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Computer Numerically Controlled (CNC) Machining Center

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Friday, March 04, 2016

Objectives

- Types and parts of CNC machines
- Hazards of CNC machines
- OSHA regulations that apply to CNC machines
- American National Standards Institute (ANSI) that apply to CNC machines
- Effective machine guarding
- National Institute of Occupational Health & Safety (NIOSH) Studies of Adverse Health effects
- General Safety Principles

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What is a CNC Machine:

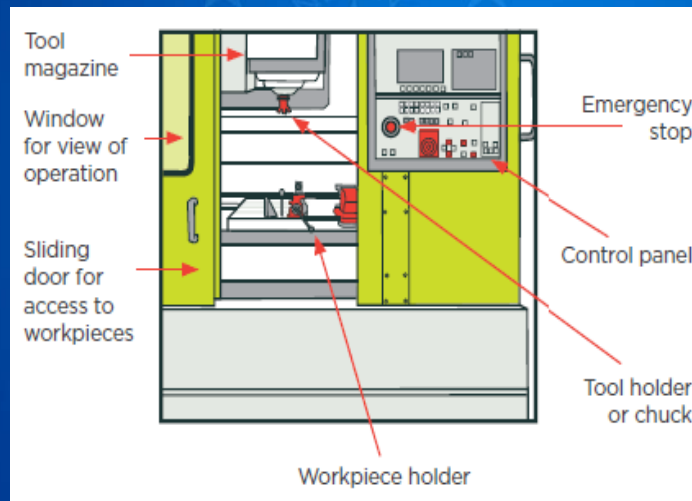
- Computer numerically controlled (CNC) machining center
- Cuts and shapes an assortment of precision products
- Operates in either horizontal or vertical positions
- CNC machinery includes machining tools such as lathes, multi-axis spindles, and milling and boring machines
- CNC machinery is either hand loaded or automatically fed

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Parts of a CNC Machine



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Types of CNC Machines

- **CNC Milling Machines** - programmed to move cutters and various other tools in a pre-programmed manner to cut metal pieces into desired sizes and shapes
- **CNC Lathe Machines** - programmed to change the tools automatically
- **CNC Routers** – programmed to cut more complex shapes and prototype models of plastics, wood, and metal sheets
- **CNC Plasma Cutters** - plasma is used to melt the metal sheet in order to cut it into desired shape and sizes

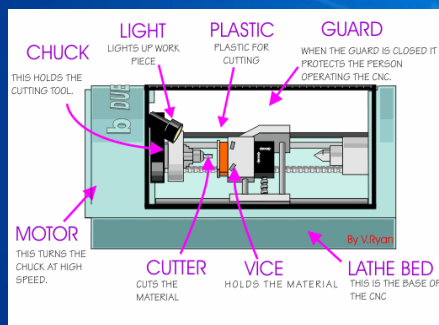
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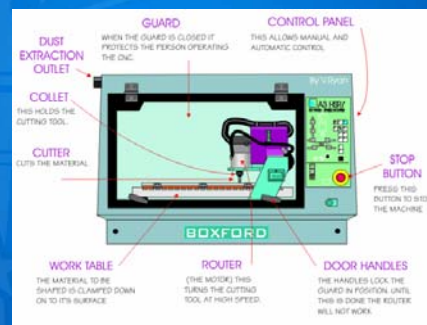


Types of CNC Machines

CNC Lathe



CNC Router



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Types of CNC Machines

Plasma Cutter



Milling Machine

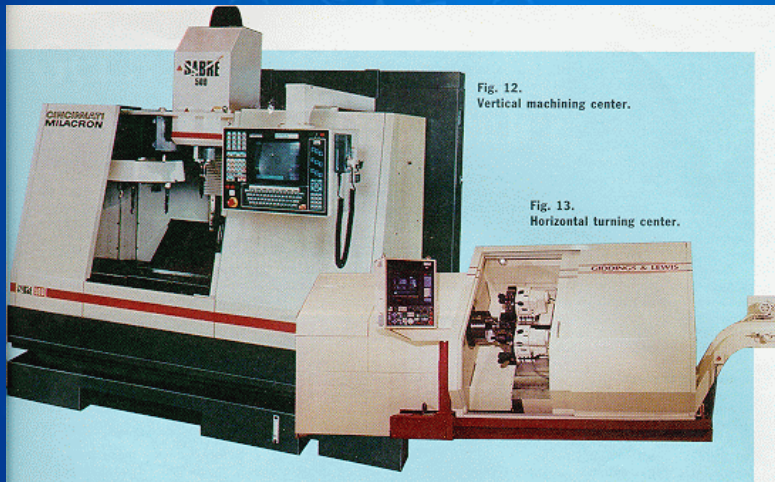


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Types of CNC Machines



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Hazards of CNC Machines

- Injuries from Machines not properly guarded include:
 - Amputations
 - Lacerations
 - Crushing
- Electrical Hazards
- Metal Working Fluids
- Noise
- Dust and Flying Particles
- Slip Trip Hazards

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CNC Machine Accidents

- A worker was killed in an industrial accident when the **CNC Fabricating Machine** he was operating ejected a piece of aluminum, striking him in the neck and head.
- A company's marketing Director was found mutilated inside a **Doosan CNC Lathe Machine** after an apparent attempt at machining a new part.
- A 23-year-old male mill worker died when a drill was thrown from a shattered hard steel tool extension and struck him in his chest. He was operating a **High-Speed CNC Machining Center**.
- A 27-year-old machinist was fatally injured when he was struck by a piece of round stainless steel bar stock that he was machining in a **CNC Lathe**.

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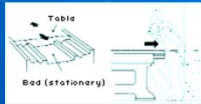


Determining if Machine Requires Safeguards:

- “A good rule to remember: Any machine part, function or process which may cause injury must be safeguarded.”
Occupational Safety and Health Administration (OSHA),
- Machines that include rotation, reciprocation, or transverse type motions are hazardous and must be safe guarded.



Rotating



Reciprocating Motion



Transverse Motion

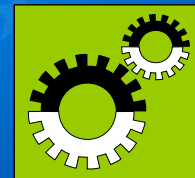
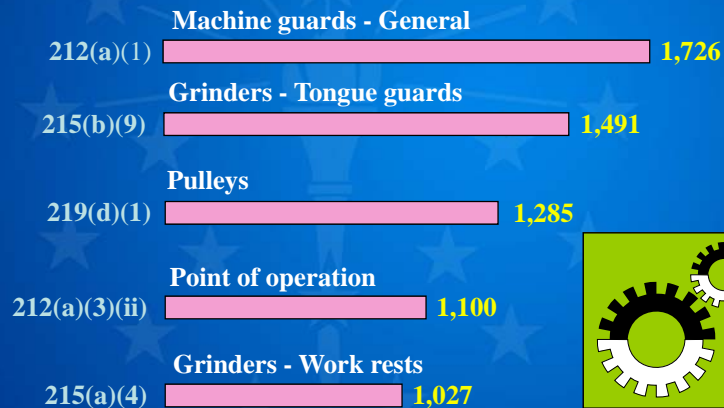
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Subpart O-Machinery & Machine Guarding (1910.211-211): *OSHA's Machine Guarding Citations: 2,295 (2015)*

Standard: 1910.



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Machine Guarding

- **OSHA's *Machine guarding* standard, §1910.212:** broadly addresses the various types of hazards that machines may present and numerous ways to properly guard the machine to protect the workers.
- **OSHA's *Abrasive wheel machinery* standard, §1910.215:** addresses the use of abrasive-coated router bits in the CNC contouring machine.

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Machine Guarding

Question: When are awareness barriers, such as a chain equipped with a warning sign or similar type of guarding, acceptable to satisfy the OSHA standards for machine guarding?

Reply: The machine guarding standard contemplates a physical means of preventing employee contact with the moving parts of machines. An awareness barrier serves as a notice to an employee that he or she is approaching a dangerous area and does not physically prevent an employee from contact with moving parts of machines.

**If an employee may be exposed to machine hazards while the machine operates, the hazardous areas of the machine must be guarded.*

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Machine Guarding (Continued)

Question: Are interlocks required by OSHA?

Reply: While properly designed, constructed, and maintained interlocks generally provide effective machine guarding, §1910.212 does not require the use of interlocks or any other specific guarding methods.

**Remember if interlocks are used they must:*

- (1) Prevent opening until hazardous motion has stopped.*
- (2) Be located at the proper safety distance so that an individual cannot reach the hazard before the hazardous motion has stopped when it is opened.*

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Interlocks Are Not Lockout Devices

- **Disconnect the energy isolating device(s):**
All energy isolating devices used to control the energy to the machine or equipment must be physically located and placed in the "off" position to disconnect the machine or equipment from its energy source and de-energize it.
- **Control circuitry** does not provide a physical barrier that controls hazardous energy and is not an energy isolation device.



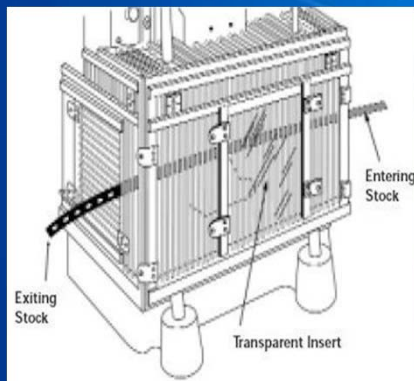
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ANSI B11.22

- ANSI allows for fixed and interlocked movable guards.



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ANSI B11.22

- Fixed Guards:
 - Shall be kept in place by either permanent means (welding) or by means of fastener (screws/bolts).
 - Tools must be used to remove guards.
- Movable Guards:
 - Shall provide access to hazard area with the use of tools.
 - Shall be interlocked so that hazardous machine functions cannot operate until the guard is closed and if the guard is opened while machine is functioning, a category 1 stop shall be initiated.



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Case Study

- Fatality when CNC door opened during operation
- Interlock disabled
- Employee struck by moving parts
- 53 other machines in facility had interlocks disabled
- Coroner initially ruled that it was a heart attack
- After coroner conducted investigation, ruled that the cause of death was due to being struck by moving parts, manner of death was undetermined
- The pathologist altered his opinion after he reviewed the slides

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Types of metalworking fluids:

- **Straight Oil:** mineral (petroleum) or vegetable
- **Soluble Oil** (emulsifiable oil): 30 to 85 percent of severely refined lubricant base oil
- **Semi-Synthetic:** a lower amount of severely refined base oil
- **Synthetic:** contains no petroleum oil



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Metalworking Fluid Properties

There are many signs that a fluid has undergone changes and is no longer safe to use because of emerging health hazards:

- Abnormal fluid appearance
- Foul smell (rancidity)
- Floating matter on the fluid
- Excessive foam
- Dirty machines or trenches
- Employees have skin irritation
- Employees have respiratory irritation



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Health, Safety and Environmental Concerns of Metal Working Fluids (MWF):

- Health, Safety, and Environmental concerns that should be considered when selecting a fluid:
 - Toxicity of the fluid components
 - Flammability of the fluid
 - Fluid disposal
- Currently two OSHA air contaminant permissible exposure limits apply to MWFs:
 - 5 mg/m³ for an 8-hour time weighted average (TWA) for mineral oil mist
 - 15 mg/m³ (8-hour TWA) for Particulates Not Otherwise Regulated [applicable to all other metalworking fluids], 29 CFR 1910.1000

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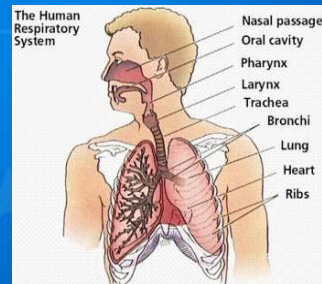
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Health Effects of Metalworking Fluids

- **Skin Disorders** - Two types of skin disease
Contact Dermatitis and Acne
- **Respiratory Diseases**
Irritation of the lungs, Throat and Nose
- **Cancer**
Rectal, Pancreas, Larynx, Skin, Scrotum, and bladder

(NIOSH 1998).



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Types of Oil Mist Air Monitoring

Detector tube and pump systems are a very effective way to do on-the-spot air monitoring and meet the OSHA requirements of 25% error. They are accurate enough to get an idea of the hazards in the workplace. Detector tubes are typically used when surveying an area, and can also give an idea of worker exposure in ppm or percent volume.



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Types of Oil Mist Air Monitoring

- Personal air-sampling pumps are a little more difficult to use.
- Sampling media, 37 mm PVC filter with a flow rate of 1 to 2 L/min.



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Engineering Controls for Reducing Employee Exposure to Metalworking Fluids :

- Design Considerations
- Isolation of the employee through mechanical parts handling equipment and machine enclosures
- Install an exhaust ventilation system.
 - Close Caption, Tunnel Total or Complete Enclosures
 - Push-Pull Ventilation
 - Side-Draft, Canopy & Downdraft Hoods
- Periodic inspection and preventative maintenance of process equipment

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Work Practice Controls to Reduce Employee Exposure to Metalworking Fluids:

- Good personal hygiene
- Barrier creams may be useful for some employees
- Personal Protective Equipment Assessment
- Good housekeeping



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Management and Employee Involvement:

- Supervisor Responsibilities
- Employees Training
- Employee Involvement
- Safety Committee



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General Safety Principles for PPE:

- *Always* wear hearing protection when operating CNC machines.
- *Always* wear safety glasses when operating or closely observing cutting tools.
- *Always* wear safety boots or other suitable footwear.
- *Always* keep long hair covered when operating CNC machines.



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General Safety Principles for Safe Operation:

- *Always* make sure the machine is not operating when loading a tool magazine.
- *Always* check that:
 - Correct tool data is entered into the CNC program
 - Tools are set correctly and in good condition
 - Test tools before use
- *Always* check that the seating surfaces are clean before installing tools.
- *Always* check that spindle direction is correct for right-hand or left-hand operation.
- *Always* use tools within the limits specified by the manufacturer



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General Safety Principles for Safe Operation:

- *Always* keep hands clear of moving parts during machining operations and avoid contact with cutting edges when changing tools
- *Always* stand clear of the machine while it is running and warn others of the dangers of being too close.
- *Always* turn the CNC machine off completely and clean it when you have finished using it.
- Always make sure that all guards are in position , work and fixtures are secure, spindle direction is correct before starting the machine.
- Always make sure that all work and fixtures are clamped securely before starting machine, complete a test run.

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Review

- Types and parts of CNC machines
- Hazards of CNC machines
- OSHA regulations that apply to CNC machines
- ANSI standards that apply to CNC machines
- Effective machine guarding
- Adverse Health effects:
 - Exposures to cutting fluids
 - Ways to minimize employee exposure

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