STO153/02

END-POINT ASSESSMENT PLAN

Power Engineer

Integrated Degree Apprenticeship

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Published February 2017

Contents

Overview

This end-point assessment plan (EPA) is to accompany the Power Engineer level 7 degree apprenticeship standard.

Power Engineers will work in Power Generation, Power Transmission or Power Distribution. They use core knowledge, skills and behaviours and specialist electrical, mechanical or control and instrumentation knowledge and skills to take responsibility for developing and leading in aspects of innovation, asset management, plant operations and plant maintenance.

Power Engineers are highly skilled focusing on some of the most complex and fundamental engineering challenges within the energy sector. Solving problems in new ways, or paradigm-shifting innovations that influence the future of the sector and how the underlying markets will operate are second nature. Working with a wide range of people, including industry experts and external bodies, they will develop and apply new technologies as well as improve safety, reliability and cost effectiveness methods for the sector.

This is an integrated Master's degree level apprenticeship (MEng), which incorporates on-programme academic and workplace learning and assessment with an independent end-point assessment to test the knowledge, skills and behaviours detailed in the standard. The awarding University will be responsible for the on-programme and end-point assessment requirements. It will typically take five years to complete, with the EPA taken in the last six months. Performance in the EPA will count towards the overall degree classification. Apprentices cannot successfully complete the Master's degree without passing the EPA. Performance in the EPA will determine the apprenticeship grade of pass, merit, distinction or fail.

This plan details the on-programme and EPA requirements. It will be of interest to apprentices, employers and Universities.

Apprenticeship Structure

The Master's degree must consist of 480 credits and 120 credits must be at level 7, 420 delivered on-programme and 60 through the EPA.

Universities will design on-programme training and assessment to develop the knowledge, skills and behaviours required in the published standard. It is recommended that in doing so they work with employers. In addition, employers should ensure that the working environment allows the apprentice the opportunity to demonstrate and re-inforce and apply their learning.

During the on-programme stage apprentices must collate an evidence portfolio upon which the end-point technical interview will be structured. It must contain evidence of meeting the requirements of the standard. The apprentice's University and employer, working in partnership, will provide guidance to support the development of the evidence portfolio in accordance with University and company policies and procedures.

The following is a suggested structure for the Power Engineer Degree apprenticeship. The apprentice should be required to demonstrate the application of their learning within an engineering business context. In order to achieve this, it is suggested that credit bearing work based projects, termed special study units (SSU), are developed for transmission, distribution and power generation. They should be scoped by the employer and the University with the assessment of each conducted by the employer, moderated by the academic mentor and quality assured by the University. The credit weighting for special study units should increase with progression, for example in years 1 and 2 they should be worth 15 credits, and in years 3 and 4 - 30 credits.

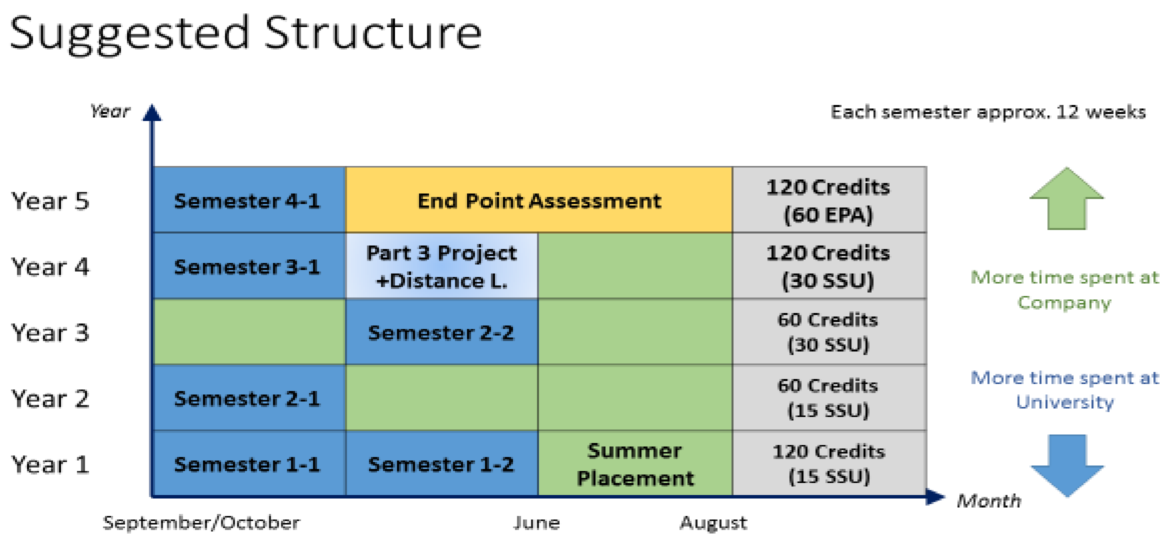

Diagram 1. Suggested Structure

End-Point Assessment Gateway

The apprentice's employer, in conjunction with the University must agree that the apprentice is eligible to enter EPA.

Prior to taking the EPA the apprentice must meet the following criteria:

- achieved a minimum level 2 English and maths as per the standard and general apprenticeship requirements
- completed the formal training plan agreed with their employer
- completed the formal academic learning as defined by the University, equating to 420 on-programme credits
- have sufficient evidence to demonstrate competence in all core knowledge, skills and behaviours and further knowledge in one option as described in the standard, in the form of a evidence portfolio.

Although the apprentice should only be recommended for EPA when they are ready, employers should have a remediation process in place to support any apprentice who fails to meet the eligibility criteria to enter EPA.

End-Point Assessment

End-point assessment activities will be completed over a maximum six month period to accommodate work scheduling and cost effective planning of resources. Moderation, University quality assurance and degree award processes may be concluded after the EPA period.

The EPA will deliver 60 credits.

End-point Assessment Organisation – Roles & Responsibilities

This sector is sensitive from a safety and regulatory perspective. This means decisions on competence have implications not only for individual safety, but also reputation and litigation. As a result, judgements of competence are required to be by necessity reliable, rigorous and robust.

As this is an integrated apprenticeship, the EPA will be delivered by the University that is awarding the degree. Universities must develop and deliver the EPA as defined in this plan, ensuring independence as described. Universities must be approved to deliver the EPA for this standard and be on the Skills Funding Agency Register of Apprentice Assessment Organisations. In this context Universities are termed the end-point assessment organisation.

End-point assessment organisations must appoint appropriately qualified and experienced staff to conduct EPA as detailed below.

Title	Criteria	Role
University Independent Examiner	Hold a Master's degree and a minimum of 5 years' engineering experience or a PhD in engineering or equivalent and will not have been involved with the on-programme academic learning of the apprentice	Project dissertation marking; project presentation and technical interview panel member - will be involved in the preliminary marking process
Independent Industry Technical Expert	Have a PhD in engineering or be a Chartered Engineer and works in Power Transmission, Distribution or Generation engineering field and will not be from the apprentice's employer	Project presentation and technical interview panel member - will be involved in the preliminary marking process
Industry Technical Expert nominated by the apprentice's employer	Have a PhD in engineering or be a Chartered Engineer and works in Power Transmission, Distribution or Generation engineering field and	Project presentation and technical interview panel member. They can inform the panel discussions but will not be involved in the preliminary marking process

	will be from the apprentice's employer	
Professional Institution Representative	Chartered Engineer and an expert in the Transmission, Distribution, or Generation engineering field and nominated by the Professional Institution	Project presentation and technical interview panel member - will be involved in the preliminary marking process
University Board of Examiners	Senior Lecturer level in a relevant engineering discipline	Review the preliminary grades of the project dissertation, project presentation and technical interview to determine the final grade for each component and combine component results to determine the overall apprenticeship grade and contribution to degree award
University Independent External Examiner	Post graduate relevant engineering experience to PhD level and a minimum of 1 years' experience as an external examiner in academia.	To secure the academic standards and awards of the apprenticeship programme. The external examiner will produce a report each year to highlight good practice and provide feedback enabling the maintenance and improvement of the programme. They provide an independent view of the procedures and processes associated with the EPA and ensure consistency across UK Higher Education Institutions.

Table 1. Roles and Responsibilities of End-point Assessment Organisation Approved and Appointed Staff

The project presentation and technical interview panel (the panel) will consist of three members: one university independent examiner and two industry technical experts (one from the apprentice's employer and one who is independent). One of the independent examiners will be the panel chair. Preliminary grade decisions will be made on a majority basis and if necessary, the panel chair has the casting vote.

End-point Assessment Methods

The EPA uses the following assessment methods and should be undertaken in this order:

- A project dissertation
- A project presentation to a panel, based on the project dissertation above
- A technical interview, conducted by the same panel as the project presentation, based on the evidence portfolio which also includes two reflective logs

The Project Dissertation (Stage 1)

Apprentices will produce a business project dissertation. The project dissertation proposal and objectives must relate to their own work environment and must be formally agreed by the employer and academic supervisor; this approval will signify the start of the EPA period. The project dissertation will typically be drawn together with final completion within two months, a maximum of three months is allowed. Typically projects will be in relation to business improvements, innovation and/or sustainability.

The project dissertation will typically be a minimum of 8,000 and a maximum of 12,000 words. It must not be more than 50 pages and will include an outline proposal and project plan, as well as an introduction, literature review, research, findings, conclusions, recommendations and evidence of reflective learning. All work must be appropriately referenced using either the Harvard Referencing System or Institute of Electrical and Electronics Engineers style.

The project dissertation will be assessed against the core and specific knowledge, skills and behaviours as detailed in Annex A, aligned to their chosen specialism. Two independent examiners (see above), not involved in agreeing the project dissertation proposal and objectives, will separately mark it and will agree a preliminary mark and grade. In cases where they cannot agree, a third independent examiner will be appointed to agree the preliminary mark. Criteria for marking the project dissertation is shown in table 3.

Apprentices must achieve a pass or higher for the project dissertation before moving to stage 2 and 3 of the EPA.

Project Presentation (Stage 2)

Apprentices will complete a presentation based on their project dissertation (as detailed above – stage 1) to the interview panel. The project presentation will typically last 30 minutes and no longer than 45 minutes. This will be followed by questions from the panel to further probe knowledge, skills and behaviours. There will be a maximum of 6 questions and will typically take 30 minutes and no longer than 35 minutes. The end-point assessment organisation will provide the questions.

The project presentation and answers to questions will be assessed against the core and specific knowledge, skills and behaviours as detailed in Annex A, aligned to their chosen specialism. The panel (see above), will agree a preliminary mark for the project presentation. Criteria for marking the project presentation is shown in table 3.

Technical Interview Panel (Stage 3 – concurrent with Stage 2)

As the final stage of the EPA process, the panel will conduct a technical interview. The technical interview will synoptically assess knowledge, skills and behaviours through six question areas. Apprentices must draw on their evidence portfolio (see above) and reflective learning logs in answering the questions. The apprentice will be required to prepare two reflective learning logs which will together be a minimum of 3,000 words and a maximum of 4,000. These logs must be no more than 15 pages in total, be completed during the project dissertation stage and the second reflection must build on the learning identified in first log. They will include description, analysis, evaluation, conclusion and an action plan in order to provide evidence that the apprentice can critically evaluate their learning and identify areas that requires further development. These must be included in the evidence portfolio which supports the technical interview.

The technical interview will typically last two hours and a maximum of three hours. The panel will use standardised questions from an agreed set of questions developed by the end-point assessment organisation. Follow-up questions may be used to probe further into the detail in order to satisfy the panel of the depth of knowledge, skills and behaviour. This interview will be conducted under controlled conditions.

The technical interview will be assessed against the core and specific knowledge, skills and behaviours as detailed in Annex A, aligned to their chosen specialism. The panel (see above), will agree a preliminary mark for the technical interview. Criteria for marking the technical interview is shown in table 3.

Re-sits/re-takes

Apprentices will be offered the opportunity to take a re-sit/retake in line with University academic regulations. Both the University and the employer have to agree that a re-sit/re-take is an appropriate course of action. Any EPA component re-sit/re-take must be taken during the maximum six month EPA period, otherwise the entire EPA must be retaken. They are not offered to apprentices wishing to move from pass to merit or distinction. Apprentices should have a supportive action plan to prepare for the re-sit/re-take.

Grading

Degree Grading

The degree will be classified in accordance with the University integrated degree regulations. The EPA will represent 60 credits towards the final degree classification. Where an apprentice fails the EPA, they will not be awarded a Master's Degree.

Apprenticeship Grading

Performance in the EPA will determine the apprenticeship grade of pass, merit, distinction or fail.

Each assessment method will be graded pass, merit, distinction or fail. In order to gain an apprenticeship pass or higher grade, the apprentice must achieve a minimum of a pass in each method. An apprenticeship pass represents full competence against the standard. A grade of merit or distinction means an apprentice is demonstrating competence above the standard.

The following table shows the combinations of assessment method grades to determine the overall EPA and apprenticeship grade:

Award	Project Dissertation	Technical Interview	Project Presentation
Distinction (85 to 100 marks)	Distinction	Distinction	Minimum grade of merit
Merit (70 to 84 marks)	Minimum grade of merit	Minimum grade of merit	Minimum grade of pass

Pass (50 to 69 marks)	Minimum grade of pass	Minimum grade of pass	Minimum grade of pass
Fail (less than 49 marks)	The apprentice has not achieved a minimum of a pass in each method		

Table 2. EPA Component Outcomes Contribution to Overall Grade

The table below outlines the scoring criteria that will be applied for each assessment method; detailed guidance will be developed by end-point assessment organisations. It is based on the following principles:

- all pass criteria needs to be achieved; in achieving this, the apprentice will be demonstrating all knowledge, skills and behaviours in the standard
- merit builds on the demonstration of pass criteria
- distinction builds on both pass and merit criterion

End Point Element	Distinction Criteria	Merit Criteria	Pass Criteria	Fail Criteria
Project Dissertation (100 marks)	**Score 85 and above** • Project recommendations identify realistic changes that have the potential to impact the wider industry and/or society	**Score 70 to 84** • Includes consideration of anticipated technology changes and power system thinking and their potential impact on business operating processes and/or procedures	**Score 50 to 69** • Using annex A provides evidence of , knowledge, skills and behaviours required, with particular emphasis on: • outcomes which link to the overall direction of the organisation and considers the political, economic, environmental and social context of the industry • based on analysis, examines asset integrity and performance, operational issues, cost benefits and efficient optimisation of assets • explores, develops and recommends initiatives/technologies that support and improve asset performance • project management principles, tools and processes	**Score 49 or less** • Fails to provide evidence to meet all knowledge, skill and behavioural requirements as contained in annex A

Project Presentation (100 marks)	**Score 85 and above** • Critically evaluate the impact on the business of their recommendations • Evidence of the impact of the alternative solutions on business and wider regulatory environment • Assimilates & synthesises information to present it effectively to their audience	**Score 70 to 84** • Critically analyses and presents recommendations in a robust business plan that includes the range of options considered and reasons for inclusion or rejection. • Uses a range of tools and techniques to present their ideas and recommendations to effectively communicate to and convince their audience	**Score 50 to 69** • Using annex A, evidence is provided against the required knowledge, skills and behaviours. Particular emphasis should be placed on: • Demonstrates application of standards, regulations, policies and legislation • Develops a robust business case that includes engineering, business and commercial skills • Articulates how the project recommendations secure future business performance by identifying risks, threats and technical opportunities for commercial advantage • Presentation is well structured and presented, summarises all major points of the final project. Answers all questions competently and demonstrates clear understanding of the subject.	**Score 49 or less** • Fails to provide evidence to meet knowledge, skill and behavioural requirements as required in annex A
Technical Interview (100 marks)	Score 85 and above • Establish their leadership skills and/or reputation in their specialist area across their organisation	Score 70 to 84 • Accurately and confidently describe the range of impacts of their actions and justify their course of action • Establish their leadership skills and/or reputation	Score 50 to 69 • Provides evidence to support the knowledge, skills and behaviours described in annex A, with particular emphasis on: • Applicable safe systems of work and the wider implications of risk management	Score 49 or less • Fails to provide evidence to meet knowledge, skill and behavioural requirements as detailed in annex A

		within their area/department	• Evidence that reflection has supported action plans and continuous development.	

Table 3. EPA Component Grading Descriptors

End-point Assessment Organisation – Internal Quality Assurance Requirements

End-point assessment organisations must:

- develop and provide end-point assessment guidance to apprentices, employers and on-programme university personnel in relation to the EPA requirements
- develop detailed marking criteria for assessment methods, in-line with table 3 and annex A
- develop compensatory assessment for learners with special requirements to allow reasonable adjustments to be made to assess the knowledge, skills and competence of the apprentice through alternative assessment techniques. Whilst these will remove barriers to participation, they must be designed to ensure judgements are not compromised to health and safety and legal requirements
- appoint EPA personnel in line with table 1 - role and responsibilities of end-point assessment organisation approved and appointed staff
- provide training for EPA personnel in terms of the requirements of the operation and marking of the assessment methods and in undertaking fair and impartial assessment
- monitor and provide support to EPA personnel where required to ensure consistent assessment
- develop and provide documentation for recording assessment decisions
- hold bi-annual standardisation events for EPA personnel to ensure consistent application of the guidance
- provide immediate guidance where end-point assessments need to be halted due to unforeseen circumstances eg system emergency, apprentice illness
- ensure EPA personnel undertake regular continuing professional development
- work collaboratively with other EPA assessment organisations for this standard to ensure standardisation in delivery and sharing of good practice

External Quality Assurance

We are exploring whether QAA can undertake external quality assurance for this standard, arrangements will be confirmed by the end of 2017.

Professional Body Recognition

The Institution of Engineering and Technology (IET) and the Institution of Mechanical Engineers (IMechE) have supported the development of the apprenticeship standard and assessment plan. The current edition of the UK Standard for professional engineering competence (UK-SPEC) has been used as a guide throughout. A successful apprentice will be eligible for membership of the Institution of Engineering and Technology (MIET) and Institution of Mechanical Engineers (or equivalent). Upon completing the apprenticeship, the apprentice will have gained the level of underpinning knowledge and understanding required and will have also acquired many of the competencies necessary for registration. The candidate could approach a relevant PEI for an assessment of their progress towards registration at Chartered Engineer (CEng) level.

Employers in the sector recognise the greater opportunity of continuing career development post-apprenticeship that professional registration offers. They are confident that retention and development of highly skilled apprentices will be enhanced by Professional registration as it will encourage the employee to identify opportunities for career progression and take responsibility for their own professional development.

Implementation

Affordability

The initial, indicative EPA costs are expected to be in the region of 8% of the total external apprenticeship costs.

Manageability/Feasibility of the Standard and Assessment Plan

While we envisage a three year 'approval' cycle we also acknowledge that we need to be prepared to monitor and evaluate early adopters reactions and performance to ensure manageability/feasibility. It is expected that there would be in the region of 20 new starts per year, subject to employers' resourcing strategies.

Approved end-point assessment organisations will need to undertake work, in consultation with employers, to develop the EPA tools and processes.

ANNEX A

Assessment Method by Element of the Standard – Power Engineer Degree Apprenticeship

Key	Assessment Method
PD	Project Dissertation
PP	Project Presentation
TIP	Technical Interview Panel

Where elements have more than one assessment method identified, both will be used in the EPA

Core Technical Knowledge	EPA
Application of Electricity Supply standards, regulations and policies	PP
Comprehensive knowledge of applicable safe systems of work including process safety and an in-depth understanding of the wider implications of risk management	TIP
Recognises and understands the capabilities/impact/selection of plant and equipment as well as a technical understanding of interdependencies of power generation, transmission and distribution plant and equipment	PD
Material science including failure modes of engineering materials and material selection	PP
Generation Technologies; Balanced Energy mix within the UK energy generation sector and the ability to technically analyse the various technical merits of different energy sources	PD
Structure of and relationships within the power industry together with regulatory structures associated with power generation, transmission or distribution	PP
Modelling and simulation of power systems	PD
Mathematical methods to support all the appropriate engineering design and analysis	PD
Specific mathematical techniques to understand control theory	PD
Understand and interpret engineering drawings including 2D and 3D Computer Aided Design models and process and component diagrams	PD
Designing for capital and operational cost efficiency, sustainability requirements and Environmental legislation	PP
Cost benefit analysis, including background financial understanding (budgets, costs and income, profit and loss accounts)	PD
Understanding of the tools and process of project management principles	PD

Understanding of emerging technologies and applications	PD
Economics of the energy industry	TIP
Demand Side Management techniques	TIP
Environmental considerations for all aspects of the Power Industry (including Generation, Transmission, Distribution and Supply)	PD
Operational requirements including operational documentation, planning consents, potential design constraints e.g. abstraction limits on rivers, potential impact of wind turbines on local wildlife etc.	PD

Knowledge Options

Power Transmission and Distribution Specific Engineering Knowledge:	**EPA**
Power Engineering- power systems theory/studies. Electrical machines, power electronics, electromagnetics, power quality (harmonics) and protection	TIP
Electricity Network Components including transformers, fuses, switches, circuit breakers, protection, system control systems, ancillaries (Low Voltage Alternating Current/Direct Current), overhead lines, underground cable	TIP
Power conversion: power electronics, control and integration of distributed generation	PD
Electrical first principles, drive and convector technology and Direct Current transmission	PD
Electricity Network Architecture including voltage levels (typical and variants), typical power levels at each voltage level, the components are used at each level, the methodology of choosing different component types, urban and rural network differences	TIP
System Performance and Resilience including customer interruptions, Customer Minutes Lost, the effect of high and low impact probability events and the influences which affect them.	PD

Electrical Engineering	**EPA**
Power Engineering- power systems theory/studies. Including power quality (harmonics) and protection, including multi-functional numerical protection, control relays and modern intelligent systems.	TIP
Control System Theory – PID Control Loops, HMI, PLC Systems, SIL Systems.	PD
Network Knowledge – network architecture, network components e.g. switches, fibre optics.	TIP

Power Generation Components (Design Theory, Maintenance and Testing) – motors, switchgear, transformers, DC battery systems, bus ducts.	PD
Understanding Electrical first principles and their appropriate application.	PD
Generators (Air and Hydrogen) including power electronics (AVR systems, static starting devices) in AC power systems incorporating converters and power factor correction	TIP
Electromagnetic principles including magnetic materials and characteristics, alternating flux, hysteresis and eddy currents.	TIP

Mechanical Engineering	**EPA**
Mechanical engineering principles, technology, systems and their applications	PD
Thermodynamics principles and their application, in power generation plant and processes	TIP
Composition of fuels and their combustion	TIP
Energy conversion and steam raising plant	TIP
Fluid dynamics – including velocity, pressure, density and temperature of liquids and gases as they impact the generation environments, including pumping system design and pump technology	TIP
The construction and design of rotating machines and machine dynamics – including stress analysis, rotor dynamics, gears, bearings (tribology), transmissions, condition monitoring	PD
The construction and design of static mechanical installations and structures, including HRSG's, boilers, condensers, cooling towers, piping systems and valves (Safety, Control and Isolation)	PD

Control & Instrumentation Engineering:	**EPA**
Engineering Thermodynamics – principles, concepts and laws, including practical applications	PD
Control theory PID Control Loops (including loop tuning), HMI, PLC systems, and SIL systems.	PD
Process measurement to include theory behind measurement of temperature, pressure, flow, and level, speed, rotating machine dynamics, water chemistry and gas analysis (emissions and fuel).	TIP
Instrumentation types and principles for the measurement of process variables, strengths, weaknesses, for both accuracy and impact on Process Control. To include instrumentation used in power station applications, considerations for SIL and Atex. Process variables to be included	TIP

temperature, pressure, flow, level, analysers (both boiler water and waste water discharge), emissions measurement, machine dynamics, control valve positioners.	
Practical application and theory of analogue and digital electronics including A to D conversion	TIP
The concept and theory of programming, communications and networking – including security, version control, network architecture and components e.g. switches, fibre optics	TIP

Core Skills	**EPA**
apply their understanding of the concept of asset lifecycle principles to various engineering activities	PD
read, interpret, develop and implement Power Industry standards, procedures and specifications across the range of assets in the Sector	PD
take ideas from concept to implementation, using sound engineering, business and commercial skills to develop robust business cases	PP
manage projects of either a technical or business change nature relevant to their area of the energy industry	PP
work autonomously to existing safety requirements relevant to their area of the energy industry as well as contributing to future requirements	PD
explore, develop and recommend initiatives/technologies that support and improve asset performance and enable the assets to operate effectively in the low carbon environment	PD
using business planning tools and techniques to develop plans and policies to ensure maximum lifecycle and cost benefit of assets that demonstrate regulatory compliance	PD
execute plans, strategies and policies to safety, environmental, time, cost and quality standards	PP
provide expert technical support, guidance and strategies for planned and preventative maintenance, operational issues, design modifications and outages	PD
ensure asset integrity, provide analysis and recommendation for avoidance of major plant failures and to secure cost effective efficient optimisation of assets	PD
secure future performance, identifying risks, threats and technical opportunities for commercial advantage	PP
analyse asset performance seeking new methods of improvement by developing innovative solutions	PD
demonstrate a practical understanding of key aspects of their business	PP

Core Behaviours	**EPA**

Safety focused – focuses on the importance of safety to themselves, others and the organisation. Takes responsibility for their own awareness and understanding of health and safety practices and legislation that protects them, their colleagues, contractors and customers	TIP
Communicating and Influencing – anticipates and responds to others' feelings, needs and concerns in order to achieve an appropriate outcome. Demonstrates sensitivity to the impact on others and modifies the approach to influence outcomes	PP
Stakeholder Centric – promotes excellent customer service to internal and external customers and uses this to maximise business performance	PP
Delivering Results – sets objectives and ensures they are achieved within agreed parameters to deliver successful business outcomes. Anticipates situations and problems, finding appropriate solutions and grasping opportunities. Takes action that potentially adds value to the business	PD
Flexibility and Innovation - adapts thinking and behaviour to suit the requirements of different situations; recognise the value of an alternative view and is receptive to changing circumstances. Thinks creatively beyond recognised boundaries to generate new ideas and approaches, ensuring that different perspectives are explored leading to successful implementation	PD
Forward Thinking - takes a forward looking perspective when considering the delivery of decisions, activities and projects. Relates forward thinking and associated planning to the overall direction of the organisation. Drives to understand the political, economic, environmental and social context which shapes the power industry	PD
Working collaboratively – is comfortable in working in teams and being a team leader to achieve agreed goals	PP