

**SKILLS FRAMEWORK FOR PRECISION ENGINEERING
TECHNICAL SKILLS AND COMPETENCIES (TSC) REFERENCE DOCUMENT**

TSC Category	Engineering and Manufacturing Fundamentals					
TSC	Heat Treatment Processing					
TSC Description	Analyse effects of heat treatments to determine suitable materials and treatment processes to achieve required material properties for manufactured components and products					
TSC Proficiency Description	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
				PRE-ACE-4027-1.1	PRE-ACE-5027-1.1	
				Review heat treatment processes for metals to meet property requirements	Apply computational analyses to review and select heat treatment processes and materials to meet property requirements	
Knowledge				<ul style="list-style-type: none"> Types of metals, heat treatment processes, furnaces, equipment and atmospheres Physical metallurgy hardenability, Fe-C diagrams, phases and phase transformations Different phases and microstructures that may form, upon heat treatment of metals, in alloy compositions, and their respective properties Continuous cooling transformation (CCT) diagrams Effects of alloying elements, and component dimensions, on phase transformations occurring upon cooling from austenitising temperature Time-temperature-transformation (TTT) diagrams Principles and effects of annealing, hardening, quenching and tempering processes 	<ul style="list-style-type: none"> Principles of precision engineering Concepts and techniques of heat treatment processes Principles, application, types and limitations of finite element heat treatment simulation and analysis Concepts and techniques of weldment heat treatment processes Relationships between distortion and material parameters after heat treatment Methods to analyse and minimise distortion 	

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				<ul style="list-style-type: none"> • Methods and principles of case hardening and carbonitriding • Principles and effects of nitriding and nitrocarburising processes • Schematic logic pictures depicting the heat treatment processes • Heat treatment process simulation tools 		
Abilities				<ul style="list-style-type: none"> • Review the required properties of components to shortlist the range of materials and corresponding heat treatment processes suited to meet requirements • Analyse the effects of phase transformations, using CCT diagrams, to determine the heat treatment processes suited to meet material property requirements • Analyse the effects of annealing operations to determine the heat treatment processes suited to meet the properties requirements • Analyse the effects of case and induction hardening to determine the heat treatment processes suited to meet material property requirements • Analyse the effects of nitriding and/or nitrocarburising to determine the heat treatment processes 	<ul style="list-style-type: none"> • Review the required properties of components to shortlist the range of materials and corresponding heat treatment processes that can meet requirements • Perform theoretical analyses on the effects of heat treatment processes • Perform finite element simulations and analyses on the effects of heat treatment processes • Perform analyses on the effects of heat treatment on weldments • Select optimal materials and heat treatment processes, based on analysis results, to meet the component properties requirements • Evaluate and refine parameters of heat treatment processes, using advanced metrology, to improve component properties • Report on selected materials and heat treatment processes used, and related 	

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				<p>suited to meet material property requirements</p> <ul style="list-style-type: none"> • Determine carburising process recipes, based on material types and required properties after heat treatment • Determine carburising time for selected materials and case depths, based on material types and required properties after heat treatment • Select optimal base metals and heat treatment processes to meet components' and/or end products' property requirements • Perform simulations and experiments in adapting heat treatment parameters, to assess usefulness of changes in material properties for applications 	<p>economic, environment and safety considerations</p>	
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