Manufacturing Intelligence:

Precision engineering; Plasma, water jet, CNC, and laser cutting machines

Manufacturing Processes

We know that your clients take risk management seriously and that it plays a key role in the service you offer. We've produced this guide to highlight the controls and prevention measures your clients can take to help reduce the risks associated with the process and types of machinery used in the manufacturing trade.

Plasma cutting

Plasma cutting is a thermal process used to cut precise shapes in electrically conductive metals such as aluminium, steel, aluminium and copper. The process works by sending an electric arc between an electrode (cathode) to the workpiece (anode) via a jet of gas, such as nitrogen, argon, argon / hydrogen or oxygen, through a constricted air or water cooled nozzle. This results in a high temperature (circa 20,000°C), high velocity plasma jet. The workpiece is heated by this thermal energy and the high velocity stream of ionised gas blows the molten metal away thus creating the cut.

Traditional oxy-fuel cutting by burning the metal can only be carried out on material that supports the oxidising process, such as steel and other ferrous metals. As plasma cutting doesn't rely on oxidisation, it can cut aluminium, stainless steel and any other electrically conductive metal.

Water jet cutting

This is a cold cutting process using a very high-pressure jet of water via a small-bore nozzle. Where hard materials are the subject of water jet cutting, as is the case with metal, glass or granite, abrasives are added to the water to achieve the cut. This method of cutting is preferred when the material being cut is sensitive to high temperatures.

Four and five axis cutting heads are now available that can produce very intricate components. These machines are unlikely to involve the use of any highly flammable liquids but may contain hydraulic oils.

Manufacturing Processes

CNC machines

Computer numeric control (CNC) cutting machines are encountered in a range of engineering businesses as part of a manufacturing process or to supplement traditional metalworking machinery.

Use of CNC lathes and milling machines is increasingly common in precision engineering workshops, particularly where high tolerance repeat items are manufactured. CNC machines are unlikely to involve the use of any highly flammable liquids but often contain machine oils, hydraulic oils and cutting fluids to lubricate or cool. CNC machines are computer controlled running computer aided design (CAD) and computer aided manufacturing (CAM) programs.

Laser cutting

A highly accurate method of thermal cutting with excellent cut quality, laser cutting makes it possible to cut very intricate shapes and small holes. A very high energy laser light beam is directed on to the material through a focusing lens concentrating the energy into a small point causing rapid localised melting and part vaporisation of the material. There are 3 types of laser cutting:

1. Fusion cutting where an inert gas such as Nitrogen is introduced through the nozzle helping to remove the molten material from the cut.
2. Flame cutting where oxygen is introduced to create an exothermic reaction increasing the energy at the cutting point.
3. Remote cutting where no cutting or assist gases are introduced.

Risk Features

Business Interruption

There are a range of CNC machines in the market, with machinery manufacturers situated worldwide. Investment in a new CNC machine or plasma / laser / water jet cutting machine is usually significant for any company, and new CNC machines can cost several hundred thousand pounds or more.

Some machines may be available ‘off the shelf’ but lead times of several months or longer can be expected depending on the complexity of the machine, especially if they’re bespoke. This can create the potential for significant business interruption claims.

It can also be both costly and lengthy for modern parts to be retrofitted to any older or obsolete machinery in the event of partial damage.

As with many other manufacturing trades, brokers will be interested in their client’s machinery dependency, process bottlenecks, manufacturing capacity, outsourcing potential and the availability of replacement machinery and parts. All these factors will influence the indemnity period, along with wider business interruption considerations.

Employer’s Liability

All precision engineering manufacturing processes carry the potential for injury to employees. Metal engineering is generally a noisy process, and chemicals used in the production process present both respiratory and dermatological hazards. COSHH and noise assessments are important for any business to identify, eliminate or mitigate the injury or disease potential from everyday processes. Most accidents involving machinery happen when operators are loading or unloading components, removing swarf or taking measurements and making adjustments. Fixed and interlocking guards play a critical role in ensuring employees are protected from dangerous machine-controlled movement. Ensuring that there are safe means to remove swarf and adjust coolant will also mitigate injury potential.

Plasma arc cutting operations provide clean cuts at fast cutting speeds and can be used to cut any metal. There’s greater potential for increased levels of fume, noise, heat and radiation when compared with oxy-fuel cutting processes. Fume levels do however depend on many factors such as the arc current, cutting speed, the material being cut and the plasma gas used.

Laser cutting operations generally involve fine cutting with gas, and generated fume levels are likely to be lower than those associated with oxy-fuel gas cutting and plasma arc cutting. Noise levels also via this method are generally lower. Additional risks associated with operation, setting and maintaining the laser and associated equipment will be introduced and need to be controlled. Accidents involving CNC controlled machines can occur when trapped items or blockages need clearing, and during fault finding, setting, repair and maintenance of the machine itself. Provision of guarding, work zone enclosures, enclosed guards to control noise and dust emissions and containment vision panels to prevent ejection of parts from the machine will all help to protect employees from workplace injury.

Typically, this type of machinery is of a more modern design and will be fitted with the necessary interlocked guarding and or trip devices (light guards). CNC machinery continues to become more advanced, with many injuries noted on such machines occurring during resetting, maintenance and cleaning operations rather than when being operated.

Risk features

Material Damage

One of the attractions of CNC machines is their ability to operate unattended and / or out of business hours for long periods. This reduces labour costs against more traditional manufacturing methods, requiring significantly less manual operation of machines and delivering high tolerances of accuracy. Machines can operate unattended when a particular job requires many hours of machining or if the machine is fitted with an automatic bar feed for example where new material can be automatically fed into the machine throughout the unattended period.

Unattended running of machinery is generally not an attractive feature for insurers. Safety cut out systems may fail to operate or not be present at all so a small fault in an unattended machine can quickly escalate to a major problem when no one is in attendance to spot and correct the issue quickly. Plasma / laser / water jet cutting machines are less likely to operate unattended or outside business hours.

Spark erosion / Electrical Discharge Machining is used when intricate detail needs to be achieved as part of the machining process, which isn't always possible with other processes. The process involves both the metal workpiece and the tool being connected to a direct current which produces a spark. Where the spark contacts the surface of the workpiece, it's heated to a high temperature and the resulting molten metal evaporates creating the desired indent, with synthetic fluid controlling the temperature of the process.

Public Liability

Products manufactured may be component parts or completed items. Consideration of risk will relate to the end usage of the product and its functionality. It's important to understand the client's position in the ultimate chain of supply and also whether they provide any design function.

Products with a safety critical function or those ultimately intended for the North American market can represent additional risks that require a robust risk management approach.

Defects in batches of products may arise if there's a fault in the metal structure of a component part. Issues can manifest as brittle fractures and latent cracks which could eventually result in the failure or unsuitability of the product supplied.

Quality control measures play an important role in mitigating this risk, particularly if any raw materials are sourced from the Far East. Imports from the Far East have increased primarily as a result of lower labour prices and greater investment in modern technology. Whilst statutory controls apply to imported goods, certification doesn't always guarantee the quality of materials and workmanship and it's important that material sourced from overseas meets the client's specification.

Where import is involved, it's important that the client retains full traceability for the materials and any parts supplied to them.

Good quality control measures include ongoing reviews of the design and products, product testing, identification and recording of product distribution, controls on packaging and labelling and formulating a product recall plan.

Common Material Damage and Business Interruption Hazards

The tables below highlight some specific hazards present in engineering and metal workers, along with those associated precautions which will help prevent major loss of physical property. Generic risks resulting from arson, electrical sources and waste aren't mentioned here.

Features always present

Hazard	Control
Risk of ignition as a result of heat being generated by the friction between the cutting tool and workpiece.	■ Regular maintenance of machinery. ■ Selection of safest cutting fluid for the specific material and operation.
Sparks generated by the cutting process.	■ Ensure working areas are clear of combustible materials and adequate fire extinguishers are provided.

Features sometimes present

Hazard	Control
Unattended operation.	■ Mustn't be run unattended.
Severe material damage can occur if a fault arises during unattended operations.	■ Regular maintenance of machinery. ■ Fitting of fire detection and fire suppression systems to individual machines. ■ Fail safe interlocks to ensure processes switch off in the event of a recognised fault, e.g. broken tool. ***Please note that not all unattended processes will be deemed acceptable to underwriters irrespective of the controls in place.**
Risk of contamination from use of minerals, cutting oils and the generation of mist.	■ Regular cleaning of surfaces in an environment that is well ventilated will reduce the risk of contamination. ■ Selection of safest cutting fluid for the specific material and operation.

Common Material Damage and Business Interruption Hazards

Features sometimes present

Hazard	Control
Machining of exotic or combustible materials (e.g. titanium, magnesium) or non-metal materials such as plastic increases the fire load, particularly when these are in a finely divided state as waste. There are also certain spontaneous combustion risks associated with exotic materials e.g. machining of cadmium and magnesium.	■ Good housekeeping and regular removal/containment of waste.
Increased potential for theft where non-ferrous materials such as aluminium, titanium, copper are present.	■ Good physical security should be supplemented by approved intruder alarm protection with police response.
There's an associated water and/or corrosion damage risk.	■ Where relevant, stock or finished goods should be stored off the floor on pallets or in racking.
Increased disruption in the event of replacing specialised equipment.	■ A business continuity plan should be formulated and regularly tested. ■ Important data (designs and drawings, customer orders etc.) should be backed up off site. ■ Opportunities for the client to source the finished product or sub-contract production from a third party in the event of a disruption should be explored.

Liability Hazards

The tables below highlight some specific hazards present in engineering and metalworking environments, along with the associated controls to help prevent significant injury or third party property damage. Generic risks arising from manual handling, warehousing or any work away from the premises aren't mentioned here.

Employer's Liability, Public and Products Liability

Hazard	Control
Cuts and burns to the skin can be incurred from the ejection of parts and / or associated waste.	■ Training of operatives in correct safe process and operation. ■ Checking of guarding systems prior to operation. ■ Provision of relevant PPE/RPE such as safety glasses with signed records. ■ Formal communication of risk assessments and safe operating systems on a signed and receipted basis. ■ Regular planned and predictive maintenance.

Hazard	Control
Range of Occupational Health issues including: ■ Respiratory illness ■ Noise induced hearing loss ■ Eyesight damage ■ Vibration exposure	■ Formal noise assessment by competent and trained person required. ■ Reduce noise levels via engineering controls. ■ Ensure all machinery is fitted with appropriate fixed or interlocking guarding which is checked and maintained. ■ Containment of vision panels to prevent ejection of parts from the machine. ■ Workplace health screening for noise, dermatitis and respiratory disease. ■ Correct selection of machinery and layout of process to achieve good segregation. ■ Use of good safe systems of work for maintenance activities. ■ Manual handling assessment and training to prevent back injuries. ■ Provision of PPE as very last line of defence. ■ Monitoring of employees to ensure PPE being worn. ■ PPE issue and sign off records.

Liability Hazards

Employer's Liability, Public and Products Liability

Hazard	Control
Failure of products due to defect.	■ Routine and robust quality control procedures with particular emphasis on safety critical or high potential liability components manufactured. ■ Quality control inspections could include visual inspection batch testing, thickness measurements and defect detection systems which can include surface and embedded techniques. ■ Records of product testing together with calibration of testing equipment need to be maintained. Full traceability should also be maintained in respect of products or parts supplied.

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