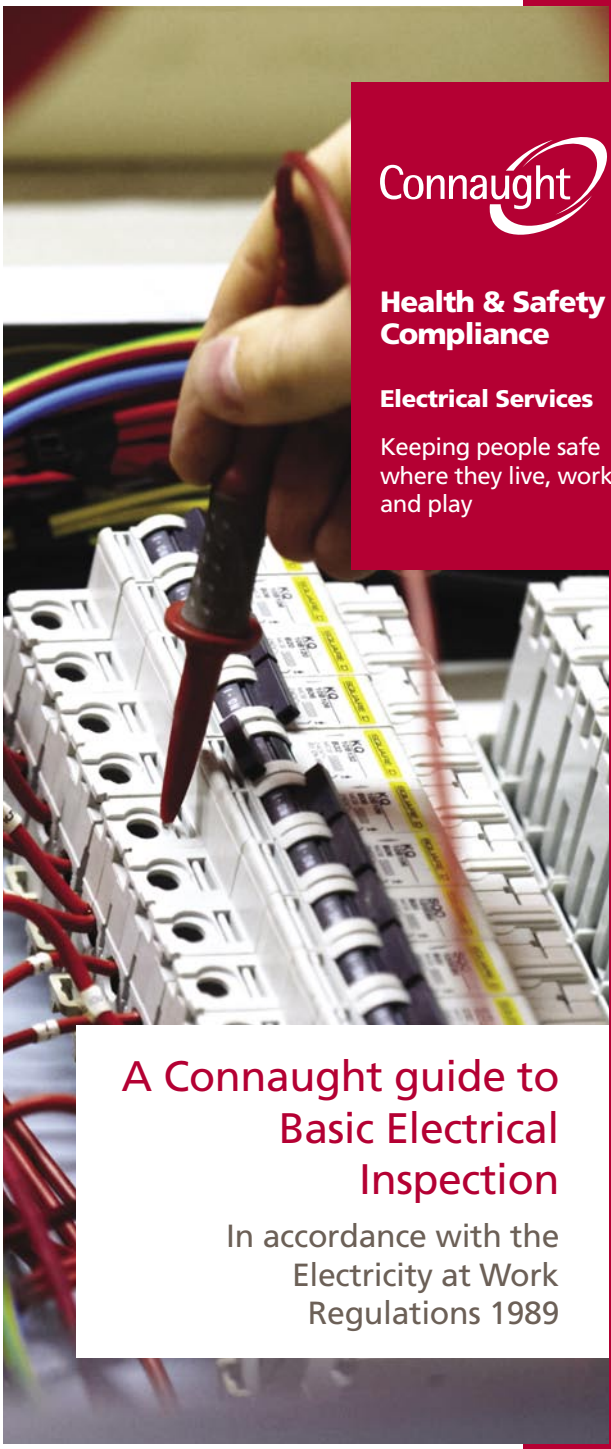

Connaught

Health & Safety Compliance

Electrical Services

Keeping people safe where they live, work and play

A Connaught guide to Basic Electrical Inspection

In accordance with the Electricity at Work Regulations 1989

Foreword

This guide has been produced to help in assessing the safety of electrical systems and connected equipment and work on such systems. It is prepared to assist those involved in inspection, such as Safety Managers, Environmental Health Officers, Maintenance Engineers (of mechanical bias) and any individual not primarily qualified in electrical engineering, but who are compelled to undertake it as part of their responsibilities.

The guide will also assist members of management who have to set up audits within their department.

However, it could still very well assist electrical engineers as a basis for in-depth assessments, but in this respect those users should be aware that the depth of electrical inspection has been deliberately omitted.

Whether qualified or unqualified, those persons involved in inspections should abide by one simple rule... let your eyes do the work and make careful judgement on what you see.

Contents

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He now divides his time between providing technical and safety consultancy and lecturing on Health & Safety law, electrical safety and machine safety.

Introduction

The notes contained in this guide serve to provide a framework on which the Inspector of an electrical installation can base his examination. The techniques given in the guide, are simple and fall within the requirements of the law.

The law governing the installation and use of electricity at the workplace, is the Electricity at Work Regulations 1989 which came into force on the 1st April 1990 and are made under the Health & Safety at Work etc. Act 1974. The Regulations provide for an 'aim to be achieved' and thereby outline the basic principles for safety, good working practice and objective means for meeting standards.

In this respect, any person undertaking electrical inspection and offering consequential advice on findings, should take recognition of modern standards such as the IEE Wiring Regulations and current British Standards. With any inspection, the eyes are the most important instrument. Whatever you see should be assessed and if you feel that it does not look correct or normal, then make enquiries or pass comment on it. With electrical installations this is vitally important; you must never walk past something that does not look right. In effect this condones a potential wrong which may eventually result in the risk of serious injury.

This guide will help you and can be used as your checklist.

General inspection of the installation

Regulations 4(1) and 4 (2) (Reasonably Practicable)

(a) **Does it look as though it is installed properly?** e.g. you will get a 'gut feeling' if an installation is safe by the general state of upkeep

(b) **Is the installation, including the equipment connected to it, adequately constructed, assembled and mounted to a safe standard?** e.g. is a 'flimsy' piece of equipment being used in a harsh environment, or are flexible cables being used where conduit or armoured cables should be used. Check also plugs and sockets

(c) **Is it properly maintained to prevent danger?** e.g. you can usually see at a glance whether equipment is being looked after; look for missing bolts, unfilled cable entry holes, broken covers, conduits, trunking, plugs and sockets. Check for open panel doors

(d) **How is it being used?** e.g.

(i) Is it being used in a dangerous state with broken covers, bare leads, damaged insulation?

(ii) Is it being given rough treatment (check portable appliances as these generally fall in this category)?

(iii) Does it look to be safe?

Exposed conductors and terminations

Regulation 7 (Reasonably Practicable)

(a) Look for any exposed conductors and ask an electrician to prove whether they are live or dead

(b) If they are LIVE, check to see if they can be easily touched. If they can then this could warrant a Prohibition Notice

(c) If they are live can they be INSULATED or SHROUDED

(d) If they are live or can be made live check to see if barriers, screens, divisions or obstacles can be positioned to prevent touch. OR can the conductors be so positioned in a place well out of reach

(e) Generally ensure that all LIVE conductors are protected by enclosures to IP2X (BSEN60529 – Degree of Protection of Enclosures)

(f) Are all cables, which terminate in plug tops, gripped under the plug clamp at the outer sheath of the cable?

(g) Are cable entries to enclosures, properly glanded with no inner cores exposed?

(h) Are flexible conduits or tubing, containing electrical cables, broken? If so, they should be repaired immediately or replaced (braided composite cables can be advised for this purpose)

(i) Do downshop bare overhead crane conductors pass windows, pipe flanges or any equipment which has to be attended to? These conductors should therefore be screened at these points

Electrical protection

Regulation 11 (Absolute)

Note 1: Inspection of protective systems and their respective elements (such as fuses and circuit breakers) can only be assessed by electrically competent persons. Nevertheless, there are some basic questions an Inspector can ask:

(a) **Is the circuit (or system) adequately protected to clear overloads, earth faults and short circuits?**

(b) **What type of protective device is installed, is it a fuse (wire fuses, cartridge or HRC fuses), circuit breaker or relay?**

(c) **Are they so selected to clear any of the above mentioned faults in the fastest time possible? 'Can you supply evidence of this, e.g. calculations or by demonstration if that is necessary (current injection test)?'**

(d) **How often are protective systems tested and by what method (this question refers primarily to relays)?**

(e) **Is the protection system graded to clear faults locally and not to cause interruption or other circuits? 'Show me how this is achieved'**

Note 2: Inspect plug tops for silver paper and/or wire or sawn off nails. Also check the appliance for its load rating and assess the fuse rating. Select a fuse with its rating as near to the design current as practicable. e.g. Watts = Volts x Amps and remember 20 Amps flowing through a 13 Amp fuse takes 3 hours for that fuse to melt.

Joints and protections

Regulation 10 (Absolute)

(a) Look for joints in flexible cables that are insulated by PVC tape. To assess whether these joints meet the requirements of electrical conductivity and insulation may be difficult in situ unless you possess all the necessary test equipment. However the 'acid' test is mechanical strength:

Turn off the supply to the cable, or disconnect the plug and pull on either side of the joint. If the joint comes apart, then it is in breach of this Regulation, but moreover it can be dangerous

Note: Over 95% of joints fall into this category and are easy 'meat' for prosecution; but much more seriously they are the largest cause of accidents. It has to be borne in mind that this Regulation applies to all voltages, but the greatest danger is where these type of joints are used on systems where mains 230 volts AC is applied.

(b) Look for chocolate type connectors or plastic strip terminals; or indeed 'screwit' thimble connectors, all of which can fall into this category

(c) The more established type joint carried out by jointers should not give any problem, but look for signs of corrosion or possible electrolytic action

(d) Check terminals, particularly the 'wrap around' type for slackness (make sure supply is isolated first) and overheating (signified by discolouration)

(e) Check plugs for security of connection, signs of overheating and damage

Isolation and cutting off supply

Regulation 11 (Absolute)

(a) Does every machine have a means of isolation provided and is it accessible?

(b) Does every machine have a means by which it can be stopped, e.g. a stop button and is this button of the mushroom head type and easily accessible?

(c) Are isolators in good condition and can they be operated without difficulty? For example, check for broken handles or any impediment in the operation?

(d) Is the system provided with adequate means of isolation back at the mains switchroom and at the respective distribution points? Does every machine have a means of isolation?

(e) Are all the isolation points clearly marked for the circuits they control? Identification is very important and should be looked for in every inspection. This should also include identification of fuse ways within distribution boards and at front and rear of switchboards.

(f) Check to ensure that all circuits have a means of switching off, e.g. lighting and fan switches and are these in good working order and not broken?

(g) Ask about OFF LOAD isolation and the procedures existing for operation of such... who does it and by which methods?

Earthing

Note: This is a specialist area and can only be adequately assessed by electrically competent personnel. Nevertheless certain pertinent questions can be asked from observations and visual examinations of the earthing arrangements.

(a) **All conductive parts, i.e. metallic enclosures, pipes, radiators, taps etc., must be bonded and efficiently connected to earth**

(b) **Check this carefully and if the earthing protective conductor is visible, examine the connections for tightness. They must be as tight as possible, because loose or slack connections give a high resistance and result in danger**

(c) **Check colour coding of the earthing protective conductor; this should be green/yellow.**

(d) **Is the conductor large enough to carry fault currents without destruction? Ask the electrical department**

(e) **How often is the EARTH FAULT IMPEDANCE tested and what are the latest results? Check with an expert if this is acceptable**

(f) **Is armouring, conduit or trunking used as the earth protective conductor? Check glands for tightness, look for signs of corrosion and damage and ask for bonding straps**

(g) **Ask about the earthing system... do they obtain this from the Supply Authority and how, or do they have an earth rod or a water pipe? Consult an expert**

Portable tools

(a) **Check the voltage they are supplied at**

Note: The safest voltage is the lowest practicable voltage. Generally the recommended voltage is 110 volts AC from a step down transformer where the mid point of the secondary 110 volt winding is connected to earth (CTE). This limits the shock to earth voltage to 55 volts AC. In confined conducting locations the voltage should be much lower than this, i.e. no more than 50 volts from an unearthed (or isolated earth) supply, or 50 volts from a CTE supply to give a 25 volt shock-earth.

(b) **Check the cables and entries, are they damaged?**

(c) **Are there any taped joints similar to those mentioned earlier. If so have them replaced by better type of joint or a new cable**

(d) **Check to see if the metal casing or any other metallic parts of the tool are sufficiently earthed. Seek the guidance of an electrician**

Note 2: Double insulated or all insulated (Class II) tools do not require an earth. It is therefore vitally important to ensure that the casing, cable insulation and plug are not damaged.

(e) **If the tool has to be supplied from a 230 volt AC supply ask for RCD (30mA trip) protection**

(f) **Are they inspected, tested and maintained regularly?**

(g) **Check plugs, fuses, cables and general conditions**

Adverse environmental conditions

Regulation 6

(a) Firstly, check the environment, i.e. is it:

- dusty
- wet or damp (do they use hosing down operations)
- corrosive
- dirty
- adverse weather or just simple weather exposure
- high temperatures and/or pressures
- flammable or explosive atmospheres

Note: Standard electrical equipment will be seriously affected by these conditions and danger will result. Electrical equipment will have to be selected accordingly to suit the environment so as to combat the consequential problems. There are many British Standards dealing with the requirements for electrical equipment in adverse atmospheres and these should be consulted along with specialist advice.

(b) Check the type of installed equipment against the environment and advise accordingly:

- dirty, dusty, wet, adverse weather – BSEN60529
- flammable/Explosive areas – BSEN60079.
- corrosion – Replace or clean down and repaint with anti-corrosive paint
- high temperature, pressures – reposition or replace with suitable equipment

(c) Check also the installation medium such as cables, conduits etc. It is better to use armoured cables or MICC cables in most environments

Work activities

Regulations 4(3) (Reasonably Practicable) Regulations 13 and 14 (Absolute)

Note: The law requires that all work done on electrical equipment should be done dead with the supply to it removed, i.e. DEAD, unless there is a strong and compelling reason for it to be done LIVE.

(a) **The above point must be established at the onset before agreeing to a work activity being done when the power is still supplied**

(b) **Whatever the manner in which the work activity is to be carried out, you must satisfy yourself that the person carrying out the work is sufficiently COMPETENT for the task at hand (see section on Competency)**

Dead working

Regulation 13 (Absolute)

(a) **Do they have a safe system of work that ensures that when the supply has been removed for work to be done on dead conductors, it remains OFF until the work is completed?**

For example:

- Are the circuits to be worked on clearly identified?
- Can they be isolated and LOCKED OFF?
- Are unique locks and keys used?
- Does the person doing the work carry his own key?

- Do they prove the circuit dead before work commences?
- Do they have suitable test instruments for this?
- Do they have proper Warning Notices?
- Do they use personal earthing equipment (optional)?

(d) This example is a proven one and has reliability. However they may have their own which could differ; if this is the case it has to be demonstrated to work and be safe at all times. Examine it carefully

Live working

Regulation 13 (Absolute)

(a) Ask for their assessment of the risks involved

(b) Check on the precautions they are incorporating to cater for these risks. Can the conductors be insulated?

(c) Examine the competency of the person doing the work.

(d) Ask for their WORK PLAN and examine it with them, looking for any potential problems which could lead to danger.

(e) Have they supplied all the necessary suitable protective equipment such as insulated tools, screens, barriers, shrouding, flooring and test equipment for the work?

(f) Is the person carrying out the work fully conversant with the equipment, system and circuit involved?

(g) Has he/she got all the necessary information and drawings for the work?

continued overleaf ...

(h) **Is supervision required and how is this made available?**

(i) **Have all the necessary precautions been taken to allow the person to work alone?**

(j) **If not will they provide accompaniment?**

(k) **Would an accompanying person know what to do in the case of an emergency? Has he been given any instructions?**

(l) **Have they provided adequate space for the work?**

Competency

Regulation 16 (Absolute)

Note: This is the responsibility of the Employer and his Management to ensure that at all times, persons are fully trained and competent for the work they are called upon to do on electrical systems and equipment. It is therefore necessary for anyone carrying out an inspection to satisfy himself that everything has been done to achieve this end.

(a) **Ask to see the training records and syllabus for the relevant personnel**

(b) **Check the 'ON THE JOB TRAINING' programme and how the individual's performance is monitored**

(c) **Enquire as to how the level of competence is arrived at and who makes the final assessment**

(d) **Ask the individual concerned such questions as:**

- Does he/she know where the dangers lie?
- Does he/she know how to AVOID these dangers?
- Is he/she happy with his/her training and what is expected of him/her?

- Is he/she confident that he/she can do the job without risk to themselves and others?
- Is he/she satisfied with his /her technical knowledge and experience or does he/she feel that more training is required?
- Is he/she provided with all the necessary information to do the job safely?
- Does he/she require any other safety training?
- Is sufficient Supervision provided?

(e) Does the company regularly monitor their employees?

Personal protective equipment

Regulation 4(4) (Absolute)

(a) Do electricians have insulated tools?

(b) Are insulated mats (to BS921) provided in front of switchboards and where applicable, at the rear?

(c) Are insulated screens, divisions, barriers etc., available to electricians when they are required to work on or near live conductors?

(d) Is the test equipment supplied to electricians suitable and safe and do the test prods satisfy HSE's Guidance Note GS 38?

(e) Is protective clothing, footwear and gloves used?

Clearance and access

Regulation 15 (Absolute)

(a) **Check the clearance space in front of switchboards and other electrical equipment that has to be worked on**

Note: The Regulations do not give distances for clearance but as a guide, the 1908 Regulations, Regulation 17 is worth consideration, i.e. 3'0" for voltages up to 650 and 3'6" for voltages beyond that.

(b) **Are the areas in front of switchboards obstructed by storage items or other foreign bodies such that access to isolation and switching equipment is severely impeded?**

(c) **Are switchrooms and/or sub-stations being used as store rooms?**

(d) **Ensure that clear access free from danger is provided at every item of electrical equipment and also that sufficient space is available for persons to work**

Lighting

Regulation 15 (Absolute)

(a) Is sufficient and adequate lighting provided where electrical work, including operation of switches and isolators, is normally carried out?

(b) Check in switchrooms, sub-stations, control stations and distribution centre

Note: For guidance it is advisable to consult HSE's Guidance Note HS/G 38 'Lighting at Work' or CIBSE documents on lighting levels in work places.

Maintenance

Regulation 4(2) (Reasonably Practicable)

(a) Do they have any form of maintenance such as inspection programmes, planned maintenance etc., so that the danger can be prevented?

(b) Is it done on a regular basis?

(c) Do they keep records (if so examine them)?

(d) Is action taken?

(e) Is the maintenance effective in your opinion?

Strength and capability of equipment

Regulation 5 (Absolute)

This aspect of the inspection could very well be outside the scope of non-electrical inspectors as it involves a degree of in-depth technical knowledge of the system involved and the equipment connected. It is very much in the interest of the employer and his electrical engineering staff to ensure that electrical equipment is operating well within its strength and capability. To accomplish this, it will require that the electrical department undertake a thorough assessment of load capacity and expectation of potential fault levels on the system. Having established these criteria, it will then become necessary to examine the relevant ratings of the installed equipment. These are not difficult to obtain as they can normally be found on attached nameplates or from manufacturer's data.

The suggested questions to ask in this case would be simply:

(a) Have you done a recent fault level calculation and assessment of loading (this is a requirement under Regulation 4(1) in any case)?

(b) If so have you checked the figures against the ratings of the equipment?

(c) Is everything satisfactory and is the equipment operating within its strength and capability?

Note: Equipment will include cables, switchgear, transformers, motors, transportable and portable appliances etc., and anything which comes within that definition under Regulation 2.

Temporary installations and flexible cables

Note 1: Quite a number of temporary installations are not temporary at all. They generally stay that way for very long periods and sometimes forever. By the very nature in which the installation is executed, it is extremely vulnerable and is very often subjected to damage resulting in ever present dangers being presented to persons working with them, on them or near to them.

The fact that they are regarded as 'temporary' does not mean that they have exemption under the law. They are most certainly NOT exempt. Every electrical installation has to meet the requirements of the 1989 Regulations irrespective of the duration it is in operation or its lack of permanency.

Installations involving flexible unarmoured cables can also be regarded as not being of a permanent nature and should be looked at similar to temporary installations.

1. Ask the question: 'Is the equipment in its final position?'
2. If the answer is YES, then request that it be installed in a permanent manner using conduit, trunking, armoured cable etc
3. If the answer is NO, then ask how long it is to remain in that temporary condition. Do not allow it to remain temporary longer than is necessary
4. Examine the way in which the equipment is erected. Check to ensure that it cannot be knocked over or in a position to be damaged

continued overleaf ...

5. Ensure that the equipment is well constructed and does not have live conductors exposed; also ensure that access to live parts is restricted to electrically competent persons only.

Note 2: Check the voltage used for temporary installations. If they are supplied at mains voltage (230 volts AC) or above, i.e. three phase and neutral (TP & N) 400 volts, then they should be protected by RCCB's (earth leakage circuit breakers) which trip at not more than 30mA in 40 m.secs.

6. Are flexible cables laid across the floor or in positions where they can be easily damaged. Have them re-routed in safe positions.
7. Check also that flexible cables are not lying in water, oil, chemicals, or combustible materials.
8. Check the conditions of the cables. Any damage should be either repaired using a plug and socket or completely replaced with a new cable.
9. Cables should always be gripped by their outer sheath when entering plugs and/or equipment.
10. Flexible cables should be kept as short as possible, preferably no longer than 2 metres.
11. Avoid the use of extension leads wherever possible. If they have to be used then they ought to be in operation for short periods only and run out in tidy fashion away from dangers.
12. On no account accept single core leads. All flexible cables should be of the composite type complete with outer sheath.
13. Flexible cables should be flexible and not of the stiff flat twin and earth type.

Note 3: Welding cables also come into this category.

14. Look very carefully at the methods of supply:

14.1 (a) Do not accept multi-way adaptors

(b) Do not accept two or more cables in one plug

(c) Do not accept conductors held in socket by matchsticks

14.2 (a) Check that the installation of isolators, switches, fuse boards etc., are securely fixed to walls, stanchions or other firm supports. Do not accept such supply equipment if it lies on the ground

(b) Always ensure that the supply points can be easily isolated or switched off without obstruction

‘Duty Holder’

Note: The ‘Duty Holder’ is not restricted to electrically competent persons only. Regulation 3 states that it is the duty of..... to comply with the provisions of the regulations in so far as they relate to matters which are within their control.

In this respect it has to be understood that any person who uses electricity, whether working on it or with it are ‘Duty Holders.’ For example, a person using an electric drill, a welder or one who uses a vacuum cleaner have the equipment in their control, therefore they are ‘Duty Holders’ for that purpose. Moreover, it is natural that an electrician who is working on or near to conductors, whether live or dead, is indeed a ‘Duty Holder.’

In addition, these persons in charge of personnel who work with or on, are ‘Duty Holders,’ but with a greater responsibility and as such they acquire the title of ‘Principal Duty Holders.’ Such persons include Engineers, Managers and Directors of companies. In Health and Safety Law the prime responsibility for safety always lies at the foot of the Employer and his immediate supervisory staff. To assess this situation, the inspector could enquire about the following:

1. Check the persons using electrical equipment and appliances are not mis-using that equipment
2. Do such persons carry out an initial check on the safety of the equipment before putting it to use?
3. Do they report any defects?
4. Enquire as to who is in overall charge of the electrical installation and check to see if they understand their role and their responsibilities
5. Examine the calibre of electrical staff and the work that is laid out before them. This will involve the competency of electrical staff and the section dealing with that subject must be referred to

Defence

Regulation 29

Note: Where the Regulation is absolute, which the majority are, then the 'Duty Holder' will have to have an opportunity to defend him/herself. The most effective way of achieving this is to ensure that the installation is to an established standard and that the equipment installed is to a good and recognised standard and that it is maintained in the same manner.

In addition, safe working practices have to be put into operation whenever work has to be done on or with electrical equipment.

1. Do they have an up to date comprehensive set of drawings for the electrical installation and respective circuit diagrams for system control?
2. Has the installation been put in to a good standard and in particular, to required British Standards e.g. BS7671?
3. Is it being regularly maintained to a required British Standard and in compliance with Regulation 4(2)?
4. Do they have a safe system of work?
5. Is it written down and made available for all to see and have those involved in the work activity been adequately trained in that system of work?
6. Is the system of work supported by adequate documentation e.g. Permit to Work etc?
7. Check to see if the system of work is being adhered to.
8. Does anyone in a management or supervisory position check that the system of work is being adhered to?

continued overleaf...

9. Is a Risk Assessment programme in operation and is it up to date?

10. Does the Risk Assessment include the overall installation and the work activities?

11. Is the Risk Assessment written down and available for all to see?

12. Ask the electrical staff and the electricians in particular, if they are aware of the risks associated with their job and the precautions laid down to minimise or eliminate those risks.

13. Is the Risk Assessment programme being adhered to?

14. Remind the company you are inspecting that they have to prove their defence by initiating good engineering standards, keeping those standards well maintained and that those involved work safely at all times.

Final word

Inspections of any type are arduous and require patience and time. In the case of electrical inspection a good degree of co-operation is required particularly if there is a limited knowledge of the subject. Do not be afraid to ask if you are not sure. If you think there is something not right then pursue the matter, irrespective of how unpopular that decision may be.

Electricity is perhaps the most dangerous form of energy known. It does not alert the human senses and it does not select its victim. It must be given the utmost respect. Therefore it is in everyone's interest to have a safe electrical system.

If you are in any doubt.... ask! Get to know your local Enforcement Officer. He/she will provide all the help you need to further the safety in your workplace.

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