogen storage** Compressed hydrogen	Understand how hydrogen can be converted into a compressed gas form, its material properties, and the activities required to store it in this state. Understand the process of loading compressed hydrogen into road transportation.	✓	✓	✓	✓	✓	✓

30	**Hydrogen storage** Liquid hydrogen	Understand how hydrogen can be converted into a liquid form, its material properties, and the activities required to store it in this state.	✓	✓	✓	✓	✓ DEVELOPMENT	✓
31	**Hydrogen storage** Conversion to hydrogen carriers	Understand how hydrogen can be converted into other chemical compounds as a carrier (e.g. ammonia, methane), the selected compound's material properties, and the activities required to store it in this state, including safety considerations for these hazardous chemicals.	✓	✓	✓	✓	✓	✓
32	**Hydrogen system maintenance** Inspect, maintain and modify hydrogen vehicles	Understand how to apply inspection and maintenance procedures to hydrogen fuel cell electric vehicles, including safely depowering and inspection of H2 gas cylinders, as well as any modifications that may be required for these systems.						
33	**Hydrogen system maintenance** Integrating hydrogen equipment	Understand how to integrate components sourced from various suppliers so that they function as intended within a single system. In hydrogen contexts this may include integrating fuel cells into electric vehicles (whether they are built to purpose or involving the certification, homologation and retrofitting of powertrains into an existing vehicle) or integrating subassemblies into an electrolyser.	✓	✓	✓			
34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.	✓			✓	✓	

Maritime Roles

	Theme	Knowledge Statement	OCCUPATION Engineer	OCCUPATION Technical & Trade	OCCUPATION Technical & Trade	OCCUPATION Technical & Trade	OCCUPATION Specialists & Quality/H&S	OCCUPATION Specialists & Quality/H&S
		HYDROGEN INDUSTRY						
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.						
2	**Hydrogen Industry** Background on hydrogen production, storage, distribution and use	Understand the global need for the hydrogen transition and how it can be produced, stored, and transported, and its benefits/uses in the energy mix (including environmental impact and safety considerations).						
3	**Hydrogen Industry** Recognition of hydrogen and waste product interchangeability in other industries	Understand how hydrogen and any associated waste products in its production process (e.g. oxygen and carbon) can be repurposed and provided to use cases (i.e. chemical processes) in other industries.						
		HAZARDS, RISK AND CONTROLS						
4	**Hazards, Risks and Controls** Risks and hazards	Understand the difference between risks and hazards and how to identify them; Simple (Dynamic) to Advanced Haz-Op and predictive analysis.						
5	**Hazards, Risks and Controls** Hydrogen Properties	Understand the processes required to convert gases into others and indicators of the interchangeability of various gases (in terms of heating or calorific value). Understand hydrogen's chemical properties, its forms (gas & liquid), structure, volumetric and energy density, how it differs from other gases, how it interacts with other materials, and its property risks (including how it affects handling, e.g. odourless, leaks quietly, rises quickly due to lightness).						
6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).						

(* not required for all roles)

7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).						
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.						
9	**Hazards, Risks and Controls** Identifying and managing hydrogen; substance interaction (hydrogen embrittlement)	Understand how hydrogen may interact with steel, plastics or composite materials at a molecular level to cause embrittlement of materials and the testing required to address this (e.g. fracture mechanics testing for components to evaluate crack propagation). Understand the materials that can be used to reduce the risk of hydrogen hazards (e.g. corrosion, loss of containment, flammability, and explosion).						
10	**Hazards, Risks and Controls** Identifying and managing other hazards associated with hydrogen generation, storage, transportation and use	Understand the domino effects of hydrogen hazards affecting others in the neighbourhood or from the neighbourhood impacting the hydrogen operations.						
11	**Hazards, Risks and Controls** Identification of appropriate control measures for managing hydrogen	Understand the control measures required for managing hydrogen; access control, personal exposure and protective equipment, gas monitoring, ventilation, controlled spaces & zoning (including area zoning), control of temporary ignition, tools and equipment, emergency protocols.						
12	**Hazards, Risks and Controls** Oversight of control measures for hydrogen processes	Understand how to program and monitor control measures in a system undertaking a chemical process with hydrogen so that the process occurs safely and efficiently.						
13	**Hazards, Risks and Controls** Storing hydrogen for transportation using cryogenic materials	Understand how to use cryogenics or related systems to maintain hydrogen in a stable form for transportation.						
14	**Hazards, Risks and Controls** Protocols for decommissioning hydrogen installations	Understand the decommissioning, decontamination and dismantling of equipment processes (including knowledge of purging methods and the use of inert gases).						

LEGISLATION & REGULATION								
15	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in an operational role	Understand the statutory authorities that regulate the industry, including ATEX, Management of H&S Regs & ACOP L21, COSHH & ACOP L5. COMAH L111* and DSEAR & ACOP L138* Health & Safety @ Work Act 1974 Gas Safety (Installation & Use) Regulations 1998* Gas Safety (Management) Regulations 1996* Awareness of the Pressure Systems Safety Regulations 2000 Awareness of the Pressure Equipment (Safety) Regulations 2016 The Control of Substances Hazardous to Health Regulations 2002* Compliance with the Dangerous Substances and Explosive Atmosphere Regulations 2002* Compliance with The Control of Substances Hazardous to Health Regulations 2002* Transport of Dangerous Goods (Safety Advisers) Regulations 1999 **(Transport & Distribution)** Provision and Use of Work Equipment Regulations 1992 **(Transport & Distribution)**						
16	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in a managerial role	Compliance with the Management of Health and Safety @ Work Regulations 1999 Awareness of the SEVESO Directive 1982 - Control of Major Accident Hazards Regulations 2015 Compliance with the Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulation 1996 (ATEX) *						
PROCESS SAFETY, DESIGN AND CONTEXTUALISED KNOWLEDGE								
17	**Process Safety** Management of incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including training and competence assessment of staff to carry out their role safely (Control of Contractors - HSG 159 & INDG 368), and ensuring compliance with Process Safety Performance Indicators - HSG 254. Understand how to conduct safety audits (Asset Integrity) and management reviews.						
18	**Process Safety** Incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including Permit to Work - HSG250; Safe Systems of Work - HSG 253 (Safe Isolations). Understand safety critical equipment and safety critical tasks.						

(* not required for all roles)

19	**Process Safety** Incident management	Understand relevant Major Accident Scenario protocols, Safe Systems of Work - HSG 253 (Safe Isolations), Emergency Preparedness - HSG 191.						
20	**Process Safety** Monitoring, testing and maintaining hydrogen equipment	Understand how to monitor, measure and test maintenance equipment in a hydrogen process to ensure functionality (e.g. checking vessels for signs of fracture, cracks, leakage).						
21	**Hydrogen design** Reading and interpreting technical drawings with hydrogen equipment	Understand how to interpret technical drawings of systems or components incorporating hydrogen (inc. plans, diagrams, drawings, graphs and tables), accurately apply standards or regulations and understand the material implications and hazardous area requirements.						
22	**Hydrogen Production** Fuel cells	Understand the different types of hydrogen fuel cell's; their functions, components, chemical and electrical processes, and advantages/disadvantages relative to other fuel cells that impact the contexts they are utilised in (e.g. operating measure, waste, temperatures). (Fuel cells can include: proton exchange membrane (PEM), molten carbonate (MCFC), phosphoric acid (PAFC), solid oxide (SOFC), and alkaline (AFC) fuel cells.)						
23	**Hydrogen Production** Fuel cells – Operating and maintaining fuel cells	Understand how to identify fuel cells that have degraded and arrange for/undertake unit replacement.						
24	**Hydrogen Production** Cooling systems	Understand the cooling systems required in hydrogen production plants, such as electrolysers, their benefits and how they operate.						
25	**Hydrogen Production** Electrolysis, biofuels, photolysis	Understand the production processes available to undertake hydrogen production, their processes, and the technology they require, such as the water quality and H2 purity requirements required for electrolysis, as well as the processes required to ensure access to these.						
26	**Hydrogen Production** SMR (steam methane reforming)	Understand the technological process required to produce hydrogen through steam methane reforming and natural gas.						
27	**Hydrogen Production** Coal gasification	Understand the technological process required to produce hydrogen through coal gasification.						
28	**Hydrogen Production:** Co-firing in natural gas and hydrogen fuelled gas turbines	Understand the operations and processes in co-firing power plants where hydrogen and natural gas may be burned simultaneously in specific proportions.						

29	**Hydrogen storage** Compressed hydrogen	Understand how hydrogen can be converted into a compressed gas form, its material properties, and the activities required to store it in this state. Understand the process of loading compressed hydrogen into road transportation.						
30	**Hydrogen storage** Liquid hydrogen	Understand how hydrogen can be converted into a liquid form, its material properties, and the activities required to store it in this state.						
31	**Hydrogen storage** Conversion to hydrogen carriers	Understand how hydrogen can be converted into other chemical compounds as a carrier (e.g. ammonia, methane), the selected compound's material properties, and the activities required to store it in this state, including safety considerations for these hazardous chemicals.						
32	**Hydrogen system maintenance** Inspect, maintain and modify hydrogen vehicles	Understand how to apply inspection and maintenance procedures to hydrogen fuel cell electric vehicles, including safely depowering and inspection of H2 gas cylinders, as well as any modifications that may be required for these systems.						
33	**Hydrogen system maintenance** Integrating hydrogen equipment	Understand how to integrate components sourced from various suppliers so that they function as intended within a single system. In hydrogen contexts this may include integrating fuel cells into electric vehicles (whether they are built to purpose or involving the certification, homologation and retrofitting of powertrains into an existing vehicle) or integrating subassemblies into an electrolyser.						
34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.						

Aerospace Roles

	Theme	Knowledge Statement	OCCUPATION Engineer	OCCUPATION Technical & Trade	OCCUPATION Technical & Trade	OCCUPATION Technical & Trade	OCCUPATION Specialists & Quality/H&S	OCCUPATION Specialists & Quality/H&S
		HYDROGEN INDUSTRY						
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.						
2	**Hydrogen Industry** Background on hydrogen production, storage, distribution and use	Understand the global need for the hydrogen transition and how it can be produced, stored, and transported, and its benefits/uses in the energy mix (including environmental impact and safety considerations).						
3	**Hydrogen Industry** Recognition of hydrogen and waste product interchangeability in other industries	Understand how hydrogen and any associated waste products in its production process (e.g. oxygen and carbon) can be repurposed and provided to use cases (i.e. chemical processes) in other industries.						
		HAZARDS, RISK AND CONTROLS						
4	**Hazards, Risks and Controls** Risks and hazards	Understand the difference between risks and hazards and how to identify them; Simple (Dynamic) to Advanced Haz-Op and predictive analysis.						
5	**Hazards, Risks and Controls** Hydrogen Properties	Understand the processes required to convert gases into others and indicators of the interchangeability of various gases (in terms of heating or calorific value). Understand hydrogen's chemical properties, its forms (gas & liquid), structure, volumetric and energy density, how it differs from other gases, how it interacts with other materials, and its property risks (including how it affects handling, e.g. odourless, leaks quietly, rises quickly due to lightness).						
6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).						

7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).						
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.						
9	**Hazards, Risks and Controls** Identifying and managing hydrogen; substance interaction (hydrogen embrittlement)	Understand how hydrogen may interact with steel, plastics or composite materials at a molecular level to cause embrittlement of materials and the testing required to address this (e.g. fracture mechanics testing for components to evaluate crack propagation). Understand the materials that can be used to reduce the risk of hydrogen hazards (e.g. corrosion, loss of containment, flammability, and explosion).						
10	**Hazards, Risks and Controls** Identifying and managing other hazards associated with hydrogen generation, storage, transportation and use	Understand the domino effects of hydrogen hazards affecting others in the neighbourhood or from the neighbourhood impacting the hydrogen operations.						
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12	**Hazards, Risks and Controls** Oversight of control measures for hydrogen processes	Understand how to program and monitor control measures in a system undertaking a chemical process with hydrogen so that the process occurs safely and efficiently.						
13	**Hazards, Risks and Controls** Storing hydrogen for transportation using cryogenic materials	Understand how to use cryogenics or related systems to maintain hydrogen in a stable form for transportation.						
14	**Hazards, Risks and Controls** Protocols for decommissioning hydrogen installations	Understand the decommissioning, decontamination and dismantling of equipment processes (including knowledge of purging methods and the use of inert gases).						

LEGISLATION & REGULATION								
15	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in an operational role	Understand the statutory authorities that regulate the industry, including ATEX, Management of H&S Regs & ACOP L21, COSHH & ACOP L5. COMAH L111* and DSEAR & ACOP L138* Health & Safety @ Work Act 1974 Gas Safety (Installation & Use) Regulations 1998* Gas Safety (Management) Regulations 1996* Awareness of the Pressure Systems Safety Regulations 2000 Awareness of the Pressure Equipment (Safety) Regulations 2016 The Control of Substances Hazardous to Health Regulations 2002* Compliance with the Dangerous Substances and Explosive Atmosphere Regulations 2002* Compliance with The Control of Substances Hazardous to Health Regulations 2002* Transport of Dangerous Goods (Safety Advisers) Regulations 1999 **(Transport & Distribution)** Provision and Use of Work Equipment Regulations 1992 **(Transport & Distribution)**						
16	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in a managerial role	Compliance with the Management of Health and Safety @ Work Regulations 1999 Awareness of the SEVESO Directive 1982 - Control of Major Accident Hazards Regulations 2015 Compliance with the Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulation 1996 (ATEX) *						
PROCESS SAFETY, DESIGN AND CONTEXTUALISED KNOWLEDGE								
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18	**Process Safety** Incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including Permit to Work - HSG250; Safe Systems of Work - HSG 253 (Safe Isolations). Understand safety critical equipment and safety critical tasks.						

(* not required for all roles)

19	**Process Safety** Incident management	Understand relevant Major Accident Scenario protocols, Safe Systems of Work - HSG 253 (Safe Isolations), Emergency Preparedness - HSG 191.						
20	**Process Safety** Monitoring, testing and maintaining hydrogen equipment	Understand how to monitor, measure and test maintenance equipment in a hydrogen process to ensure functionality (e.g. checking vessels for signs of fracture, cracks, leakage).						
21	**Hydrogen design** Reading and interpreting technical drawings with hydrogen equipment	Understand how to interpret technical drawings of systems or components incorporating hydrogen (inc. plans, diagrams, drawings, graphs and tables), accurately apply standards or regulations and understand the material implications and hazardous area requirements.						
22	**Hydrogen Production** Fuel cells	Understand the different types of hydrogen fuel cell's; their functions, components, chemical and electrical processes, and advantages/disadvantages relative to other fuel cells that impact the contexts they are utilised in (e.g. operating measure, waste, temperatures). (Fuel cells can include: proton exchange membrane (PEM), molten carbonate (MCFC), phosphoric acid (PAFC), solid oxide (SOFC), and alkaline (AFC) fuel cells.)						
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25	**Hydrogen Production** Electrolysis, biofuels, photolysis	Understand the production processes available to undertake hydrogen production, their processes, and the technology they require, such as the water quality and H2 purity requirements required for electrolysis, as well as the processes required to ensure access to these.						
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27	**Hydrogen Production** Coal gasification	Understand the technological process required to produce hydrogen through coal gasification.						
28	**Hydrogen Production:** Co-firing in natural gas and hydrogen fuelled gas turbines	Understand the operations and processes in co-firing power plants where hydrogen and natural gas may be burned simultaneously in specific proportions.						

29	**Hydrogen storage** Compressed hydrogen	Understand how hydrogen can be converted into a compressed gas form, its material properties, and the activities required to store it in this state. Understand the process of loading compressed hydrogen into road transportation.						
30	**Hydrogen storage** Liquid hydrogen	Understand how hydrogen can be converted into a liquid form, its material properties, and the activities required to store it in this state.						
31	**Hydrogen storage** Conversion to hydrogen carriers	Understand how hydrogen can be converted into other chemical compounds as a carrier (e.g. ammonia, methane), the selected compound's material properties, and the activities required to store it in this state, including safety considerations for these hazardous chemicals.						
32	**Hydrogen system maintenance** Inspect, maintain and modify hydrogen vehicles	Understand how to apply inspection and maintenance procedures to hydrogen fuel cell electric vehicles, including safely depowering and inspection of H2 gas cylinders, as well as any modifications that may be required for these systems.						
33	**Hydrogen system maintenance** Integrating hydrogen equipment	Understand how to integrate components sourced from various suppliers so that they function as intended within a single system. In hydrogen contexts this may include integrating fuel cells into electric vehicles (whether they are built to purpose or involving the certification, homologation and retrofitting of powertrains into an existing vehicle) or integrating subassemblies into an electrolyser.						
34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.						

Industrial Decarbonisation Roles

	Theme	Knowledge Statement	Chemical/ Process Engineer/ Hydrogen Process Engineer	Process Safety Professional
			Engineer	Specialists & Quality/H&S
		HYDROGEN INDUSTRY		
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.	✓	✓
2	**Hydrogen Industry** Background on hydrogen production, storage, distribution and use	Understand the global need for the hydrogen transition and how it can be produced, stored, and transported, and its benefits/uses in the energy mix (including environmental impact and safety considerations).	✓	✓
3	**Hydrogen Industry** Recognition of hydrogen and waste product interchangeability in other industries	Understand how hydrogen and any associated waste products in its production process (e.g. oxygen and carbon) can be repurposed and provided to use cases (i.e. chemical processes) in other industries.	✓	✓
		HAZARDS, RISK AND CONTROLS		
4	**Hazards, Risks and Controls** Risks and hazards	Understand the difference between risks and hazards and how to identify them; Simple (Dynamic) to Advanced Haz-Op and predictive analysis.	✓	✓
5	**Hazards, Risks and Controls** Hydrogen Properties	Understand the processes required to convert gases into others and indicators of the interchangeability of various gases (in terms of heating or calorific value). Understand hydrogen's chemical properties, its forms (gas & liquid), structure, volumetric and energy density, how it differs from other gases, how it interacts with other materials, and its property risks (including how it affects handling, e.g. odourless, leaks quietly, rises quickly due to lightness).	✓	✓
6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).	✓	✓
7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).	✓	✓
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.	✓	✓

9	**Hazards, Risks and Controls** Identifying and managing hydrogen; substance interaction (hydrogen embrittlement)	Understand how hydrogen may interact with steel, plastics or composite materials at a molecular level to cause embrittlement of materials and the testing required to address this (e.g. fracture mechanics testing for components to evaluate crack propagation). Understand the materials that can be used to reduce the risk of hydrogen hazards (e.g. corrosion, loss of containment, flammability, and explosion).	✓	✓
10	**Hazards, Risks and Controls** Identifying and managing other hazards associated with hydrogen generation, storage, transportation and use	Understand the domino effects of hydrogen hazards affecting others in the neighbourhood or from the neighbourhood impacting the hydrogen operations.	✓	✓
11	**Hazards, Risks and Controls** Identification of appropriate control measures for managing hydrogen	Understand the control measures required for managing hydrogen; access control, personal exposure and protective equipment, gas monitoring, ventilation, controlled spaces & zoning (including area zoning), control of temporary ignition, tools and equipment, emergency protocols.	✓	✓
12	**Hazards, Risks and Controls** Oversight of control measures for hydrogen processes	Understand how to program and monitor control measures in a system undertaking a chemical process with hydrogen so that the process occurs safely and efficiently.	✓	
13	**Hazards, Risks and Controls** Storing hydrogen for transportation using cryogenic materials	Understand how to use cryogenics or related systems to maintain hydrogen in a stable form for transportation.	✓	
14	**Hazards, Risks and Controls** Protocols for decommissioning hydrogen installations	Understand the decommissioning, decontamination and dismantling of equipment processes (including knowledge of purging methods and the use of inert gases).	✓	✓
		LEGISLATION & REGULATION		
15	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in an operational role	Understand the statutory authorities that regulate the industry, including ATEX, Management of H&S Regs & ACOP L21, COSHH & ACOP L5. COMAH L111* and DSEAR & ACOP L138* Health & Safety @ Work Act 1974 Gas Safety (Installation & Use) Regulations 1998* Gas Safety (Management) Regulations 1996* Awareness of the Pressure Systems Safety Regulations 2000 Awareness of the Pressure Equipment (Safety) Regulations 2016 The Control of Substances Hazardous to Health Regulations 2002* Compliance with the Dangerous Substances and Explosive Atmosphere Regulations 2002* Compliance with The Control of Substances Hazardous to Health Regulations 2002* Transport of Dangerous Goods (Safety Advisers) Regulations 1999 **(Transport & Distribution)** Provision and Use of Work Equipment Regulations 1992 **(Transport & Distribution)**	✓	✓
16	**Legislation & Regulation** Legislation and regulatory requirements relating to the use of hydrogen in a managerial role	Compliance with the Management of Health and Safety @ Work Regulations 1999 Awareness of the SEVESO Directive 1982 - Control of Major Accident Hazards Regulations 2015 Compliance with the Equipment and Protective Systems intended for use in potentially explosive atmospheres Regulation 1996 (ATEX) *	✓	✓

(* not required for all roles)

PROCESS SAFETY, DESIGN AND CONTEXTUALISED KNOWLEDGE				
17	**Process Safety** Management of incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including training and competence assessment of staff to carry out their role safely (Control of Contractors - HSG 159 & INDG 368), and ensuring compliance with Process Safety Performance Indicators - HSG 254. Understand how to conduct safety audits (Asset Integrity) and management reviews.	✓	✓
18	**Process Safety** Incident prevention	Understand the relevant information, documentation, records, policies & procedures as they relate to hydrogen including Permit to Work - HSG250; Safe Systems of Work - HSG 253 (Safe Isolations). Understand safety critical equipment and safety critical tasks.	✓	✓
19	**Process Safety** Incident management	Understand relevant Major Accident Scenario protocols, Safe Systems of Work - HSG 253 (Safe Isolations), Emergency Preparedness - HSG 191.	✓	✓
20	**Process Safety** Monitoring, testing and maintaining hydrogen equipment	Understand how to monitor, measure and test maintenance equipment in a hydrogen process to ensure functionality (e.g. checking vessels for signs of fracture, cracks, leakage).	✓	✓
21	**Hydrogen design** Reading and interpreting technical drawings with hydrogen equipment	Understand how to interpret technical drawings of systems or components incorporating hydrogen (inc. plans, diagrams, drawings, graphs and tables), accurately apply standards or regulations and understand the material implications and hazardous area requirements.	✓	✓
22	**Hydrogen Production** Fuel cells	Understand the different types of hydrogen fuel cell's; their functions, components, chemical and electrical processes, and advantages/disadvantages relative to other fuel cells that impact the contexts they are utilised in (e.g. operating measure, waste, temperatures). (Fuel cells can include: proton exchange membrane (PEM), molten carbonate (MCFC), phosphoric acid (PAFC), solid oxide (SOFC), and alkaline (AFC) fuel cells.)	✓	
23	**Hydrogen Production** Fuel cells – Operating and maintaining fuel cells	Understand how to identify fuel cells that have degraded and arrange for/undertake unit replacement.	✓	✓
24	**Hydrogen Production** Cooling systems	Understand the cooling systems required in hydrogen production plants, such as electrolysers, their benefits and how they operate.	✓	✓
25	**Hydrogen Production** Electrolysis, biofuels, photolysis	Understand the production processes available to undertake hydrogen production, their processes, and the technology they require, such as the water quality and H2 purity requirements required for electrolysis, as well as the processes required to ensure access to these.	✓	✓
26	**Hydrogen Production** SMR (steam methane reforming)	Understand the technological process required to produce hydrogen through steam methane reforming and natural gas.	✓	✓
27	**Hydrogen Production** Coal gasification	Understand the technological process required to produce hydrogen through coal gasification.	✓	✓
28	**Hydrogen Production:** Co-firing in natural gas and hydrogen fuelled gas turbines	Understand the operations and processes in co-firing power plants where hydrogen and natural gas may be burned simultaneously in specific proportions.	✓	✓

29	**Hydrogen storage** Compressed hydrogen	Understand how hydrogen can be converted into a compressed gas form, its material properties, and the activities required to store it in this state. Understand the process of loading compressed hydrogen into road transportation.	✓	✓
30	**Hydrogen storage** Liquid hydrogen	Understand how hydrogen can be converted into a liquid form, its material properties, and the activities required to store it in this state.	✓	✓
31	**Hydrogen storage** Conversion to hydrogen carriers	Understand how hydrogen can be converted into other chemical compounds as a carrier (e.g. ammonia, methane), the selected compound's material properties, and the activities required to store it in this state, including safety considerations for these hazardous chemicals.	✓	✓
32	**Hydrogen system maintenance** Inspect, maintain and modify hydrogen vehicles	Understand how to apply inspection and maintenance procedures to hydrogen fuel cell electric vehicles, including safely depowering and inspection of H2 gas cylinders, as well as any modifications that may be required for these systems.		
33	**Hydrogen system maintenance** Integrating hydrogen equipment	Understand how to integrate components sourced from various suppliers so that they function as intended within a single system. In hydrogen contexts this may include integrating fuel cells into electric vehicles (whether they are built to purpose or involving the certification, homologation and retrofitting of powertrains into an existing vehicle) or integrating subassemblies into an electrolyser.	✓	
34	**Hydrogen Logistics** Supply Chain Logistics	Understand how to oversee and manage the logistical movement of hydrogen materials across a supply chain, ensuring a consistent, even flow of supply.	✓	

Automotive Roles

	Theme	Knowledge Statement	OCCUPATION Engineer	OCCUPATION Technical & Trade	OCCUPATION Technical & Trade	OCCUPATION Technical & Trade	OCCUPATION Specialists & Quality/H&S	OCCUPATION Specialists & Quality/H&S
HYDROGEN INDUSTRY								
1	**Hydrogen Industry** UK Net-zero targets, alternative fuel sources, hydrogen usages, legal and compliance regulations	Understand the current position of the hydrogen industry within the wider net-zero ambition and the potential future uses. Understand the UK low-carbon hydrogen standard and relevant legal and compliance regulations.						
2	**Hydrogen Industry** Background on hydrogen production, storage, distribution and use	Understand the global need for the hydrogen transition and how it can be produced, stored, and transported, and its benefits/uses in the energy mix (including environmental impact and safety considerations).						
3	**Hydrogen Industry** Recognition of hydrogen and waste product interchangeability in other industries	Understand how hydrogen and any associated waste products in its production process (e.g. oxygen and carbon) can be repurposed and provided to use cases (i.e. chemical processes) in other industries.						
HAZARDS, RISK AND CONTROLS								
4	**Hazards, Risks and Controls** Risks and hazards	Understand the difference between risks and hazards and how to identify them; Simple (Dynamic) to Advanced Haz-Op and predictive analysis.						
5	**Hazards, Risks and Controls** Hydrogen Properties	Understand the processes required to convert gases into others and indicators of the interchangeability of various gases (in terms of heating or calorific value). Understand hydrogen's chemical properties, its forms (gas & liquid), structure, volumetric and energy density, how it differs from other gases, how it interacts with other materials, and its property risks (including how it affects handling, e.g. odourless, leaks quietly, rises quickly due to lightness).						
6	**Hazards, Risks and Controls** High pressure gas systems and vessels	Understand the high pressures hydrogen is piped and tubed through in gas systems relative to other gases and the impact on pipeline/vessel design, operation and safety in planning and construction (e.g. what materials, sizing and density are to be used for hydrogen pipes).						

7	**Hazards, Risks and Controls** Power electronics	Understand high-voltage power electronics that provide large energy inputs into hydrogen production (e.g. transformers, substations, capacitors).						
8	**Hazards, Risks and Controls** Identifying and managing hydrogen hazardous areas	Understand the hazards that arise from using hydrogen (e.g. explosion, fire, suffocation) and which environmental/material factors may contribute to these (e.g. ignition factors, loss of containment factors, embrittlement), as well as the appropriate safety zones and emergency procedures. Understand the correct ATEX-rated equipment that may be required.						
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