Introduction

The electrical industry can be split into three distinct categories; new works, that is installation work; manufacturing, that is the building of switchboards, control panels etc.; and maintenance, which is repairing and maintaining electrical equipment.

With proper training during a real apprenticeship not a cut price modern apprenticeship an electrician can switch between any of the industry sectors.

It must be noted that the numbers of electricians who entered the trade via fully indentured apprenticeships is fast diminishing due to retirement. Thus there are fewer true electricians available to train the future electricians.

A major sector of the electrical industry is new works of which the majority of work is in the construction industry which is why it has it’s own section in this article.

Other sections detail the work and responsibilities of the various personnel in the electrical industry from entry as an apprentice to electrician, charge hand, foreman and authorised person which are seen as manual work. Historically, due mainly to the class system prevalent up to the mid twentieth century, there was always a ceiling on manual work which could not be crossed into office based work, that was perceived as moving from working class to middle class or blue collar to white collar. The office based work ranges from design engineer to project engineer, contract manager, quantity surveyor and consulting engineer by tradition these are seen as graduate entry points into the industry.

Due to the education requirements many electrical engineers come straight out of university with absolutely no practical experience and have never ever done any work as an electrician or as an electrical designer and have no site experience, yet they are going to tell you what to do, how to do it and in what time.
Which is one of the reasons why so many electrical engineers are held in complete contempt by those that do have the relevant experience.

There is much to be said for a route of training and education to enable an apprentice to rise to the highest levels of the industry. As there is, at present, little chance of starting as an electrical apprentice and working your way up to be a chartered engineer, and if you do

manage it you will be looked down on by chartered engineers as you have worked with your hands. However electricians will look up to you and will normally cover your mistakes! That route of training would also diminish the us and them barriers that exist at present, it would also increase the respect level for the ‘office’ based workers and diminish the contempt level which exists in the ‘manual’ workers for the ‘office’ workers.

For further proof of how the parachuting in *(officially called fast tracking)* of graduates in preference to those with ability to positions of seniority creates discord among the established work force look at the most recent examples of industry where graduates are fast tracked to senior positions. That dirty stinking war mongering piece of scottish socialist filth Tony Blair who was the prime minister for most of the labour goverment of 1997 to 2010 created graduate entry schemes for both the fire brigade and police service. The resentment level from the lower ranks towards these graduate entrants is intense. Higher education is no substitute for workplace experience. Obviously these graduate entrants prevent the career progression of lower ranks, there is also a tendency for the graduate entrants to promote other graduate entrants to prevent real competition for the most senior positions, the reasoning being that if those that can do the job are kept down the idiots that can't increase their promotion chances. Ask any fireman or policeman their respect levels of the graduate entry officers, it will be low in the extreme although any verbal reply will probably be in more colourful language.

So why anyone wishes to join the industry is a mystery. You will make more money buying run down houses, doing them up and selling them at a profit, or even better renting them out and building up a property portfolio, in ten to fifteen years you will be able to retire. In the construction industry in the same time you may just make foreman, take a pay cut to get there and increase your risk of a heart attack or stroke due to the stress the added responsibility brings.

A word of warning on renting out property, the law is against you, if you walk out of Asda without paying you are a thief, if a tenant does not pay their rent the law will prevent you evicting them, the local council will help them to stay in your property without paying.

The law protects that thief.

In England there are lots of laws but very little justice and you are governed by foreigners, Scots, who have more say in the English (UK) Parliament than the English have in the Scottish Parliament.

Also don't ever accept payment of a tenant's housing benefit direct to you. If the tenant has falsely claimed or has been overpaid housing benefit then you the landlord are liable for the tenants over payment, even though you are in no way at fault, it is not justice but it is the law.

Justice and fairness is something that if you are English you will never get in England.

In fact England is a country where if you are English you are one of an oppressed people, it is a country where if you are either foreign or a do nothing know nothing you get everything. If you are English and work hard, try to better yourself and leave something for your children you will get taxed to the hilt and constantly kicked in the teeth and kept down by an establishment that is run by foreigners.

The best advice that an old man can give – get a trade then emigrate whilst you are young enough, don’t hang around in this dump of a country!!!!!!!!

The Construction Industry in England

If you do not have a sense of humour do not consider working in the construction industry as it is full of comedians.

It is the only industry where the customer (client) expects to pay for a Mini and get a Rolls Royce, and after agreeing the price for the purchase of the Rolls Royce then, half way through the delivery period, wants it gold plated at no extra cost and with no change to the delivery period. Get real, it cannot be done, if quality is required then it has to be paid for.

In the construction industry today the busword is teamwork, on the bigger sites they even have team evenings which you will attend and you will enjoy, yet the reality is bully boy tactics. Package managers, which is the industry term for project and sub project supervisors, employed by the project management/main contractor whose sole aim in life is to get their bit done to program no matter what, doing the job properly is not an option nor a requirement, they are modern day slave drivers with little or no knowledge of their package trade/discipline, sites are staffed with cheap unskilled imported labour with little or no command of the English language, or contract labour, many of whom lack the proper skills, indeed few can read drawings those that can are charge-hands or more usually foremen, in many canteens you will have to speak a foreign language to get served, skilled tradesmen are used as factory production workers, there is no real training for apprentices in fact no real apprenticeships just those daft NVQs and modern apprenticeships.

Many installation electricians work in the construction industry; unfortunately in that industry in England today on large projects electricians are used as factory production line workers, instead of being given an area to install the complete electrical service they are given specific tasks. For example one team will install all the cable racking, another will install the cable tray, another the trunking, another the conduit, another the wiring in the trunking and conduit, another the connections and yet another team the testing of the circuits.
It is debatable as to whether this task based system is efficient there can be little to recommend it, and against it is the boredom and demeaning of the electricians involved. It is not possible to have pride in one's work when part of this production line system, and it is highly recommended to avoid the big sites where these techniques are used. Try to transfer to smaller sites where you do the complete job or a complete area of larger jobs, or get into maintenance.

Apprentice Electrician

By reading this you are indicating an interest in either being an electrical apprentice or are already an apprentice and wish to know more of what is ahead or what should be ahead.

The only way to learn the trade of electrician is to be taught by experienced electricians on site or other work place, learning the practical aspects at a college is not the same, college should be complimentary to the site work and by tradition apprentices had day release to go to college where they are taught the calculations relevant to electrical engineering. That tradition of training was known as an articled or indentured apprenticeship, it was formally recognised by a contract between the employer and apprentice regarding the level of training. On completion of the apprenticeship the apprentice received his recognition as a tradesman and his articled or indenture documents which proved his right to be called a tradesman. In the England this traditional method of training was destroyed in the 1970s by the Labour government of the day, and as the traditional training methods were not re-instated by the Conservatives when they regained power they too must stand condemned for the total failure of the apprenticeship system. The so called modern apprenticeship, where paper qualifications take absolute precedence over practical ability, is no substitute for the real thing.

The politicians of the UK have between them wrecked the traditional apprenticeship system that has worked for hundreds of years. In England there are three major political parties, the scum class benefit party (Labour Party), the mathematically challenged party that lies (Conservative Party) and the party without honour and integrity (Liberal & Social Democrat Party). Then there are the smaller parties, the party of slime which wants to prevent anyone having a life and wishes to drive the country back to the dark ages (Green Party), the looney left, fascist right and overtly racist parties which do not deserve recognition by being named, and finally there is the party growing in stature that may just be the country's salvation UKIP. No real choices for us poor voters, just desperation!!!

Companies from the biggest to the smallest should receive tax breaks and possibly subsidies for employing persons engaged on indentured apprenticeships following defined modular courses and attending day release colleges. There should also be a clear pathway so that a person starting an apprenticeship at sixteen can if they have the necessary abilities progress from apprentice to chartered engineer. In other words it should not only be ‘A’ levels that get you to university. Conversely it should also be a requirement that to become a chartered

engineer a person must have a number of years practical experience and a number of years design experience.

Since the purpose of the apprenticeship is to learn a trade it is sad that the relevant trade unions do not take a much more active role in the promotion of the trade. A trade union is by definition a union of tradesmen, that union should be setting out the training required and level of qualifications to be obtained before someone may be called a tradesman. At present the government and various employers' bodies have taken on that role, and let’s be honest as with anything else that has been touched by politicians, they have screwed it up completely. The Labour government introduced the modern apprenticeship with all those daft NVQs and the employers have set up bodies to register the tradesmen and charge them annually for the privilege of being registered (one of the great British rip-offs). Why should a tradesman pay a pen pusher to give him a card saying he is a tradesman, the electrical section of AMICUS should stand up for the electrician tell the employers where to stick their cards. And since the government and employers have completely screwed up the training of tradesmen take on that role, they will almost certainly relinquish it without a fight.

Although in this article the traditional apprenticeship is promoted that does mean that there should be no changes. Apprenticeships should not only include the practical and theoretical aspects of electrical engineering; they should also include training in running a business. A significant number of apprentices will when they become electricians become either self employed or start companies.

Obtaining an Electrical Apprenticeship

To become an apprentice it is essential to have GCSEs in maths and English, this is necessary as much of the theoretical work involves maths, and English is necessary as it shows competence in the use of language, it also proves that you are able to read and write; it is also an advantage to have a GCSE in Physics.
Due to the absolute dumbing down of the exams over the last fifty years the pass grades of those GCSEs must be A*, A or B the lower pass grades of C to G are not high enough to warrant an apprenticeship placement.

Here is the proof of the lowering of standards in the English education system, in 1956 you learnt the times table up to the twelve times table at the age of 9, an announcement by the

education ministry on 8th July 2013 stated that in 2014 you will be expected to learn that table at the age of 10, in 2013 that age was 11.

You must have normal colour vision, be physically fit and strong and be comfortable in confined spaces and at height. Normal colour vision is essential to enable the identification of wires, physical fitness is required as many tasks that are undertaken by electricians require a high degree of manual dexterity other tasks such as busbar trunking and cable racking installations take strength. Many tasks that an electrician performs will be in small spaces perhaps underground other tasks will require a head for heights, tall buildings have aviation obstruction lights, guess who installs and maintains them.
You should also be able to do paper folding and gear train exercises as these are often used as aptitude tests during the interview.

When you attend interviews for the position of electrical apprentice you will have had little or no practical experience and that makes interviewing difficult for the interviewer. What questions can he/she ask that are relevant to an electrical apprenticeship that you can answer sensibly. So although the questions may be of a technical nature it is how you answer rather than the answer itself that will be important.

The interview is not only difficult for you.

How you walk into the interview room and sit down has a great effect on the interviewer, by that act alone you will be either half way to getting the job or halfway to failing to get it. This may be teaching your grandmother to suck eggs but you must be clean, neat and tidy, that is, do have a shave, or if you have a beard it must be trimmed to be neat, and shower or bath on the day of the interview, dress smartly, groom properly and make sure you are early. It is vital that you are comfortable with yourself, that is you are not concerned that you are not looking your best, you have to focus on the interview not whether you have dirt on your face! Always speak to the interviewer with respect, if you do not understand a question say so and if necessary ask for it to be put another way. Always look the interviewer in the eye.

Until you have interviewed other people for jobs you will never know how to act at an interview. In years to come when you do interview others you will realise just how bad you were when you were being interviewed.

A tip, never ever allow yourself to be filmed either interviewing or being interviewed as the playback will be the most humiliating experience of your life.

The interview itself should be a two way experience you should have questions for the interviewer as this demonstrates that you have thought seriously about being an apprentice. Ask your questions at the end of the interview or when you are invited to ask questions. Here are some questions that may be asked of you, it is for you to consider what responses to make.

Have you ever done any paid work such as a paper round or Saturday job?
Why do you want to become an electrician?
What do you think an electrician does?
Have you considered an apprenticeship in any other trade?
Do you think trade unions have a role in a modern economy?
What is GDP?
What hobbies do you have?
What is the purpose of each of the wires and their colours in a three core flexible cable?
How about a four core armoured cable?
What is the standard UK electrical supply?
Is that supply the same throughout the European Union?
Why is ac used for general distribution in preference to dc?
What is the purpose of a fuse?
Looking at a BS 1363 13A plug which is the live pin?
How does a GLS light bulb work?
Why is it that when light bulbs blow it is usually as they are being switched on?
What does a RCD do?
Can you explain what a transformer does?
Can you explain how a generator works?
Can you explain how a power station works?
What is the voltage of the overhead catenary wires on the railway main lines?
Are those catenary wires ac or dc?
What are the voltages of the national grid and super grid?
What does IEC stand for?
If we offer you an apprenticeship how would you see your career progressing after you become an electrician?

If we offer you an apprenticeship we will be committing ourselves to investing a lot of money in your training what are you going to give to us in return?

Yes, no and don't know are not the correct answers to any of the above questions.

And here are some questions you may wish to ask
Do I get day release during the whole of my apprenticeship?
How many electricians do you employ directly?
How many fatalities and notifiable accidents have there been in this company in the last ten years (this is a mummy question)?
What is the company turn-over and the percentage profit on that turn-over for the last five years?
Will my training cover maintenance, production and installation work?
What different types of installation work are covered by this apprenticeship?
What different types of production work are covered by this apprenticeship?
What different types of maintenance work are covered by this apprenticeship?
Will my training include learning drawing using AutoCad?
Will my training include project estimating and programming?
If your company cannot offer training in a particular aspect do you make placements with other companies to cover those aspects?
If the company should cease trading will you guarantee to transfer my apprenticeship to another company?
Is this apprenticeship articled or indentured?
What are the hours?
What is the wage structure during the apprenticeship?
What is the holiday entitlement per annum?
Is the training program laid out in the contract of employment?
When will I be notified of the result of this interview?

If you are having interviews at a number of companies the above will help sort out which one you wish to work for.

Electrician

The first people to call themselves electricians were magicians who used electricity as part of their shows. They date back to the time of Francis Hauksbee's (1660-1713) demonstrations of static electricity in the first decade of the 18th century at the Royal Society in England.

Those electricians used the effects of static electricity to amaze and astonish their audiences.

Today electricians are still magicians as they are expected to conjure up miraculous works at insignificant cost, in a negative time scale.

An electrician is a tradesman or if you prefer a skilled person who has completed an indentured apprenticeship and achieved a minimum standard of technical education.

When electrical installations were first undertaken the electricians were in fact carpenters, the wires were of iron and uninsulated, the insulation was achieved by installing the wires in planks/blocks of timber which had grooves cut in them, the wires were then inserted into the grooves and a timber cap placed over the them, guess who cut the grooves and inserted the wires, yes it was a carpenter. An electrical installation at that time was basic in the extreme.

As electrical equipment developed and electrical installations became larger and more complex the trade of the modern electrician evolved.

An electrician is able to carry out all the general aspects of electrical installation, maintenance and production work, either alone or as part of a team and can due to the extensive training during his/her apprenticeship, providing it was a proper indentured apprenticeship and not an NVQ or college based training scheme, undertake specialised works with little additional training.

The modern apprenticeship described in the apprenticeship.gov.uk website is extremely difficult to understand, in other words the old system was easy and straight forward you learnt your trade by being taught by tradesmen and going to college one day a week to learn the calculations and regulations that pertain to an electrician. Now you need to be a lawyer to understand the website and an electronics whizz kid to navigate it. Because the trade has become paper qualification based the modern electrician believes advancement is by going

to college to obtain additional qualifications, this is of course true, however a paper qualification does not automatically infer the ability to do the work qualified for, all chartered electrical engineers have paper qualifications!

Many installation electricians work in the construction industry; unfortunately in that industry in England today on large projects electricians are used as factory production line workers, instead of being given an area to install the complete electrical service they are given specific tasks. For example one team will install all the cable racking, another will install the cable tray, another the trunking, another the conduit, another the wiring in the trunking and conduit, another the connections and yet another team the testing of the circuits.
It is debatable as to whether this task based system is efficient there can be little to recommend it, and against it is the boredom and demeaning of the electricians involved. It is not possible to have pride in one's work when part of this production line system, and it is highly recommended to avoid the big sites where these techniques are used. Try to transfer to smaller sites where you do the complete job or a complete area of larger jobs, or get into maintenance.

Maintenance electricians carry out routine maintenance and testing on the electrical installation of a premises, that installation can range from repairing light fittings and replacing lamps to maintaining large production machines. Maintenance electricians respond to equipment breakdown calls to carry out emergency repairs. They also need to respond to accident calls in case equipment requires isolation.

Production electricians construct and test complex electrical equipment such as control panels, motor control centres and switchboards. Once the metalwork has been constructed electricians use layout drawings to install the electrical components and accessories; and wiring diagrams to install the wiring between the components and accessories.

Charge Hand Electrician

A charge hand electrician is a senior electrician with a number of years experience, who leads a group of electricians in a specific area or department and reports to a foreman electrician.

A charge hand normally works as an electrician with the additional duties of organising the materials, supervising junior electricians and apprentices, monitoring progress, issuing electric drills and other communal tools.

A charge hand for an electrical installation will in conjunction with the foreman mark out the electrical installation in an area and will then supervise a number of electricians to complete the installation to the allotted program.

A charge hand for a site maintenance area will issue planned maintenance sheets and monitor progress of maintenance works. The charge hand will also be the first responder to equipment breakdowns.

A charge hand for equipment production will lead a group of electricians all working on the same control panel, motor control centre or switchboard and will liaise with the metal workers building the equipment carcases and painters responsible for the painting of the equipment carcases.

Foreman Electrician

A foreman electrician is a senior electrician with a number of years experience, who has normally served as both electrician and charge hand; and is fully conversant with the Electricity at Work Regulations, the Health and Safety at Work Act, Construction, Design and Management Regulations, the various Employment Acts and Regulations and the IET Regulations. (The rewards for all that experience and knowledge are grief – you get it from behind, below, above and from both sides – it will almost certainly not be financial or an increase in social status).

It has to be mentioned that a foreman can also be a forewoman, however the term foreman is for all intents and purposes is now a unisex term.

The duties of a foreman can include the hiring and firing of electricians, labourers and the appointment of charge hands (those duties may alternatively be undertaken at head office). Duties will normally be the timely ordering of materials, checking receipt for those materials and authorising payment for same and sourcing alternatives when necessary. Then there are the office tasks that the foreman undertakes including receiving and checking the time sheets of the charge hands, electricians, apprentices and labourers. A foreman will also be the focal point for technical queries and often becomes a ‘grandfather’ figure for his staff.

A foreman for electrical installation works will lead a number of groups of electricians each group of electricians being led by a charge hand on a particular project or sub project. A foreman may lead a larger group of electricians without charge hands on smaller projects. Duties will include the allocation of work and the monitoring of the works against the project program and that is the easy part. In the allocation of work it will be the foreman, and usually the area charge hand that review the drawings and mark out the works; it will also be the foreman’s responsibility to mark up the drawings to enable the record drawings to be produced. The preparation of reports for the contract manager, never forget you the foreman are his scapegoat for everything that goes wrong (that’s when you get it from behind – *ie stabbed in the back*).

Where the foreman is the senior electrical presence on site for a project or sub project he/she will also be the point of contact for the main contractor and as such will need to coordinate the works with the other trades as well as attend site meetings. The foreman will effectively

be the electrical contractor’s representative and will need to attract the respect of the client, other contractors and his/her staff.

A foreman for maintenance work will lead the maintenance electricians and on large sites their charge hands. Duties will include the allocation of planned maintenance works and staff to breakdowns and call outs, the monitoring of maintenance work and adjusting the frequency of maintenance to suit site conditions. He/she will ensure the instruments used in maintenance operations are calibrated and are within date.

A foreman for production work will lead the production teams to ensure the smooth flow of works through the production cycle, and will monitor the quality of the products and oversee the testing of the products through to the organising of the transportation and delivery of the products. He/she will ensure the instruments used in the production operation are calibrated and are within date.

Electrical Contract Manager

The electrical contract manager is the contractors equivalent to the electrical systems project manger, it will be the electrical contract manager that takes control of the works after the award of the contract on behalf of the contractor and will appoint the electrician foreman and any site support staff. The position is unique to the new works and has no equivalent in either maintenance or production work.

Depending on how the electrical installation contract for a project is set up will influence the duties of the electrical contract manager. The position may be site based for the larger contracts or office based when the contract manager is responsible for multiple projects.

The most important duties of the contracts manager is to manage the health and safety of his own staff and where necessary that of the other contractors and the client whilst on site, to co-ordinate the works with other disciplines and ensure that the project is financially rewarding, ie the contractor makes a profit. To this end the contract manager will make the applications for payment, ensure that orders are received for additional works or other variations to the contract and will when any part of the contract is cancelled negotiate any reductions of the contract price. In respect of all the financial matters relating to a project the contract manager is often supported by an electrical quantity surveyor.

When the contract manager receives the drawings and specifications the first duty is to verify the viability of the design, and then to determine what works will be carried out in house and what will be sub-contracted. Where works are to be sub-contracted he will invite tenders and award sub-contracts and then manage those sub-contracts to ensure the timely delivery of the services or goods contracted and the proper integration of those services or goods into the project. The contract manager will monitor the project program and endeavour to keep the constituent parts of the contract delivered to that program.

The contract manager will be the nominated contact with the client, main contractor and all other contractors on a particular project, although the day to day contact is more often the electrical foreman. As such the contract manager will attend site meetings with the client, main contractor and other contractors.

Electrical Design Engineer

The electrical design engineer is able, either alone or as part of a team, to take a client's brief and in conjunction with the architect's plans prepare all the calculations that relate to the provision of the project electrical systems, prepare all the drawings necessary to enable the electrical capital plant to be purchased and the project electrical systems to be installed, prepare the technical specifications and the contractual documentation for the project electrical systems and prepare the project program.

The electrical design engineer must be able to negotiate with the architect the spatial requirements for the electrical equipment. This is always a difficult negotiation as the architect will try to give you the least amount of space he/she considers necessary whilst the you have to have adequate space for the equipment to ensure compliance with the Electricity at Work Regulation 15 - Working space, access and lighting - For the purposes of enabling injury to be prevented, adequate working space, adequate means of access, and adequate lighting shall be provided at all electrical equipment on which or near which work is being done in circumstances which may give rise to danger.

The electrical design engineer must also, if necessary, negotiate with the local public electricity supplier (PES) for the electricity supply required. This is also a difficult negotiation as the PES engineers are usually fresh out of university with no knowledge of real hands on engineering, their experience is limited to inputing data into a computer and declaring the computer output as the gospel. They are for the most part completely unable to think for themselves and therefore you have to think for them but in a way they do not realise you are doing it.

The electrical design engineer must be able to negotiate with the other project disciplines to ensure that their electrical requirements are met and that there is adequate space for electrical equipment and routes for cables. Under no circumstances take the word of other disciplines regarding the sanctity of space for equipment and cable routes; show it on drawings and issue them to all the other disciplines and get signatures against receipts for the drawings.

The electrical design engineer must be fully conversant with the Electricity Supply, Quality and Continuity Regulations; the Electricity at Work Regulations; the Health and Safety at

Work Act; Construction, Design and Management Regulations; the Supply of Machinery (safety) Regulations; the IET Regulations; and any other applicable statutes and regulations.

The electrical design engineer must be fully conversant with AutoCad, to enable the preparation of drawings; Microsoft Excel, to enable the undertaking of the project calculations; Microsoft Project, to enable the preparation of the project program and Microsoft Word, for the preparation of the specifications and contract documents.

The electrical design engineer must be fully conversant with the costs of electrical equipment and the installation of that equipment,

It is necessary to have worked as an electrician to be able to design sensibly, as it is only by working as an electrician can you learn the limitations of installation work, a prime example of this are the bending radii of cables; the figures given in the catalogues are the minimum that can be achieved without damaging the cable, they do not relate to the physical ability to achieve that radius.

The calculations required for electrical installations include short circuit, earth fault and volt drop calculations around the entire electrical system of the project, protection grading from the intake from the PES to the final distribution protective devices, calculations for load assessment to determine the maximum demand and calculations for cable sizing.

The drawings required for electrical installations include single line diagrams, circuit and wiring diagrams and layout drawings showing the electrical equipment, wiring accessories, cable racking, cable tray, trunking and conduit.

The technical specifications required for electrical installations describe in detail the capital plant and the standards of workmanship expected.

The electrical project program has to be prepared to show the delivery periods for the capital plant, installation of the capital plant and the general electrical installation. The predecessors and successors must also be shown to enable the main contractor to integrate the electrical project program into the overall project program.

Electrical Systems Project Manager

The electrical systems project manager is the person designated to oversee the electrical installation of a project, in today's modern buildings the supply of power is the most critical of all the disciplines of the building trade, and yet is one of the least appreciated.

The heating and ventilating, lift, fire protection and mechanical engineers will insist that their plant be delivered with their own panels and that the electrical systems project manager shall have no say in what is specified, the heating and ventilating engineers will also insist on having complete control over the BMS (building management system). Most BMSs have Microsoft Windows based operating systems, and as local control of the plant is not normally possible it is a major single point of failure.
In section 02-09-19-01 - Electrical System Design - Motor Starting and Control Systems - Starter Design - Design Responsibility the arguments for the project electrical designers and managers to have resposibility for all electrical equipment is made.

As the electrical systems project manager you will be responsible for determining the amount of power that is required and for preparing drawings and specifications for the power distribution system.

The heating and ventilating, lift, fire protection and mechanical engineers cannot tell you how much power they require or where they require it until their sub contractors are appointed and have submitted their plans. But you have to go out to tender at the same time as them, so how do you sensibly plan the system, the answer is you don't; you guestimate based on building type and previous experience and then take a hammering for getting it wrong. The other engineers will say why didn't you ask (because you know they don't have a clue)? The architects requires a special mention they expect you to supply a 100 storey building from the equivalent of a shower room, you will never have adequate space for the equipment, as your 'bit' does not earn rent you will make do with the absolute minimum of space for the equipment with no consideration given to the cable installation, the book says a 4c 400mm armoured cable with an overall diameter of 76mm can be bent to a radius of 608mm; that is the cable overall diameter multiplied by eight; try it sometime whilst squeezing between a panel and the racking above it and trying to terminate it.

Then there are the value engineers, these people, normally electrical quantity surveyors, are appointed to vet the design and identify cost savings, their actions usually increase costs as they delay the whole project whilst the arguments take place over the design.

A question, if the value engineers change a design in order to save money who is legally responsible for the design. I would suggest that since the value engineers have changed the design the legal responsibility for the design is transferred to them.
So a shrewd move would be to over design a system, then allow the value engineers take out the 'over' bit you get the design you wanted and none of the design responsibility and liabilities.

At this grade in the electrical industry the politics of a project starts to increase in importance and the engineering responsibilities start to diminish.

The electrical systems project manager will, where necessary, personally or will delegate the negotiations with the public electricity supplier (PES) for the electricity supply to the project oversee specs and contract docs and project program; review tenders, award contracts, deal with the contractors contract manager and be the focal point for financial control of the electrical project.

Electrical Consultant

The electrical consulting engineer is probably the best job to have, the job description will state that consulting electrical engineers design, develop and maintain electrical control systems and/or components to required specifications, focusing on economy, safety, reliability, quality and sustainability. They are involved in projects from the concept and detail of the design through to implementation, testing and handover. They may also be involved in maintenance programmes. As well as technical knowledge, consulting electrical engineers need to project manage and multitask. They also need to have commercial awareness. Additional attributes, such as team leadership or management skills, are required as careers progress.

This is part of the consulting electrical engineers job description that is in fact an advertisement, the consulting electrical engineer works in a multi-disciplinary project team, which is likely to include engineers from other specialist areas as well as architects, marketing and sales staff, manufacturers, technicians and customer service personnel. They may also work with representatives from customer organisations. Depending on the organisation, the consulting electrical engineer may be involved at every stage of design and development or may just be involved at one particular stage. The nature of the role varies according to industry or sector, but the range of activities common to many posts is likely to include the following: identifying customer requirements; designing systems and products; reading design specifications and technical drawings; researching suitable solutions and estimating costs and timescales; making models and prototypes of products using three-dimensional design software; working to British (BS), European (EN) and other standards; liaising with others in the design team; liaising with clients and contractors; attending meetings on site; designing and conducting tests; recording, analysing and interpreting test data; proposing modifications and retesting products; qualifying the final product or system; servicing and maintaining equipment; preparing product documentation, writing reports and giving presentations; monitoring a product in use to improve on future design.

From meeting many consulting electrical engineers the one thing that can be said is that they use big and long words to talk a good job and go to lots of meetings, their whole method of working is to put design responsibility onto contractors and then to stand back and criticise; which is why it is the best job to have.

Electrical consulting engineers 'write' specifications for projects with minimal drawings; it is said they write specifications what some or maybe many actually do is get contractors to write the specifications for free so that the contractor gets on the tender list whilst charging the client for preparing the specification. Contractors will admit to doing this but will never go 'public' for fear of being blacklisted. The drawings the electrical consultants prepare are called tender drawings which they require tenders to be prepared against, the contract will then require the successful tenderer to prepare the working drawings which again allows the consultant to stand back and criticise. Their whole method of working increases costs and initiates disputes which allows them to charge even more for their services.

Electrical Quantity Surveyor

The electrical quantity surveyor is the person who is most concerned with the financial aspects of a project.

The most important task that the electrical quantity surveyor undertakes is the financial risk assessment of the persons/company inviting the tender. There is absolutely no point in preparing a tender, winning the contract, delivering a spectacularly successful project to time and budget if the client either does not or cannot settle the invoice for the works and has insufficient assets to cover the invoiced amount. This is one reason that contracts have stage payments it will be for the electrical quantity surveyor to determine whether the stage payment regime is financially prudent. If the electrical quantity surveyor suggests that no tender should be submitted for a project then walk away.

The next key task for the electrical quantity surveyor is to read the contract terms and conditions, which are often called the contract preliminaries, again if the conditions are to onerous then either endeavour to get them changed or walk away.

Because of the manner that consultants let contracts where they do not design the projects but let contracts on concepts or basic 'ideas' where the detail design is by contractors after the contracts are let there is clearly a need to manage the project's finances as the contract price is never the final price, this is why electrical quantity surveyors are necessary. If consultants designed in detail then the contract price would also be the final account price and the need for electrical quantity surveyors would diminish.

An electrical quantity surveyor may work for either the client or the contractor, working in an office or on-site. They are involved in a project from the start, preparing estimates and costs of the work, assessing the works to permit interim payments. When the project is in progress, electrical quantity surveyors keep track of any variations to the contract that may affect costs and create reports to show profitability. Therefore an electrical quantity surveyor is necessary to manage the costs relating to the electrical works for a project, from the initial financial calculations to the final figures.

Authorised Person Electrical

An authorised person electrical (APelectrical) is a senior electrician, charge hand, foreman or other person that is fully conversant with the site electrical distribution system, both practically and technically. Since the position is a specialised one it is appropriate to describe in some detail the duties and responsibilities of an APelectrical.

The requirement for an authorised person electrical can be traced back to the Electricity at Work Regulations and before that the various Factory Acts. The applicable regulation and the guidance notes thereto are reproduced below.

Regulation 16 of the Electricity at Work Regulations 1989 states - Persons to be competent to prevent danger and injury

> No person shall be engaged in any work activity where technical knowledge or experience is necessary to prevent **danger** or, where appropriate, **injury**, unless he possesses such knowledge or experience, or is under such degree of supervision as may be appropriate having regard to the nature of the work.

The guidance notes to Regulation 16 of the Electricity at Work Regulations 1989 state

233 The defence (regulation 29) is available in any proceedings for an offence under this regulation.

234 The object of the regulation is to ensure that people are not placed at risk due to a lack of skills on the part of themselves or others in dealing with electrical equipment.

"... prevent danger or, where appropriate, injury ..."

235 This regulation uses both of the terms, 'injury' and 'danger'. The regulation therefore applies to the whole range of work associated with electrical equipment where danger may arise and whether or not danger (or the risk of injury) is actually present during the work. It will include situations where the elimination of the risk of injury, ie the prevention of danger, for the duration of the work is under the control of someone who must therefore possess sufficient technical knowledge or experience, or be so supervised, etc to be capable of ensuring that danger is prevented. For example,

where someone is to effect the isolation of some electrical equipment before they undertake some work on the equipment, they will require sufficient technical knowledge or experience, to prevent danger during the isolation. There will be no danger from the equipment during the work, provided that the isolation has been carried out properly; danger will have been prevented but the person doing the work must have sufficient knowledge or experience so as to prevent danger during that work, for example by knowing not to work on adjacent 'live' circuits.

236 But the regulation also covers those circumstances where danger is present, ie where there is a risk of injury, as for example where work is being done on live or charged quipment using special techniques and under the terms of regulation 14. In these circumstances, people must possess sufficient technical knowledge or experience or be so supervised etc, to be capable of ensuring that injury is prevented.

Technical knowledge or experience

237 The scope of 'technical knowledge or experience' may include:

(a) adequate knowledge of electricity;

(b) adequate experience of electrical work;

(c) adequate understanding of the system to be worked on and practical experience of that class of system;

(d) understanding of the hazards which may arise during the work and the precautions which need to be taken;

(e) ability to recognise at all times whether it is safe for work to continue.

Allocation of responsibilities

238 Employees should be trained and instructed to ensure that they understand the safety procedures that are relevant to their work and should work in accordance with any instructions or rules directed at ensuring safety which have been laid down by their employer.

Supervision

239 The regulation recognises that in many circumstances people will require to be supervised to some degree where their technical knowledge or experience is not of itself sufficient to ensure that they can otherwise undertake the work safely. The responsibilities of those undertaking the supervision should be clearly stated to them by the duty holders who allocate the responsibilities for supervision and consideration should be given to stating those responsibilities in writing. Where the risks involved are low, verbal instructions are likely to be adequate but as the risk or complexity increase there comes a point where the need for written procedures becomes important in order that instructions may be understood and supervised more rigorously. In this context, supervision does not necessarily require continual attendance at the work site, but the degree of supervision and the manner in which it is excercised is for the dutyholders to arrange to ensure that danger, or as the case may be, injury, is prevented.

240 Further advice on working procedures is given in guidance publications listed in appendix 1. - *Appendix 1 of the Electricity at Work Regulations*.

The next question is when is it necessary to employ an APelectrical? The reverse is also true, an electrician, charge hand or foreman must also be able to recognise when the task to be carried out requires the intervention of an APelectrical.

The now defunct PSA had a poster that showed various distribution systems together with the level of expertise require to operate that system.
The PSA was a typical civil service department, the lazy and incompetent could not be dismissed - the only way of getting rid of those persons was by promotion, thus, in general, the more senior the person the bigger the idiot. An organisation run by incompetents will fail and the PSA was chopped by the government of the day because it was a failure.

Back to the poster or more properly Keemag Ltd.'s interpretation of it;
For LV systems where there is only one supply to a switchboard then any electrician competent for the tasks to be undertaken on that switchboard should be allowed to operate the switchgear.

For LV systems where there are two supplies to a switchboard that are mutually exclusive then any electrician competent for the tasks to be undertaken on that switchboard should be allowed to operate the switchgear.
For LV systems where there are two or more supplies to a switchboard that may be paralleled then an APelectrical should be appointed to operate the switchgear and issue permits to work for any work carried out on the switchboard.
For all MV and HV systems an APelectrical must be appointed to operate the switchgear and issue permits to work for any work carried out on the switchboard.
It must be noted that generation systems are not specifically mentioned above, the voltage output of either a generator or generating system and whether the system feeds a switchboard and the number of supplies at that switchboard should determine whether an APelectrical is required.
For purposes of operation a MCC should be considered as a switchboard as should stand-alone change-over units; whilst UPSs should be considered to be the electronic equivalents of generators and generating systems.

The most important qualification for an APelectrical is a complete understanding of the electrical system that he/she is to be responsible for. It is therefore surprising that there are companies that run APelectrical courses at locations remote from the site to which the prospective APelectrical is to be based, how can a lecturer at a college instruct a student in a specific electrical distribution system and it's intricacies? The answer is they can not, the courses deal with the theoretical rather than the practical. But they can issue a certificate stating that an APelectrical course has been attended and that a student has passed the test that the lecturer has set, which the duty holders believe absolves them from the responsibility of the appointment of the APelectrical. The next most important quality for an APelectrical is to have the respect of those persons to whom he/she may issue permits to. Those that are about to work on electrical equipment where they may come into contact with the constituent components of equipment that are normally live but have been made dead and safe by the APelectrical must be confident in his/her abilities to make that equipment safe to work on.

That understanding of the system will range from a full knowledge of the distribution system, but not necessarily the final distribution, the operation of the switchgear, the supervision of all maintenance activities on the system, the checking of the competence levels of persons to whom permits to work will be issued all this is whilst the duty APelectrical. When an

APelectrical hands over at the end of a shift to another APelectrical it is most important to appraise the 'incoming' APelectrical of the system status and all permits that are extant to effect a proper handover of duties.

To assist the APelectrical the system designer should issue, as part of the design documentation, operation instruction cards; these cards should contain step by step instructions for every conceivable switching operation and maintenance activity that may be required for the proper operation of the system.

The best way to show this is to give an example of an instruction card. The example used is that of isolating a system transformer for maintenance that operates in parallel with another system transformer. For the purposes of this example the transformer to be isolated has ident Tx/01, fed by 33kV circuit breaker ident HV1/2 and feeding 11kV circuit breaker ident MV1/1.

Circuit breaker HV1/2 is fitted with three Castell locks with idents:-

H12 Key H12 is free when the selector is in the **isolated** or **earth** positions and trapped when the selector is in the **service** position, the service position cannot be selected unless the key is inserted.

M11 Key M11 is free when the circuit breaker is not closed in the **earth** position and trapped when the circuit breaker is closed in the **earth** position, the circuit breaker cannot be closed in the earth position unless the key is inserted.

Tx1 Key Tx1 is free when the circuit breaker is closed in the **earth** position and trapped when the circuit breaker is not closed in the **earth** position, the circuit breaker cannot be opened from the earth position unless the key is inserted.

Circuit breaker MV1/1 is fitted with three Castell locks with idents:-

M11 Key M11 is free when the selector is in the **isolated** or **earth** positions and trapped when the selector is in the **service** position, the service position cannot be selected unless the key is inserted.

H12 Key H12 is free when the circuit breaker is not closed in the **earth** position and trapped when the circuit breaker is closed in the **earth** position, the circuit breaker cannot be closed in the earth position unless the key is inserted.

Tx1 Key Tx1 is free when the circuit breaker is closed in the **earth** position and trapped when the circuit breaker is not closed in the **earth** position, the circuit breaker cannot be opened from the earth position unless the key is inserted.

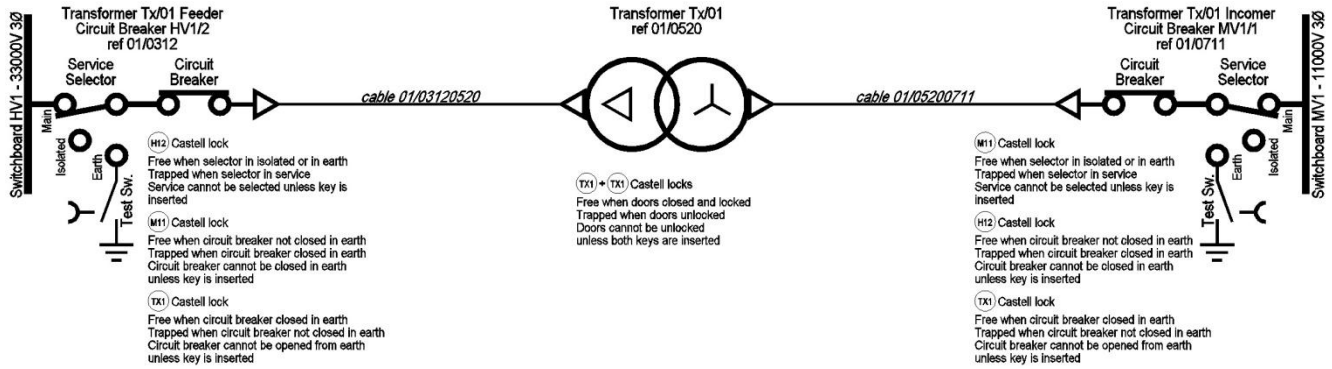
Transformer Tx/01 is fitted with two Castell locks with idents:-

Tx1 which are free when the doors to the transformer enclosure are closed and locked and trapped when the doors are unlocked, the doors cannot be opened unless both keys are inserted.

There is only one key with ident H12, one key with ident M11 and two keys with idents Tx1.

Circuit breaker HV1/2 is part of switchboard HV1 which is located in switchroom HV1. Circuit breaker MV1/1 is part of switchboard MV1 which is located in switchroom MV1. Transformer Tx/01 is located in transformer room Tx/01.

Instruction Card



1. Determine whether the person requesting the permit to work is competent to undertake the works described in the request for the permit and that relevant risk assessments and method statements (RAMS) for the works are in place.
2. At either the SCADA display or physically on site, check that circuit breaker HV2/2 is closed in service, circuit breaker MV2/1 is closed in service and that transformer Tx/02 is carrying load. - This will enable the site to continue to receive power when the parallel transformer is isolated.
3. At switchroom MV1 isolate the fire suppression system by padlocking the mechanical discharge mechanism.
4. Enter switchroom MV1.

5. At switchroom MV1 control panel unlock and switch on switchboard MV1 indication circuits.
6. At switchroom MV1 control panel unlock and switch on switchboard MV1 control circuits.
7. At switchroom MV1 control panel press button MV1/1 TRANSFORMER T1 INCOMER Lamp Test - check all indicators related to MV1/1 are illuminated.
8. At switchroom MV1 control panel check that circuit breaker MV1/1 SELECTOR IN SERVICE indicator is illuminated.
9. At switchroom MV1 control panel press circuit breaker MV1/1 button LOCAL to transfer control of MV1/1 to this control panel. - The REMOTE indicator should extinguish and the LOCAL indicator illuminate.
10. At switchroom MV1 control panel press circuit breaker MV1/1 button CIRCUIT BREAKER OPEN to open the circuit breaker - The CIRCUIT BREAKER CLOSE indicator should extinguish and the CIRCUIT BREAKER OPEN indicator illuminate.
11. At switchboard MV1 circuit breaker MV1/1 move the selector to Earth.
12. At switchboard MV1 circuit breaker MV1/1 withdraw Castell key M11.
13. At switchroom MV1 control panel check that circuit breaker MV1/1 SELECTOR IN SERVICE indicator has extinguished and SELECTOR IN EARTH indicator has illuminated.
14. At switchroom MV1 control panel switch off and lock switchboard MV1 indication circuits.
15. At switchroom MV1 control panel switch off and lock switchboard MV1 control circuits.
16. Exit switchroom MV1.
17. At switchroom HV1 isolate the fire suppression system by padlocking the mechanical discharge mechanism.
18. Enter switchroom HV1.
19. At switchroom HV1 control panel unlock and switch on switchboard HV1 indication circuits.
20. At switchroom HV1 control panel unlock and switch on switchboard HV1 control circuits.
21. At switchroom HV1 control panel press button HV1/2 TRANSFORMER T1 FEEDER Lamp Test - check all indicators related to HV1/2 are illuminated.
22. At switchroom HV1 control panel check that circuit breaker HV1/2 SELECTOR IN SERVICE indicator is illuminated.

23. At switchroom HV1 control panel press circuit breaker HV1/2 button LOCAL to transfer control of HV1/2 to this control panel. - The REMOTE indicator should extinguish and the LOCAL indicator illuminate.
24. At switchroom HV1 control panel press circuit breaker HV1/2 button CIRCUIT BREAKER OPEN to open the circuit breaker - The CIRCUIT BREAKER CLOSE indicator should extinguish and the CIRCUIT BREAKER OPEN indicator illuminate.
25. At switchboard HV1 circuit breaker HV1/2 move the selector to Earth.
26. At switchboard HV1 circuit breaker HV1/2 withdraw Castell key H12.
27. At switchboard HV1 circuit breaker HV1/2 insert Castell key M11.
28. At switchroom HV1 control panel check that the circuit breaker HV1/2 SELECTOR IN SERVICE indicator has extinguished and SELECTOR IN EARTH indicator has illuminated.
29. At switchroom HV1 control panel press circuit breaker HV1/2 button CHARGE CLOSING SPRINGS to arm the charging springs, the circuit breaker HV1/2 CHARGE CLOSING SPRINGS indicator should illuminate during the charging operation, when that indicator extinguishes check that the circuit breaker HV1/2 CHARGING SPRINGS ARMED indicator has illuminated.
30. At switchroom HV1 control panel press circuit breaker HV1/2 button CIRCUIT BREAKER CLOSE to close the circuit breaker - The CIRCUIT BREAKER OPEN indicator should extinguish and the CIRCUIT BREAKER CLOSE indicator illuminate. - The circuit breaker is now closed in the earth position thereby earthing transformer Tx/01 primary winding.
31. At switchboard HV1 circuit breaker HV1/2 withdraw Castell key Tx1.
32. At switchboard HV1 circuit breaker HV1/2 padlock the circuit breaker open button to prevent operation.
33. At switchroom HV1 control panel switch off and lock switchboard HV1 indication circuits.
34. At switchroom HV1 control panel switch off and lock switchboard HV1 control circuits.
35. Exit switchroom HV1.
36. At switchroom HV1 re-instate the fire suppression system by unlocking the mechanical discharge mechanism.
37. Enter switchroom MV1.
38. At switchroom MV1 control panel unlock and switch on switchboard MV1 indication circuits.

39. At switchroom MV1 control panel unlock and switch on switchboard MV1 control circuits.
40. At switchboard MV1 circuit breaker MV1/1 insert Castell key H12.
41. At switchroom MV1 control panel press circuit breaker MV1/2 button CHARGE CLOSING SPRINGS to arm the charging springs, the circuit breaker MV1/2 CHARGE CLOSING SPRINGS indicator should illuminate during the charging operation, when that indicator extinguishes check that the circuit breaker MV1/2 CHARGING SPRINGS ARMED indicator has illuminated.
42. At switchroom MV1 control panel press circuit breaker MV1/1 button CIRCUIT BREAKER CLOSE to close the circuit breaker - The CIRCUIT BREAKER OPEN indicator should extinguish and the CIRCUIT BREAKER CLOSE indicator illuminate. - The circuit breaker is now closed in the earth position thereby earthing transformer Tx/01 secondary winding.
43. At switchboard MV1 circuit breaker MV1/1 withdraw Castell key Tx1.
44. At switchboard MV1 circuit breaker MV1/1 padlock the circuit breaker open button to prevent operation.
45. At switchroom MV1 control panel switch off and lock switchboard MV1 indication circuits.
46. At switchroom MV1 control panel switch off and lock switchboard MV1 control circuits.
47. Exit switchroom MV1.
48. At switchroom MV1 re-instate the fire suppression system by unlocking the mechanical discharge mechanism.
49. At transformer room Tx/01 isolate the fire suppression system by padlocking the mechanical discharge mechanism.
50. Enter the transformer room.
51. Isolate transformer Tx/01 auxiliary supplies and padlock off.
52. Insert both Castell keys Tx1 into the transformer cubicle door.
53. open the transformer doors and test for voltage at the transformer terminals.
54. install temporary earth bonds to the HV and MV terminals of the transformer.
55. Place circuit breaker stop button lock keys and transformer auxiliary supply padlock key into transformer room Tx/01 AP/CP box, lock the box issue one key of the box to the CP (competent person) and retain the second key.
56. Issue a permit to work to the CP for the works to be undertaken.

57. Check either SCADA display reflects the status circuit breakers HV1/2 and MV1/1 or set mimic diagram to show their status.
58. Place transformer room Tx/01 AP/CP box AP key into secure storage.

The end of the instructions, that simple task will take at least 45mins to complete.

Prior to powering up the distribution system the system designer and APelectrical should verify the accuracy of the operating instruction cards by carrying out every operation on each operating instruction card, with the APelectrical actually performing the operations and the system designer verifying that the operating instruction is correct or where necessary modifying it to reflect actual operation. If an operating instruction card is modified due to these actions it is essential to repeat the verification process of that instruction card.

On a site where it is necessary to have an APelectrical it will be necessary to have at least four to cover for holidays and sickness, of those APelectricals there may only be one on duty at any time. On a large site it may be necessary to split the site into sub-sites with each sub-site having it's own APelectricals, the key point is to have distinct areas for the sub-sites so that there is a clear line of demarcation for the areas of responsibilities.