

Technical Construction Files

Date: 2016-08-05



NOVA Wood Lathe

**Model(s):
1624II**

**According to
2006/42/EC Machinery Directive,
2014/35/EU Low Voltage Directive**

**Presented By
Teknatool International Limited
7D Dallen Place, Rosedale, Auckland, 0632, NZ**

Documents Reference

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EC Declaration of conformity

Applicant:

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Manufacturer:

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**Yangjialin, Beiguan Street Office, Jiaozhou, Qingdao City,
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Tel: 86-13863907033 Fax: 86-532-88279799

Product Name:

NOVA Wood Lathe

Model(s):

1624 II

We here declare that the products described above are in conformity with the following Directive(s):

**2006/42/EC Machinery Directive,
2014/35/EU Low Voltage Directive**

Moreover the following harmonized standards have been applied to the Model(s) above:

**EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010,
EN 349:1993+A1:2008, EN ISO 14120:2015, EN ISO 13857:2008,
EN 13850:2015**

**The technical construction files required to demonstrate that the product(s) meet(s) the requirement(s) of the
aforementioned directive(s) has been compiled.**

European representative:

Name:

Company Name:

Address:

Tel:

Issue place:

Manufacturer stamp and Signature of authorized personnel



2.0 Machine General Description

Read item 4~7 for these machine models detail information. Basically, these kinds of machines models belong to simple machine and with low risk when using them. All possible risk have been analyzed in the risk assessment report and been prevented by suitable ways.

The main risk of these kinds of machine models could be:

- The risk of access to the in-running nips.
- The risk of access to the power transmission elements.
- The risk of access to the area between moving parts and fixed parts which with crushing hazards.

In order to evaluate the main risks mentioned above, the occupational safety and health risk assessment has been done according to the requirement of EN ISO 12100:2010

In order to ensure the conformity for CE marking for these machines models, some main European and/or International standards have been used for the assessment of conformity, they are:

- EN ISO 12100:2010 Safety of machinery - General principles for design - Risk assessment and risk reduction
- EN 60204-1:2006+A1:2009+AC:2010 Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- EN 349:1993+A1:2008 Safety of machinery - Minimum gaps to avoid crushing of parts of the human body
- EN ISO 14120:2015 Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards
- EN ISO 13857:2008 Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)
- EN ISO 13850:2015 Safety of machinery. Emergency stop function. Principles for design

To present the conformity of these series machines models with Machinery and Low Voltage Directives, we discuss the conformity systematically with the relative Directives and standards.

3.0 Quality Control System

In order to ensure the conformity of the series production, we have taken the related procedures mentioned below:

1) The complete technical construction file (TCF) has been established before applying for the CE marking certificate.

2) Carry out the inspection for parts and components according to the TCF

Before the assemblies of the series production, the QC engineers of our company have to check and inspect the technical specifications and intended functions of parts and components to ensure the correct use of them according to the contents of TCF and principle described in the related technical information.

3) Carry out the inspection & testing for the products before packing

Before packing the products, the QC engineers of our company have to do the necessary inspection and testing to ensure the conformity of related requirements. In particular, they should do the testing and inspection of electrical characteristics and outer feature.

4) Carry out the inspection for the packing

After finishing the necessary inspection and testing for the products, an inspection for the packing has to be done to ensure the necessary elements being included in this packing before shipment.

5) Provision for the change of design

Any change of the products described in this TCF must be checked in detail and written down again in the TCF by the designer if the change may effects the related electrical or mechanical characteristics.

6) Provision for the Quality Assurance

For the provisions of internal control measures to ensure the conformity of series production of the machines, we have built an internal quality control system in accordance with the international standard of ISO 9001.







nova 1624 II



swivelhead

Manufactured by Teknatool International

www.teknatool.com

111-0605-002

SWING OVER BED

- 400mm (16")

SWING OUTBOARD

- 740mm (29")

(Headstock at 90°, using optional outrigger unit accessory)

BETWEEN CENTRES

- 600mm (24")
- Extendable in 20" (510mm) bed sections

(using optional bed unit accessory)

SPINDLE THREAD

- 1 1/4" UNS RH USA, Canada, UK, Australasia
- M33.35RH Europe

BORE

- 2MT Headstock & Tailstock
- Hollow Spindles

SPINDLE INDEX

- 24 Division

HEADSTOCK INDEX

- 0°-90°
- 0°, 22.5°, 45°, 90°
- Detent Pin Lock Positions

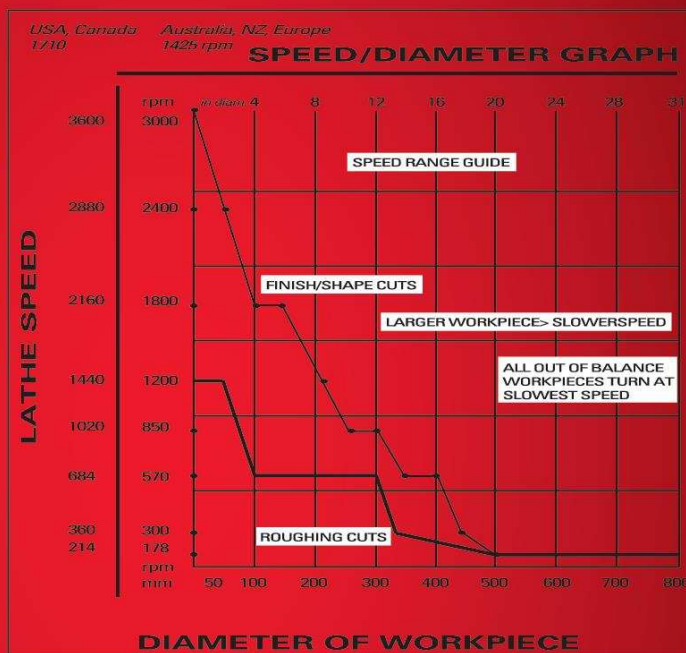
SPEEDS

(Australia, UK, New Zealand)

- 8 speed 178, 300, 570, 850, 1200, 1800, 2400, 3000 RPM

(USA, Canada)

- 8 speed 214, 360, 684, 1020, 1440, 2160, 2880, 3600 RPM



Serial



warning for your own safety

- 1 Do not operate before Nova 1624-44 Manual is read and understood.
- 2 Closely follow safety rules in Nova 1624-44 Manual.
- 3 Keep guards in place and in working order.
- 4 Examine workpiece carefully. Do not mount and turn if flawed or poorly glued.
- 5 Make sure workpiece is securely fastened to faceplate or chuck. Rotate workpiece by hand to check clearance before engaging power.
- 6 Make sure headstock is locked in position and all locks/clamps are tight before operation.
- 7 Make all adjustments with the power off. Change speeds only when lathe is switched off and at a complete stop.
- 8 Excessive speed is a serious lathe hazard. Always turn at the slowest speed available for the workpiece diameter. For new workpiece always start at the slowest speed possible. Follow speed recommendations in manual.
- 9 Always wear safety glasses and face and head protection when operating lathe.

nova 1624 II

1.5 hp

8 Speed

**Most powerful mid range
lathe on the market**

- Quick action swivel head brings the work to you
- Easy cam action belt change
- Extendable Bed (with optional Bed Extension Accessory)
- Long reach Toolslide
- Hollow Headstock and Tailstock
- Large heavy duty spindle bearings
- Easily adjustable spindle lock
- 24 position spindle index
- Easy view speed window – know where you are at a glance
- Outboard turning capable (with optional Outtrigger Accessory)
- 5 Year Warranty (Limited) mechanical parts and components
- 1 Year Warranty on motor

111-0605-003

**STAND DIRECTLY IN FRONT
TO READ BELT POSITION**

**SEE MANUAL TO CHANGE
BELT POSITION**

Aus,
UK, NZ

3000

2400

1800

1200

850

570

300

178 rpm

USA,
Canada

3600

2880

2160

1440

1020

684

360

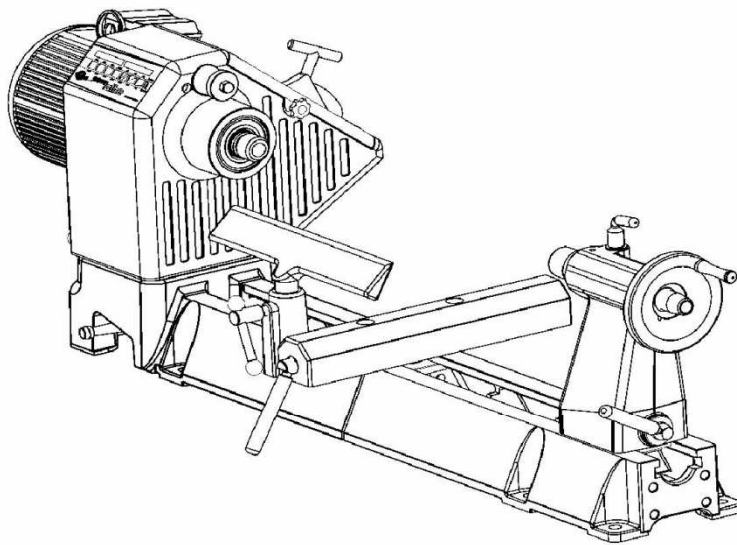
214 rpm



nova
1624 II 8 SPEED RANGE

111-0605-004

NOVA 1624 II TM WOODLATHE



Smart Tools Powerful Solutions
www.teknatool.com



IMPORTANT Please Note:

Your new NOVA 1624 II Woodlathe comes with additional safety feature, and is fitted with an emergency stop button on the motor.

This button is for "Emergencies" only. The machine will coast to a stop if this button is pushed in. Important: Once this Emergency stop button is pushed, you must release into the "OUT" position before you can use the lathe again. You must twist to release it into the OUT position before you can turn on the lathe.

- Use the regular STOP button if you want the lathe to come to a stop.
- To turn the machine on and off, use the on/off switch on the motor.

Welcome

Thank you for choosing our Nova 1624 II Woodlathe and welcome to the NOVA Product Family. Your choice shows that you want the best for your woodturning and recognise the superior and unique features that the Nova 162 II lathe offers.

We strive to achieve the best value for your money – providing quality where it counts, innovative features, a wide variety of accessories (some of them unique to Teknatool) plus comprehensive, ongoing support (latest manuals downloadable from our website, free newsletters, projects etc). We are only a phone call or email away with technical advice or assistance on the operation of your lathe or your woodturning enquiries.

Please feel free to contact us about any aspect of our products or service – we regard our customers as our best development and improvement team – we'd love to hear from you!

Once again, welcome to the "NOVA Family". We hope you enjoy our products and hope they enhance the pleasure you experience from the wonderful craft of Woodturning!

Best Regards

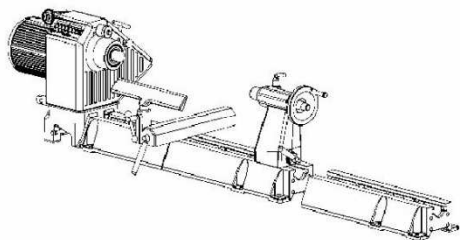
A handwritten signature in blue ink, appearing to be 'J. F.', located below the 'Best Regards' text.

Nova 1624 II Lathe Features at a glance

Note: Some options have a stand included! Motor & Specifications vary depending on the Country

Add on Bed System

A lathe that meets your woodturning needs, your workshop space, or your pocket! Each segment is about 20.3" in length. The feature appeals for many different reasons:

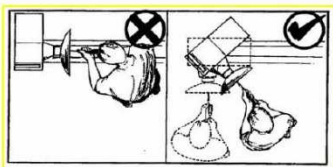


As a compact lathe (standard configuration) it is great for small turning workshop spaces.

As an extended lathe for those wanting to do extra long spindles (beyond the traditional between centre of most lathes) the Nova 1624/44 delivers big turning capacity. Illustrated left.

As a bowl lathe for those just wanting to turn bowls.

Sophisticated Swivel Head



Swivel head lathes have many advantages:

- Space saving
- Allows the turner (not the machine!) to decide the most comfortable position for your turning (saving you from backstrain)
- Elimination of lefthand 'outboard' turning techniques and no extra outboard chucks and faceplates are necessary.

There are a number of swivel head lathes available, but the Nova 1624 II has by far the most sophisticated, accurate and easy to use swivel head on the market.

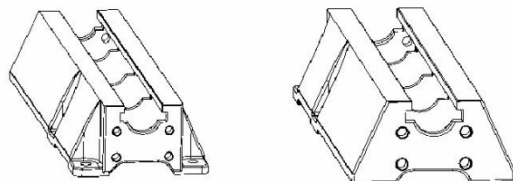
The Nova 1624 II lathe can be easily and quickly swiveled to any position (360 degrees). It can be solidly locked in any position plus it has the added security of a detent pin lock at 0, 22.5, 45, 90 and 315 degrees (for left hand use).

The swivel head turns, locks easily and has a very accurate detent position, to lock the spindle in line with the tailstock. Then for super accuracy the adjustable tailstock can be finely tuned for pin point alignment (this is factory set but can be adjusted in the field). This combination of detent pin and adjustable tailstock delivers superb accuracy and is unique to the Nova 1624 II.

Speed Range

The Nova 1624 II lathe has an eight speed range, one of the very best available. From very low speeds for large and out of balance work through to very high speeds for small and finishing work. Some markets also have the added advantage of a variable speed motor option (check with your reseller).

Solid Construction



Well proven design, the Nova 1624 II is made from Cast Iron components for strength and rigidity. Added features like the heavy duty twin bearing system, and special webbed bed design makes the lathe well equipped to take heavy turning stresses. The bed has been designed with vibration dampening qualities - a solid 1/2" cross rib is positioned along the bed unit, quickly absorbing any vibration as it travels down the bed.

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United States

NOVA Customer Care & Innovation Center

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Email: service@teknatool.com

Website: www.teknatool.com

Or contact the Reseller where you purchased the NOVA 1624-44 Wood Lathe, see our website for their contact details in your country

www.teknatool.com

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GENERAL SAFETY RULES

1. **FOR YOUR OWN SAFETY, READ THE MANUAL BEFORE OPERATING THE TOOL.** Learn the machine's application and limitations plus the specific hazards peculiar to it.
2. **ALWAYS USE A FULL FACE SHIELD** (must comply with ANSI STANDARD Z87.1 -USA) Everyday eye-glasses usually are only impact resistant and safety glasses only protect eyes. A full face shield will protect the eyes and face. Also use face or dust mask if cutting operation is dusty.
3. **WEAR PROPER APPAREL.** Do not wear loose clothing, gloves, neckties, rings, bracelets or other jewelry which may get caught in moving parts. Non slip footwear is recommended. Wear protective hair covering to contain long hair.
4. **USE EAR PROTECTORS.** Use ear muffs for extended period of operation. Use muffs rated to 103 DBA LEQ (8 hour).
5. **DON'T USE IN A DANGEROUS ENVIRONMENT.** Don't use power tools in damp or wet locations, or expose them to rain. Keep work area well lighted. The Nova 1624/44 Lathe is intended for indoor use only. Failure to do so may void the warranty.
6. **KEEP WORK AREA CLEAN.** Cluttered areas and benches invite accidents. Build up of sawdust is a fire hazard.
7. **KEEP CHILDREN AND VISITORS AWAY.** All children and visitors should be kept a safe distance from work area.
8. **MAKE WORKSHOP CHILDPROOF** with locks, master switches, or by removing starter keys.
9. **GROUND ALL TOOLS.** If the tool is equipped with a three prong plug, it should be plugged into a three-hole electrical receptacle. If an adapter is used to accommodate a two prong receptacle, the adapter lug must be attached to a known ground. Never remove the third prong.
10. **MAKE SURE TOOL IS DISCONNECTED FROM POWER SUPPLY** while the motor is being mounted, connected, or reconnected.
11. **DISCONNECT TOOLS** before servicing and when changing accessories such as blades, bits cutters, etc.
12. **AVOID ACCIDENTAL STARTING.** Make sure switch is in the Off position before plugging in power cord.
13. **NEVER LEAVE MACHINE RUNNING UNATTENDED.** Do not leave tool unless it is turned off and has come to a complete stop.
14. **KEEP GUARDS IN PLACE** and in working order.
15. **USE RIGHT TOOL.** Do not use a tool or attachment to do a job for which it was not designed.
16. **USE RECOMMENDED ACCESSORIES.** The use of improper accessories may cause hazards.
17. **DON'T FORCE TOOL.** It will do the job better and be safer at the rate for which it was designed.
18. **MAINTAIN TOOLS IN TOP CONDITION.** Keep tools sharp and clean for best and safest performance. Follow instructions for lubricating and changing accessories.
19. **NEVER STAND ON TOOL.** Serious injury could occur if the tool is tipped or if the cutting tool is accidentally contacted.
20. **REMOVE ADJUSTING KEYS AND WRENCHES.** Form a habit of checking to see that keys and adjusting wrenches are removed from tool before turning it on.
21. **DON'T OVERREACH.** Keep proper footing and balance at all times.
22. **DIRECTION OF FEED.** Feed work into a blade or cutter against the direction of rotation of the blade or cutter only.
23. **ATTENTION TO WORK.** Concentrate on your work. If you become tired or frustrated, leave it for awhile and rest.
24. **SECURE WORK.** Use clamps or a vice to hold work when practical. It's safer than using your hand and frees both hands to operate tool.
25. **CHECK DAMAGED PARTS.** Before further use of the tool, any part that is damaged should be carefully checked to ensure that it will operate properly and perform its intended function. Check for alignment of moving parts, binding of moving parts, mounting, and any other conditions that may affect its operation. Any damaged part should be properly repaired or replaced.
26. **DRUGS, ALCOHOL, MEDICATION.** Do not operate tool while under the influence of drugs, alcohol, or any medication.
27. **DUST WARNING.** The dust generated by certain woods and wood products can be injurious to your health. Always operate machinery in well ventilated areas and provide for proper dust removal. Use wood dust collection systems whenever possible.

ADDITIONAL SAFETY RULES FOR WOODLATHES



Warning! Failure to follow these rules may result in serious personal injury.

1. **DO NOT MODIFY OR USE LATHE FOR USES OTHER THAN FOR WHICH IT WAS DESIGNED.**
2. **SEEK INSTRUCTION.** If you are not thoroughly familiar with the operation of woodlathes, obtain advice from your supervisor, instructor, or other qualified person. Instruction from a qualified person is strongly recommended.
3. **DO NOT OPERATE LATHE** until it is completely assembled and installed.
4. **FOLLOW ELECTRICAL CODES.** Make sure wiring codes and recommended electrical connections are followed and that the machine is properly grounded.
5. **KEEP WORK AREA CLEAN.** Do not turn the lathe On before clearing the lathe of all objects (tools, scraps of wood, etc.). Keep the nearby area and floor clear of debris.
6. **CHECK SET-UP** with power Off. Examine the set-up carefully and rotate the work piece by hand to check clearance before turning on power.
7. **DO NOT MAKE ADJUSTMENTS** when the lathe or work piece is turning. Make all adjustments with power Off.
8. **TIGHTEN ALL CLAMP HANDLES** on the headstock, tailstock, and toolrest before operating lathe.
9. **EXAMINE WORK PIECE** and glue joints before turning to make sure it has no defects that would cause it to break when turning.
10. **USE LOWEST SPEED** when turning a new or unbalanced work piece.
11. **TURN AT RECOMMENDED SPEED.** Always operate the lathe at the recommended speeds. Consult this manual for suggested speeds.
12. **ADJUST TOOLREST** close to the work piece. Before turning, revolve the stock by hand to make sure it clears the rest. At intervals, stop the lathe and readjust the toolrest.
13. **KEEP TOOL ON TOOLREST.** The lathe tool or chisel should be on the toolrest before the lathe is turned On. Tools should remain on the toolrest whenever the tool is engaged in contact with the work piece.
14. **REMOVE TOOLREST** when sanding or polishing so fingers do not get pinched.
15. **USE CORRECT LATHE TOOLS.** Do not use spindle turning chisels for faceplate mounted work, and vice versa. Spindle turning tools used for faceplate turning may grab the work piece and pull the chisel from your control.
16. **WHEN ROUGHING STOCK** do not jam the lathe tool or chisel into work piece or take too big a cut.
17. **DO NOT POUND WORK PIECE** into headstock drive (spur) center when turning between centers. Pound the drive center into the work piece with a soft mallet before installing it between centers in the lathe.
18. **DO NOT USE TAILSTOCK** to drive work piece into the drive (spur) center when turning between centers. Secure work between centers with light pressure from the tailstock quill action.
19. **FASTEN STOCK SECURELY BETWEEN CENTERS.** Make sure the tailstock is locked before turning on the power.
20. **NEVER LOOSEN TAILSTOCK** spindle or tailstock while work piece is turning.
21. **COORECTLY USE FACEPLATE.** When faceplate turning, make sure work piece is securely fastened to the faceplate and that appropriate size faceplate is used to support the work piece. Any screw fasteners must not interfere with the turning tool at the finished dimension of the work piece. Rough-cut the work piece as close as possible to finished shape before installing on faceplate.
22. **DO NOT OPERATE LATHE IF DAMAGED OR FAULTY.** If any part of your lathe is missing, damaged or broken, in any way, or any electrical component fails, shut off the lathe and disconnect the lathe from the power supply. Replace missing, damaged, or failed parts before resuming operation.
23. **ADDITIONAL SAFETY INFORMATION** regarding the safe and proper operation of this product is available from the National Safety Council, 444 N. Michigan Avenue, Chicago, IL 60611 in the Accident Prevention Manual of Industrial Operations and also in the Safety Data Sheets provided by the NSC. Also refer to the American National Standards Institute ANSI 01.1 Safety Requirements for Woodworking Machines and the U.S Department of Labor OSHA 1910.213 Regulation.

Guidelines to symbols used in this manual:



Warning Symbol. Pay close attention!



Note/Information Symbol. Please read - important information for you.

Nova 1624 II Woodlathe Specifications

Size: see drawing below.

Weight: 72 kg (158.7 lb) (without motor)

Swing Over Bed: 400 mm (16 in.)

Distance Between Centers: 600 mm (24 in.); expandable in 516 mm (20.3 in.) units with add-on Bed sections.

Swing Outboard: 740 mm (29 in.) with headstock at 90° with outrigger toolrest.

Headstock:

Spindle Thread:

1-1/4 x 8 TPI RH ⁽¹⁾ or

M33 x 3.5 RH ⁽²⁾

Headstock Bore: No. 2 Morse Taper (#2 MT)

Headstock Swivel: 0 to 360 degrees, with detents at 0, 22.5, 45, and 90 degrees.

Outboard End Internal Thread: M20 x 1.5 LH

Spindle Index: 24 divisions (every 15 degrees)

Tailstock:

Tailstock Bore: No. 2 Morse Taper (#2 MT)

Quill Travel: 85 mm (3-1/4 in.)

Hole Through Tailstock: 15 mm (9/16 in.)

Toolrest:

Length: 300 mm (12 in.)

Shaft Diameter: 25.4 mm (1 in.)

Motor Options (Recommended):

AC Motor, 1.5 HP, 1425 rpm, 50 Hz ⁽¹⁾

AC Motor, 1.5 HP, 115v 1720 rpm 60Hz ⁽²⁾

DC Motor, 1.5 HP, 0-1750 rpm, 50-60 Hz 3

Speeds (rpm): 8-step motor pulley

178, 300, 570, 850, 1200, 1800, 2400, 3000 ⁽¹⁾

214, 360, 690, 1030, 1450, 2180, 2900, 3630 ⁽²⁾

Standard Equipment:

300 mm (12 in.) Toolrest, Poly Vee Drive Belt, Motor Pulley, Motor Mounting Kit, 150 mm (6 in.) Faceplate (Not all countries, see notes below), Spur Center, and Live Center

Optional Accessories:

Nova Chuck Systems

SuperNova2 Chuck System

Faceplates: 80 mm (3 in.), 150 mm (6 in.)

Vacuum Faceplate

Toolrest: 100 mm (4 in.)

Bowl Toolrest

Outrigger Toolrest Unit

Handwheel

Vacuum Coupler

Revolving Center System

Notes:

(1) United States, New Zealand, Australia, Canada and UK.

(2) Europe (except UK)

Note: Standard equipment varies from country to country. In other markets, the motor and the faceplate are optional equipment. Check with your reseller if you are unsure.



For Europe, Australasia, UK and South Africa

Directives this equipment complies with:

Low voltage directive (LVD) 73/23/EEC + 93/68/EEC+2006/95/EC

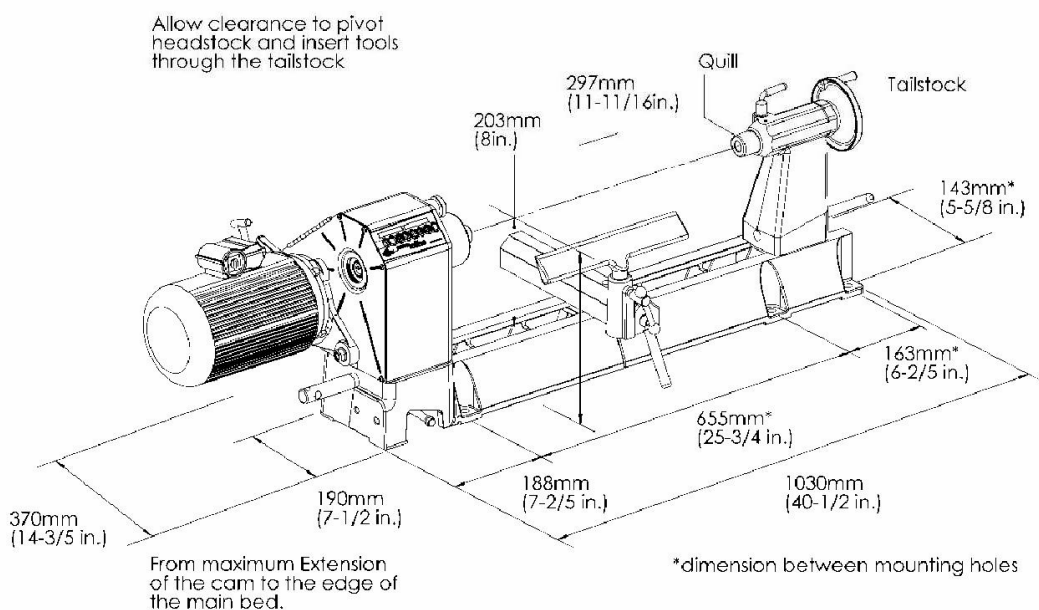
Machinery directive (MD) 89/392/EEC + 91/368 EEC + 93/68/EEC+2006/42/EC

Harmonized Standards applied in order to verify compliance with

Directives: EN 61029-1:2009 (Low Voltage Directive and Machinery Directive.

Signed.....Dated 10/12/2010

Nathan Stantiall
Development Manager



Setting Up Your Workshop

Workshop Requirements

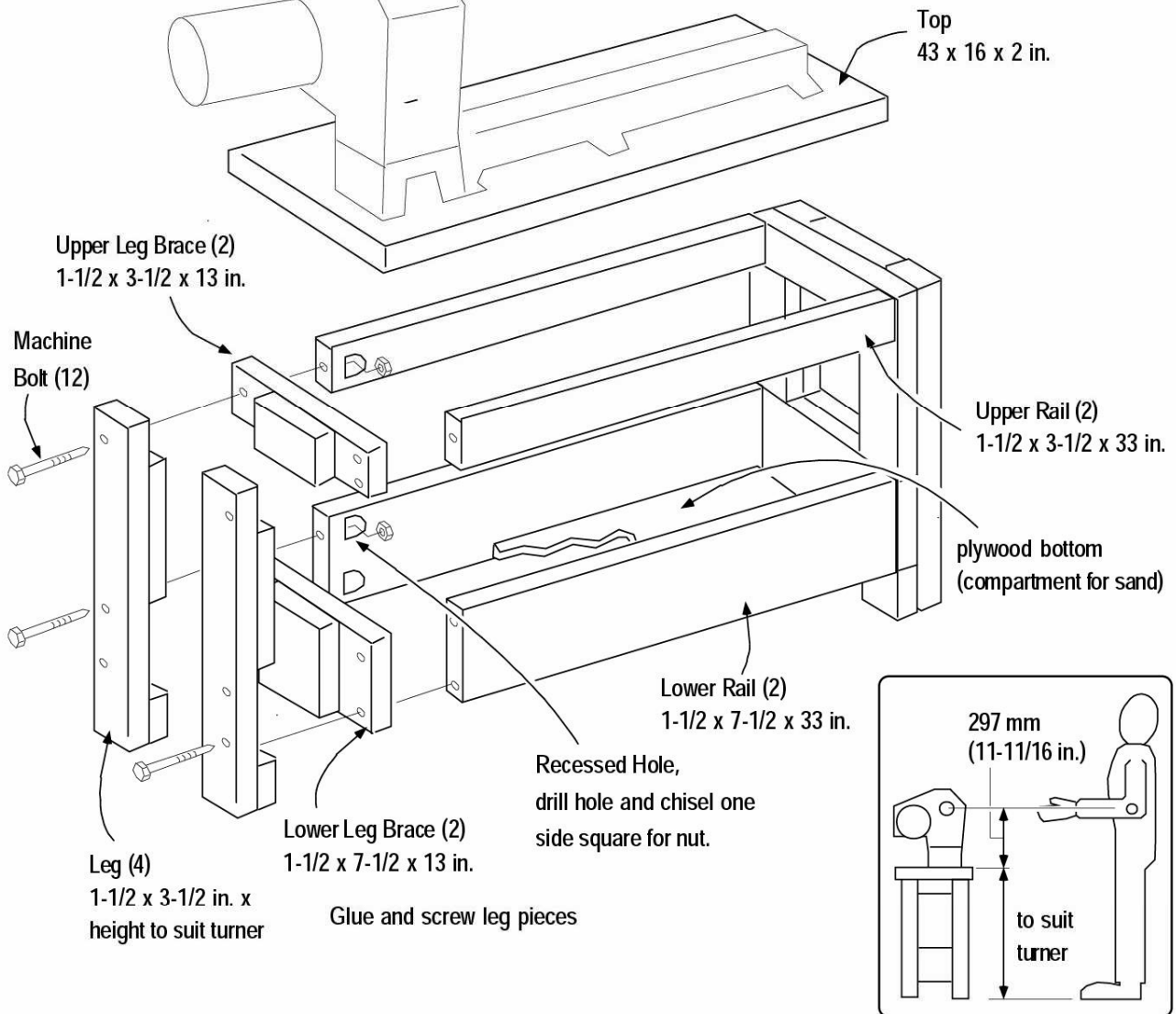
<i>Consideration</i>	<i>Recommendation</i>
Lathe Location	Locate the Nova 1624 II close to a power source in an area with good lighting. Leave clearance to all sides of the lathe; allow for motor clearance when the headstock is swiveled. Other machines in your shop should not interfere with the operation of the lathe.
Lighting	Your shop should have adequate lighting. The work area of the lathe should be well lit; there should not be shadows cast on your work. If possible, locate near a window. A movable spotlight may be helpful.
Electrical	The Nova 1624 II requires the appropriate outlet nearby to power the motor. Wiring and outlets should adhere to local electrical codes. If in doubt, seek advice from an electrician. Minimize use of extension cords.
Ventilation	Your shop should be adequately ventilated. The degree of ventilation will vary based on the size of the shop and the amount of work done. The use of dust collectors and filters will minimize risks to your health.

Lathe Stand Recommendations

A sturdy and rigid stand is required so that the Nova 1624 II Woodlathe can deliver optimum performance. A common flaw with many woodlathe installations is an inadequate stand for the lathe. The larger the size of your turnings, the greater the importance of the lathe stand design.

<i>Consideration</i>	<i>Recommendation</i>
Lathe Height from floor	The height of the stand should locate the centerline of the lathe spindle at the elbow height of the turner.
Stand Top	The stand top should be flat so the lathe does not twist when it is bolted down. Check for any gaps between lathe feet and stand top before bolting down. Shim and prepare stand as necessary.
Stand Weight	The stand should have enough weight and mass so it doesn't move when turning large work pieces, and so that the stand can absorb vibrations. A lathe stand's stability can be improved by weighing it down with sand bags on a lower shelf.
Stand Legs	The stand should sit level on the floor and not rock.

Example of Shop-made Lathe Stand



AC Motor Recommendations

<i>Country</i>	<i>Motor Recommendations</i>
United States, Canada	1 Hp or 1.5 Hp totally enclosed fan cooled (TEFC), continuous duty, 1725 rpm, single phase, 60 Hz, with a keyed shaft (we prefer to use 7/8 " shaft diameter), NEMA 56 frame C face flange mount.
New Zealand, Australia, UK, Europe, South Africa	1 Hp or 1.5 Hp, totally enclosed fan cooled (TEFC), continuous duty, 1425 rpm, single phase, 50 Hz, with a keyed 22 mm shaft, D80 Metric flange frame B14 face mount.

Assembling the Nova 1624 II

1. Unpack the lathe and components from the shipping container.

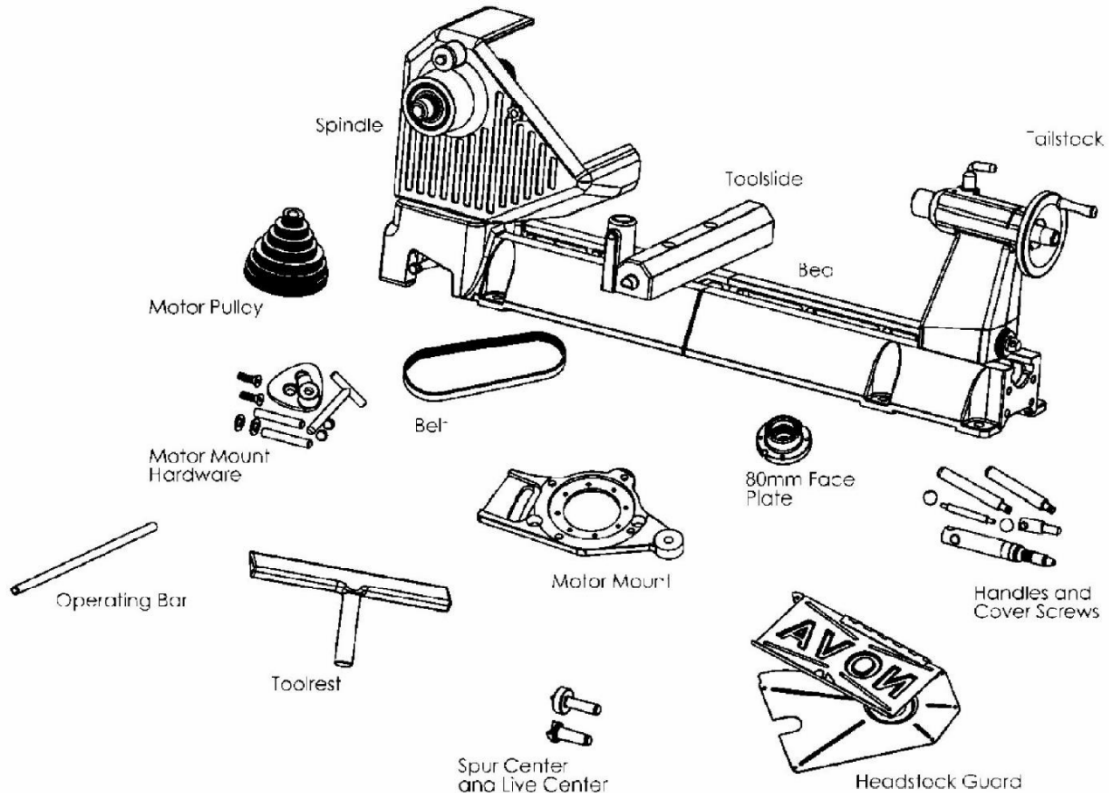


Warning!

Have other people help when moving or lifting the Nova 1624/44 Woodlathe; it weighs about 72 kg (158.7 lb) without a motor.

2. Clean any parts coated with rust preventative with a cloth moistened with a petroleum-based solvent or cleanser. Coat the lathe bed with paste wax.

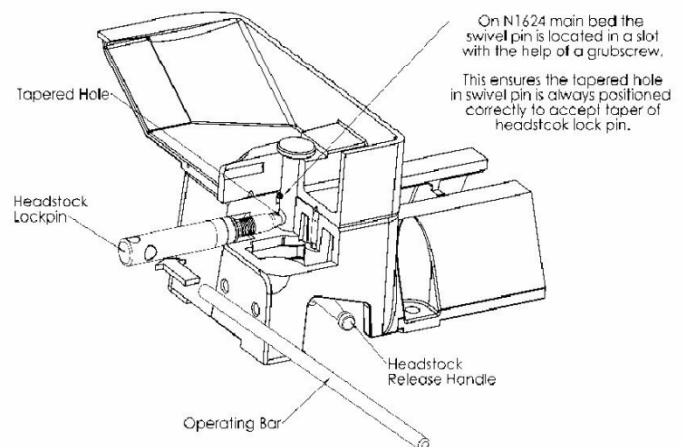
Nova 1624 II Components after Unpacking



3. Screw the Headstock Lockpin into the threaded hole at the bottom of the headstock. Insert the operating bar into the hole in the Lockpin and firmly tighten the Lockpin to lock the headstock in position; then remove the operating bar. NOTE: When the pin is fully engaged the groove machined into the pin furthest from the thread should line up with the edge of the hole in the casting. By doing this the pin will be engaged in the hole of the swivel pin.
4. Loosen the Lockpin 1 – 2 turns. Push the Headstock Release Handle down and rotate the Headstock so the spindle points to the tailstock and lines up parallel to the lathe bed. Tighten lock pin again.

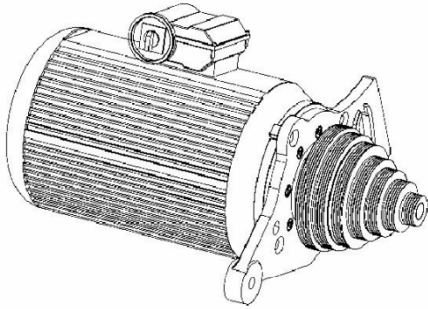
①Note: Do not use excessive force when tightening the Lockpin.

Installing the Headstock Lockpin

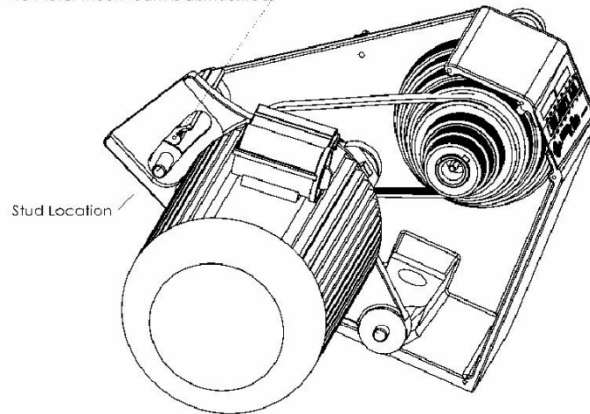


5. Remove the headstock guard from the lathe.

6. Place the motor mount plate with attached motor over both the Headstock studs

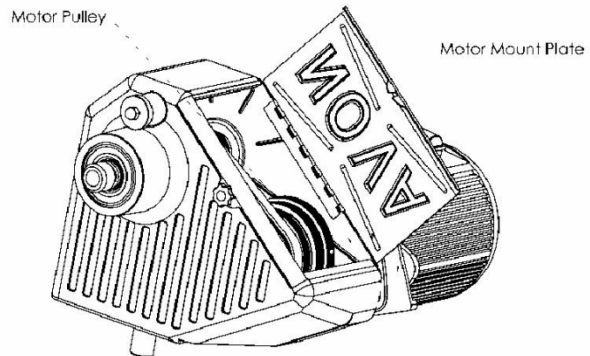


IMPORTANT!!!
This guard hole can only be fastened while the the motor mount cam is dismounted.



Tip: To ease holding the motor while fastening the guard hole (Motor cam end). You may engage the belt at 570 rpm. By engaging the belt at 570 rpm the weight of the motor is supported by the headstock pulley.

7. Place the headstock guard on the headstock; part of it slips between the motor mount plate and the motor pulley. Attach the guard to the headstock with six M4x10 screws. Tighten the screws after the guard has been correctly positioned.

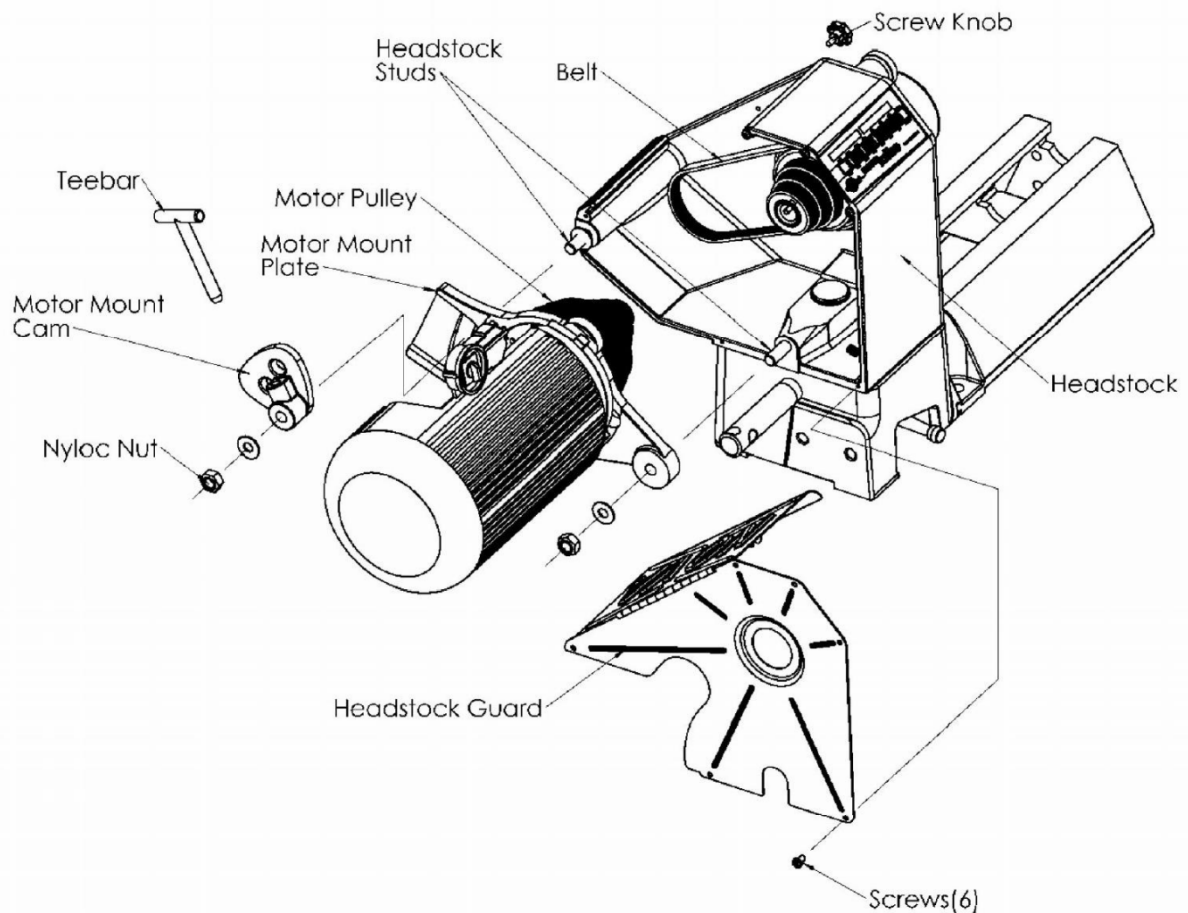


Headstock Guard slips between the motor mount plate and the motor pulley.

8. Install a M12 washer and M12 Nyloc nut on the lower (pivoting) headstock stud. Tighten the nut until the motor mount plate is secure, but movable.

9. Place the motor mount cam over the upper (cam) headstock stud. Install a M12 washer and M12 Nyloc nut. Tighten the nut until smooth sliding action is achieved. Screw the Teebar into the cam.

Installing the Motor and Guard



10. Fit the belt over both pulleys. Adjust the position of the motor pulley on the motor shaft so the belt is aligned square between the pulleys. Tighten the M8 set screw on the motor pulley.

① *Note: The drive belts correct positioning is with the belt overhanging the outside of the pulley by one rib. It is only on the bottom (smallest step) that all six ribs are used.*

11. Push the Teebar away from the lathe to increase the belt tension. Tighten the Teebar to lock the motor in place. Close the guard lid and secure the lid with the screw knob.

12. Assemble the handles:

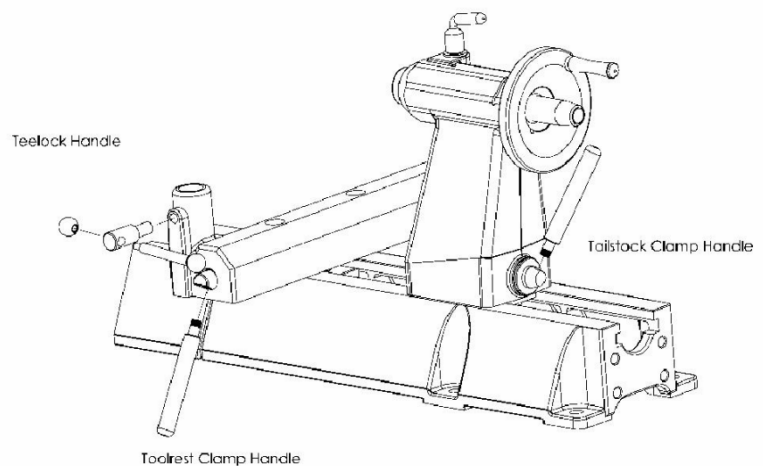
① *Note: Some handles may come pre-assembled.*

Toolrest Clamp Handle - insert the rod through the handle and screw the ball knobs onto each end of the rod.

Toolslide Clamp Handle - screw the rod into the toolslide.

Tailstock Clamp Handle - screw the rod into the tailstock.

Installing Handles



Thank you for purchasing the Add on Trapezoidal Bed Extension, this unit will greatly allow you to increase your turning capacity.

For safety reasons, please carefully read and understand these instructions. The Nova 1624 Add on Trapezoidal Bed Extension is designed to fit and be used only with the Nova 1624 Woodlathes. The use of this bed extension with other lathes could cause a malfunction and risk of serious injury. If you are unsure of the use or the application of this accessory, contact the technical support department of Teknatool International or your reseller. Further information can also be found in your lathe manual.

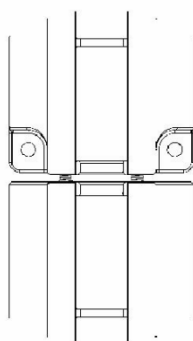
PARTS LIST:

PARTS LIST			
CODE	COMPONENT DESCRIPTION		QUANTITY
55195	Machined Trapezoidal Cast Iron Bed Segment		1
FKUBU300	Fastening Kit <i>(Parts are listed below)</i>		1
	Code	Description	Quantity
	55201	M12 x 35 Cap Screws	4
	55202	M12 Spring Washers	4
	AK10	Allen Key 10mm	1

FITTING PROCEDURES:

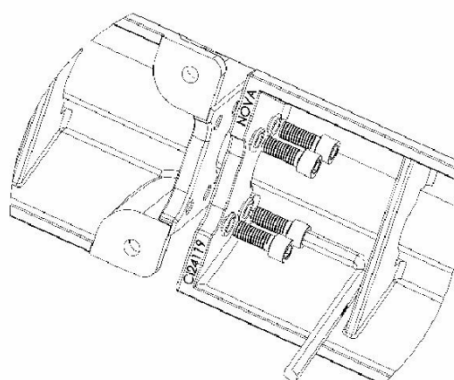
1. Ensure that the bed pieces are flat and the two faces of the bed (which are to be mated) are clean, free of any burrs and dents.
Note: >>> The end of the extension bed with no feet should be mated to the lathes end face.
 >>> Also, wipe off any yellow rust protective, dirt etc (if applicable).

2. Place the add on bed extension close to the lathes face, align the holes and screw on the four M12 screws (with one spring washer each)

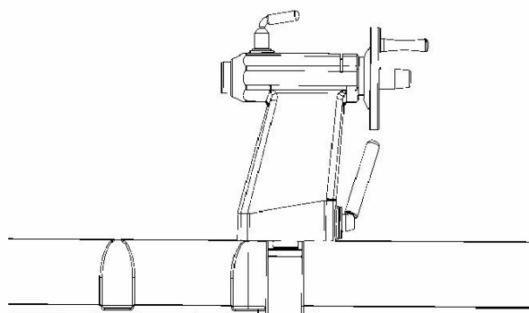


into the four tapped holes with the help of the 10mm Allen key provided.

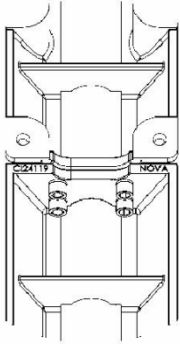
Do NOT fully tighten the cap screws at this stage, but tighten enough so that the add on bed extension is secured to the end of the lathe.



end
cap



3. Move the tailstock over the two joining extension beds (tailstock approximately covering equal length on either extension). Lock the tailstock firmly over the joining faces.
4. Now, use the 10mm Allen key to fully tighten all four cap screws. The torque required is approximately 30 N-m (22 lb-ft).
5. Check that the tailstock runs smoothly over the mating joint, and also over the full length of the extension. Although all components manufactured by Teknatool International are made to closest possible tolerances, it is possible for a difference of approximately 0.1mm to put the bed 'out of true'. The tailstock can bind in any given area in two possible ways:



A) Jamming between slides (inside the wall of the bed)

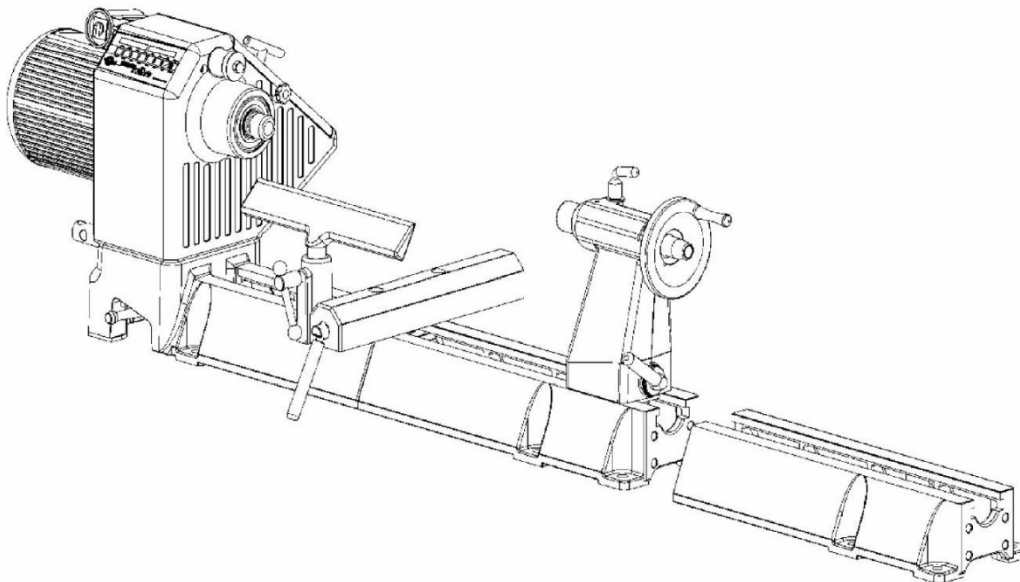
Using a smooth flat file, run over the area a few times until the tailstock frees itself. To maintain central running of the tailstock, both sides must be filed evenly.

B) The Tailstock clips or appears to jump over the join

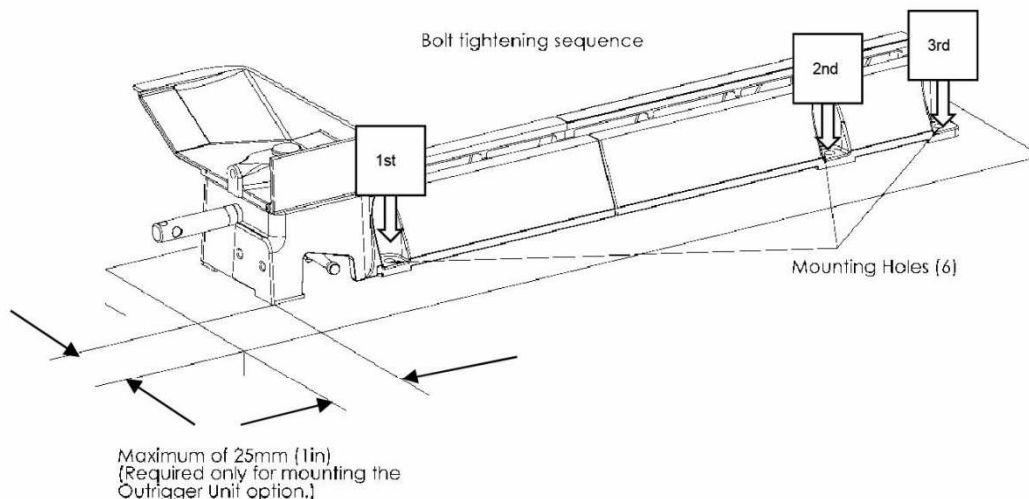
The machined flat surfaces may not be quite flush. Use a flat file and run over the join until the 'railroad clacking' sound disappears.

❶ Some Notes on the Bench Top:

Make sure that the bench top where you place your lathe to bolt down is flat, and is not warped or buckled. The bed bolt points need to have flush contact with the bench.



Mounting the Lathe to a Support Surface



⚠ The lathe *must* be fastened to a support surface, such as a lathe stand or bench.

1. Place the lathe on the stand top. Locate the front and left corner of the lathe approximately 25 mm (1 in.) from the corner edge of the stand top. This provides a comfortable reach when turning and allows the optional outrigger unit to be easily installed.
2. If necessary, mark the six hole locations on the top and drill M12 (1/2-inch) holes.
3. Place a spirit level along the top of the lathe bed. Any movement of the bubble as the lathe is secured, indicates a twist on the bed. For the lathe to operate correctly the bed must not twist; if necessary, use shims between the bed and stand top.
4. Use bolts of suitable length (not included) to secure the lathe. Tighten the two headstock bolts first, then the two tailstock bolts, and finally tighten the two middle bolts.
5. The two 12mm threaded holes underneath the outrigger end of headstock can be optionally used (making a total of 8 bolt positions) ensure that the bolt is a metric M12 x 1.75 mm pitch and that the length is correct to ensure that the bolt doesn't bottom in the threaded hole and potentially damage casting.

Connecting to Power

Follow any instructions that came with the electric motor and switch. The motor should be wired so it rotates in a counter-clockwise direction (when facing the output shaft of the motor). A properly rated on/off switch should be used. DC motor electronic controls may require adjustment for correct operation.

The power cord should be 3-wire, having a grounding conductor and a grounding plug. The plug must be plugged into a matching outlet that is properly installed and grounded in accordance with local electrical codes.



Warning!

Improper connection of the motor can result in a risk of electrical shock.

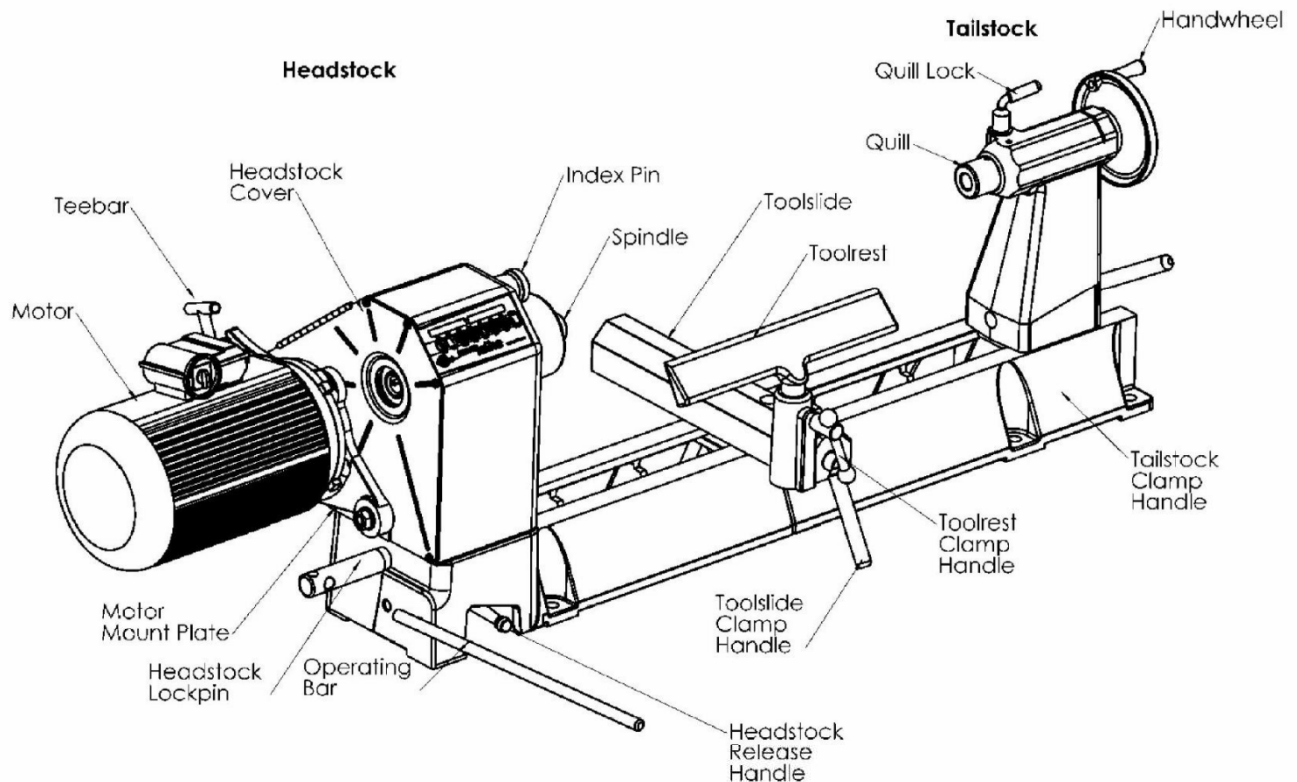
If it is necessary to use an extension cord, the cord should be grounded. Use the proper wire size for the extension cord, for a given cord length, to avoid power loss and over-heating.

Recommended Extension Cord Size for 1 HP and 1.5 HP Motors

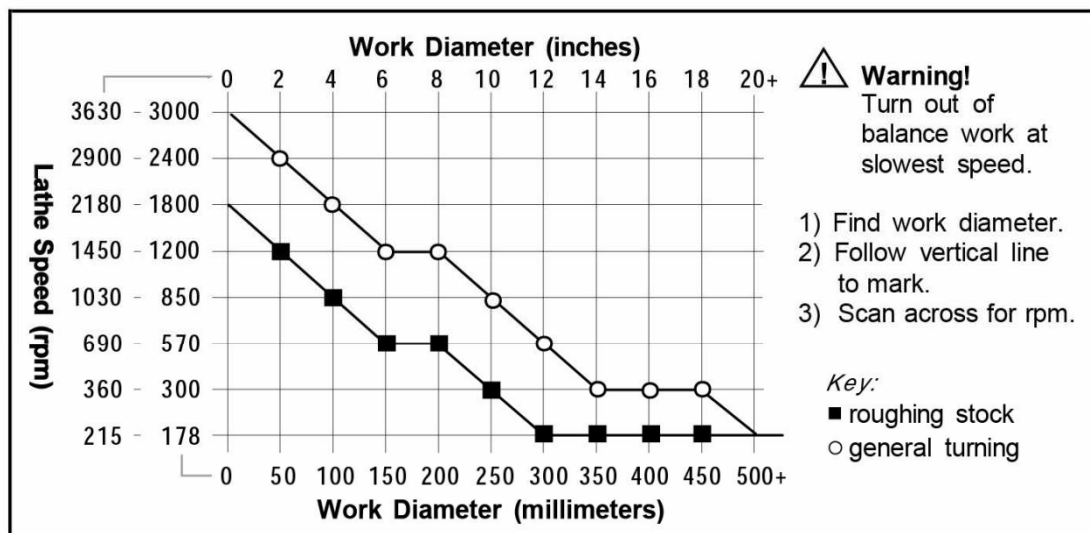
<i>Cord Length</i>	<i>Wire Size (American Wire Gauge)</i>
0-25 ft (0-7.5 m)	16 AWG
26-50 ft (8-15 m)	14 AWG (<i>preferred</i>)
51-100 ft (16-30 m)	12 AWG

Using the Nova 1624 II

Parts of the Nova 1624/44 Woodlathe



Recommended Turning Speeds



① Note: Turning Speeds and DC Motors

Use the electronic variable speed control in combination with the step pulley. Variable speed DC motors may have poor torque (power) at low speeds. Use the lower speed pulley steps for better torque. The available speeds will be from zero up to the maximum speed of the pulley step.

In general, select a belt setting in the lower 4 steps to provide good torque when turning. Use the upper steps only when higher speed spindle turning is required.

Changing Speeds

Change speeds by moving the belt position on the two 8-step pulleys. The speeds vary due to the rpm's of the motor. Speed position can be checked by viewing the belt through the window at the front of the headstock.

Lathe Speed Selection

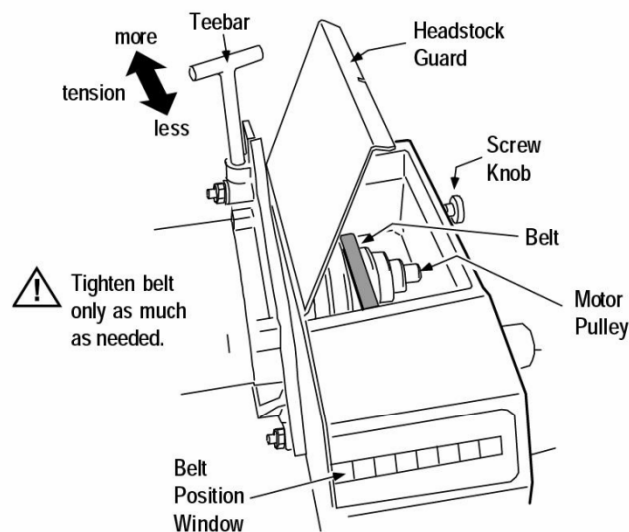
<i>Country</i>	<i>Motor rpm</i>	<i>Lathe Speeds (rpm)</i>
United States, Canada	1725	215, 360, 690, 1030, 1450, 2180, 2900, 3630
Australia, New Zealand, UK, Europe, South Africa	1425	178, 300, 570, 850, 1200, 1800, 2400, 3000



Warning!

Don't apply excess tension to the belt. You should be able to push the belt down at the center point between the pulleys from 8-12 mm (5/16 – 1/2 inch) with your thumb. Excess belt tension can cause increased vibration, bearing wear, belt wear, and damage to the motor shaft.

1. Stop the lathe.
2. Loosen the screw knob and open the headstock guard.
3. Loosen the Teebar and pull the lever toward the front of the lathe to loosen the belt. Tighten the teebar to hold the motor while the belt position is changed.
4. Position the belt on the selected set of pulleys.
5. Push the Teebar away from the lathe to tension the belt and tighten the teebar.
6. Close the headstock guard and tighten the screw knob.



IMPORTANT PLEASE NOTE:

Your new NOVA 1624 Woodlathe now comes with additional safety feature, and is fitted with an emergency stop button on the motor.

This button is for "Emergencies" only. The machine will coast to a stop if this button is pushed in. Important: Once this Emergency stop button is pushed, you must release into the "OUT" position before you can use the lathe again. You must twist to release it into the OUT position before you can turn on the lathe.

- Use the regular STOP button if you want the lathe to come to a stop.
- To turn the machine on and off, use the on/off switch on the motor.

Swiveling the Headstock

1. Stop the lathe. Insert the operating bar into a hole in the Headstock Lockpin. Loosen the Lockpin half a turn.

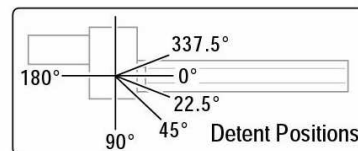
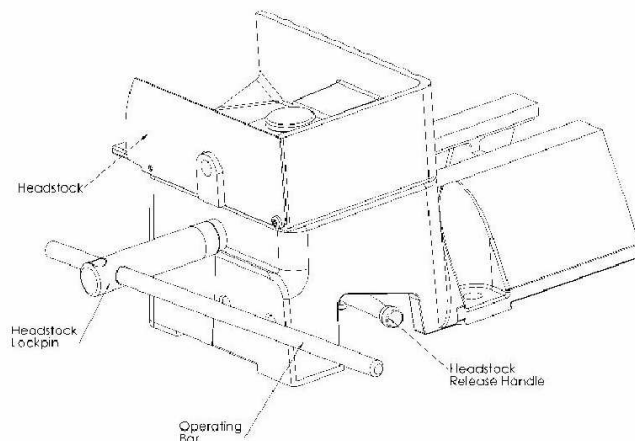
1. Slide the Headstock Release Handle towards Inboard end of lathe, and rotate the headstock to a detent position. Do not push down on the handle.



Warning!

Use the detent latch positions to prevent headstock movement during turning.

4. Firmly tighten the Headstock Lockpin with the operating bar; but do not use excessive force. Remove the operating bar.



	Right-Hand Turners	Left-Hand Turners
Detent Positions	0, 22.5, 45, 90 degrees	180, 337.5 degrees

Spindle Index

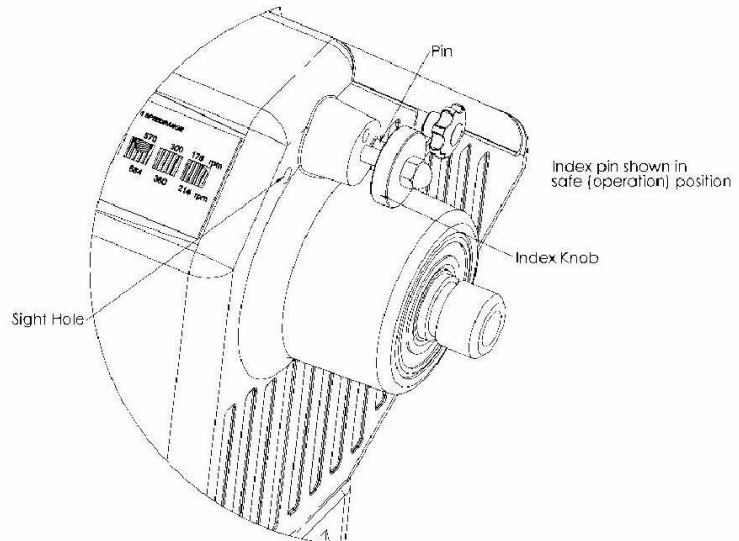
The spindle index pin locks the headstock spindle. It is selectable in 15 degree increments (24 divisions). There is sight hole to read index numbers (0 through 23).

1. Stop the lathe.
2. Pull the index knob and turn it left until the pin drops into the hole. To lock the spindle it must engage into a hole in the headstock pulley.



Warning!

Make sure the index pin is out before operating the lathe. The pin should drop into the indentation in the headstock to prevent it from engaging while the spindle is turning.



<i>Divisions</i>	<i>Index Number</i>	<i>Degrees</i>
2	0,12	180
3	0,8,16 (every 8th)	120
4	0,6,12,18 (every 6th)	90
6	0,4,8,12,16,20 (every 4th)	60
8	0,3,6,9,12,15,18,21 (every 3rd)	45
12	0,2,4,6,8...22 (every 2nd)	30
24	every hole	15

Headstock

The headstock houses the motor pulley, headstock pulley, bearings, and the spindle. The headstock spindle accepts centers and accessories with no. 2 Morse taper (#2 MT), plus threaded faceplates and chucks.

Spindle Thread Size

<i>Country</i>	<i>Threads</i>
United States, Canada, UK	1-1/4 x 8 TPI RH
Europe	M33 x 3.5 RH

Mounting a faceplate or chuck

1. Use the spindle Index Pin to lock the headstock spindle.
2. Screw the faceplate or chuck onto the spindle threads. A spindle washer in-between may be used to make removal easier.

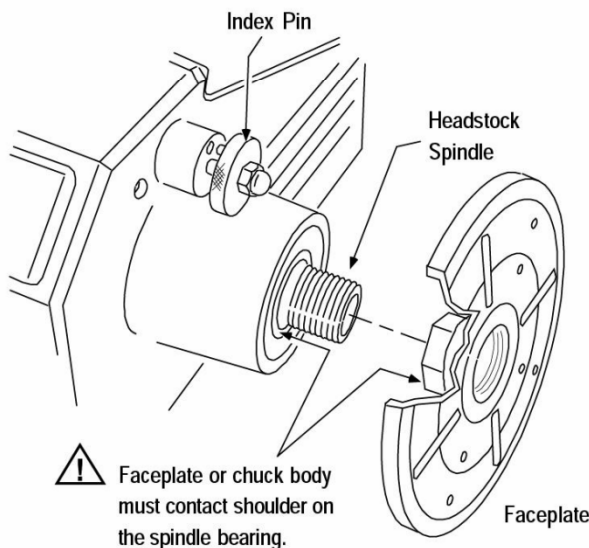


Warning!

The faceplate or chuck body must contact the shoulder on the spindle bearing.

When installing or removing the faceplate or Chuck from the spindle, the side-locking grub screw **MUST** be completely removed.

This avoids any potential damage to the spindle that the grub screw may cause if it were not completely removed, when winding the Faceplate or Chuck on or off the spindle.



3. Pull and turn the Index Pin and place it in the "safe" indentation in the headstock.

Using a spur center

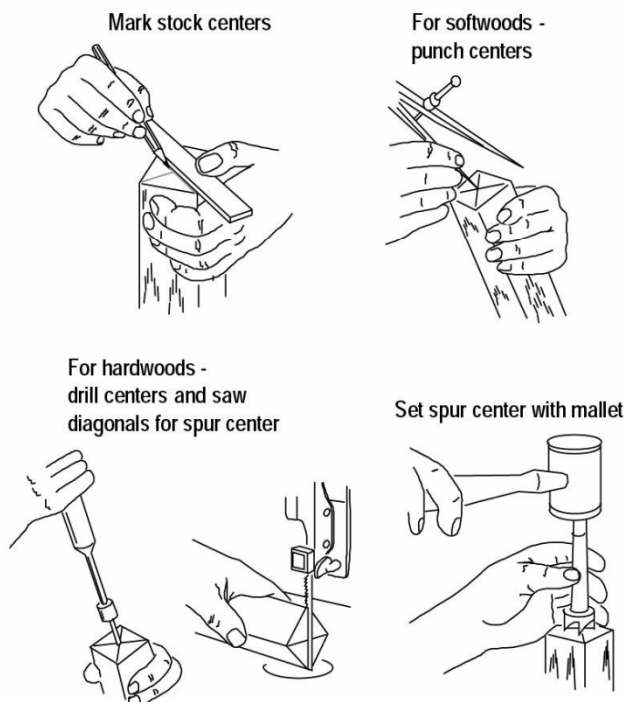
Mount the spur center to the work piece as shown and then insert the spur center and work piece into the headstock spindle.



Warning!

Do not pound work piece into headstock drive center when turning between centers or you may damage the headstock.

To remove the center, insert a 10 mm (3/8-inch) diameter wooden dowel or steel rod through the headstock spindle hole. While holding the center so it doesn't fall, tap it out.



Toolrest

To move the toolslide along the bed, loosen the Toolslide Clamp Handle, move the slide to the desired position, and tighten the clamp handle.

To adjust the toolrest, loosen the Toolrest Clamp Handle, position the toolrest, and tighten the clamp handle.

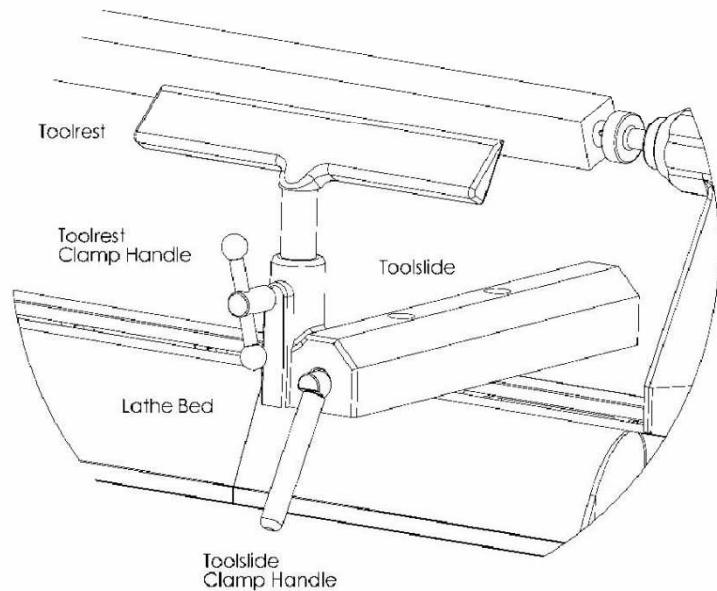
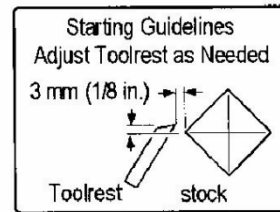
Adjust the toolrest close to the work piece. Exact positioning may be varied to suit the turner. Before turning, revolve the stock by hand to make sure it clears the rest. At intervals, stop the lathe and readjust the toolrest.



Warning!

Lathe tools and chisels should remain on the toolrest whenever the tool is in contact with the work piece.

Remove the toolrest when sanding or polishing so fingers do not get pinched.



Tailstock



Warning!

Never loosen the tailstock quill or tailstock while the work piece is turning.

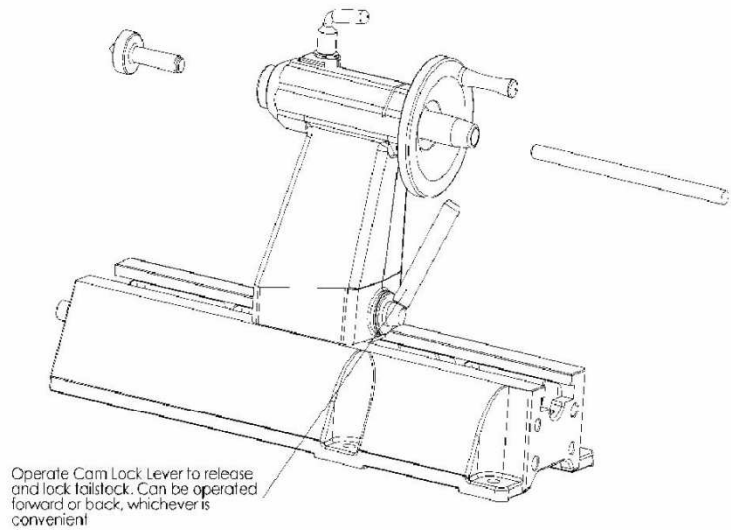
To move the tailstock along the bed, loosen the Tailstock Clamp Handle, slide the tailstock to the desired position, and tighten the clamp handle.

To move the tailstock quill in or out, loosen the Quill Lock and turn the Handwheel. Lock the quill in place with the Quill Lock.

The tailstock quill accepts centers and accessories with no. 2 Morse taper (#2 MT). To install a taper use a quick, firm action by hand. Do not pound the taper in.

To remove a taper, insert the operating bar through the tailstock quill hole. While holding the taper so it doesn't fall, tap it out.

The tailstock quill is hollow, allowing you to bore holes through turnings if a hollow center is used.



Adjusting the Tailstock for Turning Between Centers

1. Mount the spur center to the work piece and insert the spur center into the headstock spindle, as previously described under "Using a Spur Center".



Warning!

Do not use the tailstock quill action to drive the work piece into the spur center. This can create an unsafe and loose work piece.

2. Mount the live center into the tailstock quill using a quick, firm action by hand.
3. While holding the work piece, slide the tailstock to meet it and lock the tailstock in place. Turn the Handwheel to apply light holding pressure to the work piece; it should turn easily by hand, yet not be loose. Tighten the Quill Lock.

Learning Turning

The art and technique of turning is a subject beyond the scope of this instruction manual. It is recommended that you receive hands-on instruction on lathe turning and/or refer to books and videos on the subject. For reference, some woodturning books are:

Woodturning A Foundation Course
by Keith Rowley

Creative Woodturning
by Dale Nish

Turning Wood With Richard Raffan
by Richard Raffan

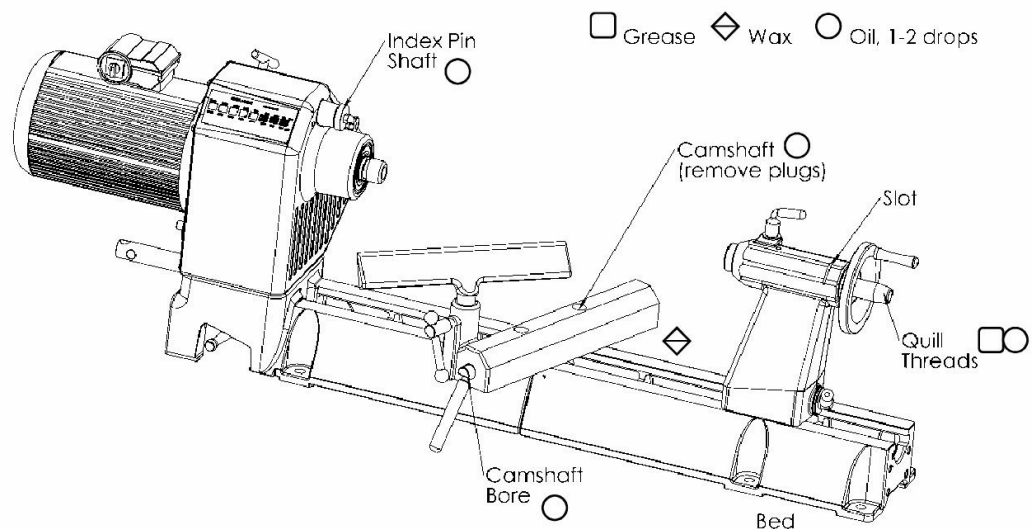
The Fundamentals of Woodturning
by Mike Darlow

Maintaining the Nova 1624 II

General Maintenance

<i>Interval</i>	<i>Maintenance</i>
After each use	Clean the work area and lathe. Vacuum scraps and dust from the inside the headstock, between the lathe bed rails, and under the toolslide and tailstock.
Monthly	Wax exposed cast iron parts with a good quality paste wax, especially the bed rails. Buff out the wax thoroughly. Check tightness of nuts and bolts; especially the set screws on the motor pulley and headstock pulley, and the lathe mounting bolts. Lubricate, with one or two drops of light-weight oil, the tailstock quill threads, index pin shaft, and the toolslide camshaft (remove plastic plugs) and toolslide front camshaft bore.
6 Months	Grease tailstock quill threads. Turn the handwheel so the quill threads are exposed, apply grease to the threads, crank the handwheel back and forth to work in the grease, wipe off any excess. Lubricate the tailstock slot with one or two drops of light-weight oil.

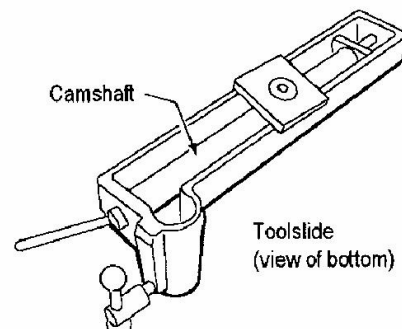
Lubrication Locations



Cleaning the Toolslide

If the toolslide becomes hard to move and adjust, cleaning and lubricating are required.

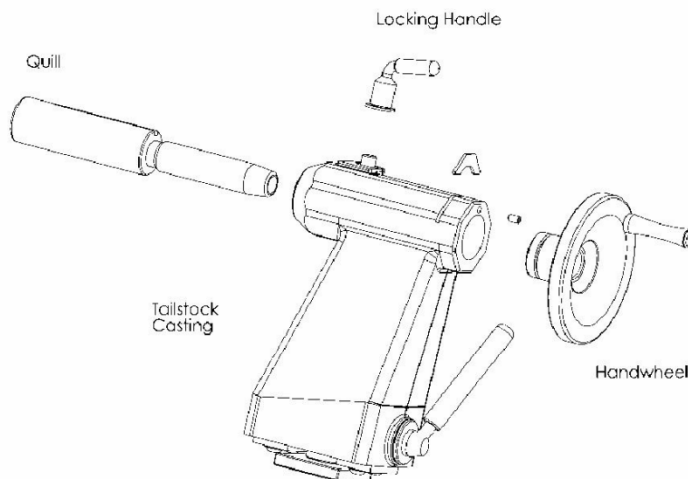
1. To make the toolslide slide more freely along the bed, make sure the bed rails are clean. Apply some paste wax to the rails.
2. If the toolslide is hard to move towards or away from you, remove the toolslide from the lathe bed. Clean the toolslide camshaft (round eccentric rod) with a petroleum-based solvent. Lubricate the rod with light-weight oil or a silicone spray.
3. Slide the base back onto the lathe bed.



Cleaning the Tailstock

If the tailstock quill becomes hard to use or the Handwheel is hard to turn, cleaning and lubricating are required.

1. Remove the 6 mm set screw from the tailstock. If necessary, turn the Handwheel to expose the set screw.
2. Using a screwdriver, remove the keeper plate from the tailstock body.
3. Remove the quill and Handwheel from the tailstock body.
4. Wipe clean all parts including the inside of the tailstock.
5. Lubricate the quill and tailstock slot with light-weight oil and apply a small amount of grease to the quill threads.
6. Reassemble.



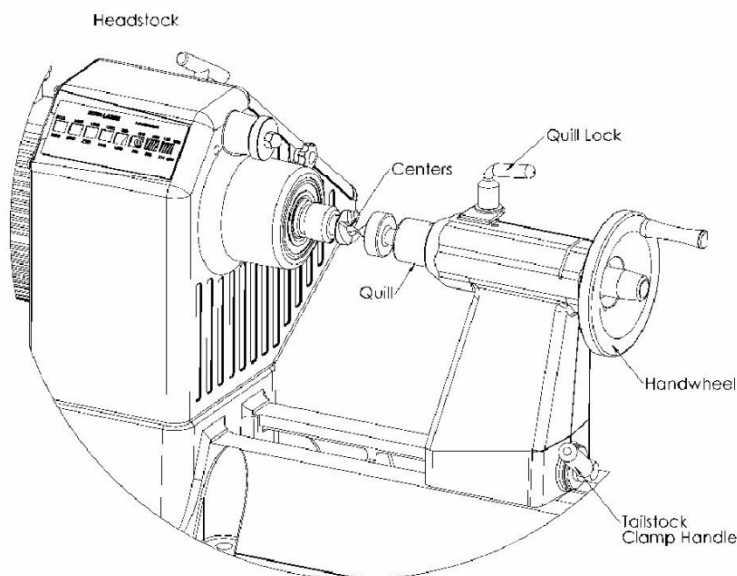
Aligning the Tailstock

1. Crank the Handwheel back so the quill is all the way in.
2. Place any #2 MT accessory you have that has a sharp point like a spur center, or live center in the tailstock quill and another center in the headstock spindle.

① Note: Tailstock alignment can be made easier by using the Teknatool Acruline Accessory Center in place of the centers.

3. Move the tailstock close to the headstock so the two centers nearly touch; check the alignment of the center points. Move the tailstock away from the headstock and extend and lock the quill. The points of the centers should align when the quill is halfway extended, fully extended, and fully retracted.

If the centers are aligned at all three locations no adjustment is necessary.



4. The tailstock does not meet the conditions in step 3, follow the steps below. This indicates that the tailstock is not parallel to the lathe bed and you will need to realign the tailstock.
5. First make sure the tailstock alignment plates are not binding inside the bed. If the tailstock doesn't move freely then remove the tailstock and look for burrs or high spots on the bed rails or the alignment plate. Using a smooth file remove any burrs or high spots. When done replace the tailstock on the bed.
6. Slightly loosen the four tailstock cap screws with a 5mm Allen wrench. Tap the tailstock with a wooden mallet in the appropriate direction to align the centers. Check and adjust the positioning of the tailstock. The centers should align when the quill is halfway extended, fully extended, and fully retracted, as previously described in step 3.
7. Lock the tailstock in place with the Tailstock Clamp Handle and fully tighten the four cap screws. The cap screws must be fully tightened in order to avoid slippage during work.
8. Check the alignment of the Tailstock by bringing it together with the Headstock with the Live center and Spur center in each spindle. The Points on the centers should be within 0.50mm (0.020") height and width of each other

Troubleshooting Guide

<i>Problem</i>	<i>Possible Cause and Solution</i>
<i>Excessive vibration.</i>	<p>Out of balance, or large work piece. Reduce lathe speed to the lowest speed possible and turn the work piece to a true circle.</p> <p>Work piece is not held in the center. Check work piece mounting and correct.</p> <p>Work piece is not secure or held tight enough. Check work piece mounting and correct.</p> <p>Lathe incorrectly bolted to stand or bench. Refer to this manual for lathe stand recommendations.</p> <p>Stand or bench not well constructed, too light, or standing incorrectly on the floor. Make sure the stand is solidly constructed. Use sand bags to weigh down the stand.</p> <p>Over tensioning of belt is a primary cause of vibration. The drive belt is running badly, over tensioned, or damaged. Apply a spray-on belt dressing on the belt grooves, readjust belt tension, or replace the belt.</p> <p>Motor pulley is not in correct alignment with the headstock pulley. Loosen the motor pulley set screw and align the pulleys.</p> <p>Headstock is loose. Tighten the Headstock Lock pin.</p> <p>Headstock pulley or motor pulley is loose. Check that the pulley set screws are tight.</p> <p>The headstock guard is loose or rattling. Check that the guard screws are tight.</p> <p>Movement in motor mount plate. Check that the nyloc nuts on the headstock studs are tight, and that the Teebar is tight.</p> <p>Motor vibrates. Many single phase motors due to their design produce minor noise or vibrations; these usually cannot be altered.</p>
<i>Faceplate or chuck running out of true.</i>	<p>Dirt build up on the rear of the faceplates or chuck. Clean off all build up and dirt. Faceplates and chucks must mount securely against the inner bearing ring surface of the spindle.</p>
<i>Turning tools not sliding smoothly across Toolrest.</i>	<p>Damaged surface on toolrest face caused by sharp edged tools. File the toolrest using a fine smooth file and polish with extra fine sandpaper. Also remove the sharp edges from the corners of turning tools.</p>
<i>Spur drive center or live center not holding into the spindle taper or quill taper when turning.</i>	<p>Small end of Morse taper is damaged due to dropping or hitting. File or polish away any damage. Check that inside of tapers have not been scored.</p> <p>Grease or oil inside of Morse tapers. Wipe clean the inside of the tapers.</p> <p>Insufficient pressure when installing the center. Use a quick, firm action by hand to install a taper. Do not knock in using any solid object.</p>

❗ *Note: Can't find the answer in this Troubleshooting guide?*

Visit the Lathe Support Section on our website - this is packed with Frequently Asked Questions.

Or

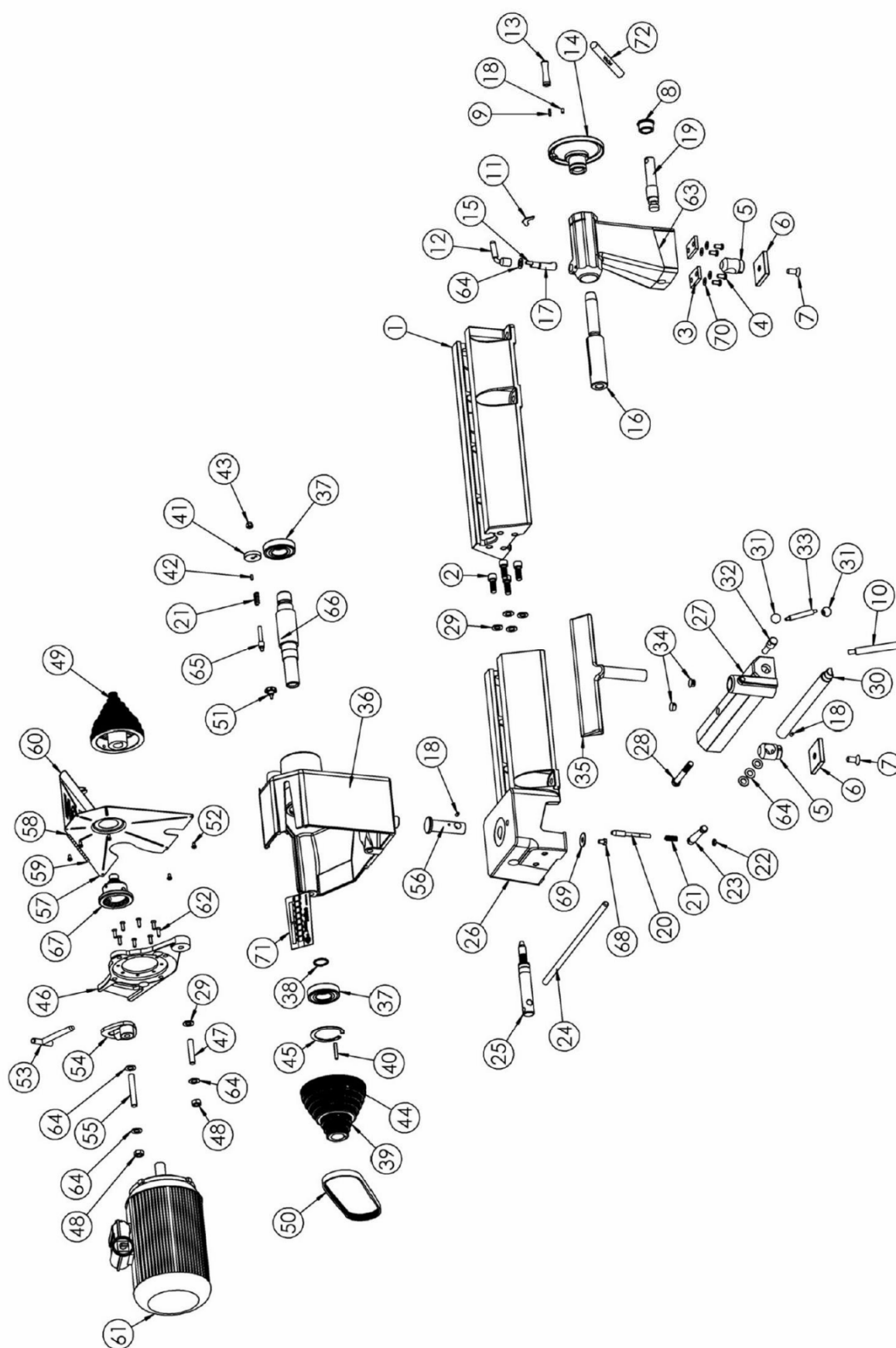
Contact us (details are at the front of this manual)

Troubleshooting Guide

<i>Problem</i>	<i>Possible Cause and Solution</i>
<i>Tailstock and headstock center not lining up correctly.</i>	<p>Tailstock not aligned to headstock; adjust as described under "Aligning the Tailstock".</p> <p>Bed incorrectly bolted to stand causing twist. Ensure stand and lathe are correctly installed.</p> <p>Headstock not returned to detent position after it has been rotated. Ensure that the headstock is locked into a detent position.</p> <p>Headstock Lockpin not fully seated. Twist the headstock back and forth to make sure it is properly seated and then tighten the Lockpin.</p> <p>Dirt or wood dust accumulated in the headstock swivel pin hole. Remove the Headstock Lockpin and clean out hole.</p>
<i>Clicking noise in headstock when lathe is operating.</i>	<p>Headstock pulley or motor pulley loose. Securely tighten the pulley set screws.</p>
<i>Tailstock handwheel hard to turn or will not turn.</i>	<p>Quill lock is locked; unlock the quill lock. If necessary, lightly tap a block of wood against the handwheel handle; tap the handle in a clockwise direction as viewed from the tailstock end.</p> <p>Build up of dust and wood resin on the quill or inside of the handwheel thread. Remove, clean, and lubricate the quill and tailstock as described under "Cleaning the Tailstock".</p> <p>The quill has been extended too far and is locked against the handwheel. Push the quill back into the tailstock when turning the handwheel.</p>
<i>Tailstock quill hard to move.</i>	<p>Quill lock is locked; unlock the quill lock.</p> <p>The quill is damaged; turn the handle to expose the quill and check for marks along the quill, especially on the edges of the slotted keyway. Remove the high spots with a smooth file and test the quill travel. Replace the quill if necessary.</p>
<i>Tailstock not locking correctly onto bed, or tailstock not sliding smoothly on bed ways.</i>	<p>Tailstock adjustment plate not adjusted correctly; adjust as described under "Aligning the Tailstock".</p> <p>Dirty bed ways and underside of tailstock body. Clean bed ways and underside of tailstock body with a petroleum-based solvent.</p>
<i>Tailstock binds.</i>	<p>The inside of the bed has a high spot. File the area with a smooth flat file until the tailstock moves freely.</p> <p>The tailstock adjustment plate has a rough spot or a burr. Remove the tailstock and file the plate with a smooth flat file.</p>
<i>Tailstock jumps where bed sections join.</i>	<p>The machined flat surfaces are not flush. File the area with a smooth flat file until the tailstock moves freely.</p>

Nova 1624 II Woodlathe Parts List

See the parts list on page 26.



Nova 1624 II Woodlathe Parts List

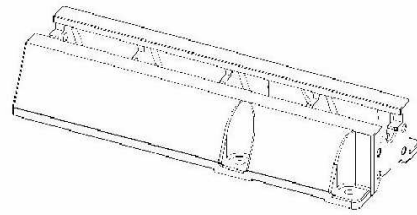
Most items are applicable to all countries; items listed with a "4 "are applicable to Europe.

<i>Item</i>	<i>Qty</i>	<i>Part No.</i>	<i>Description</i>	<i>Item</i>	<i>Qty</i>	<i>Part No.</i>	<i>Description</i>
1	1	24119	Bed Extension - Machined	38 (4)	1	EC30	Circlip External 30mm
2	4	24011	Capscrew M12 x 30	39	1	24025	Pulley Headstock
3	2	25029	Plate Alignment	40	1	24109	Key 6mm Square M5x40 Long
4	4	BHC0816	Capscrew Button Head M8X16	41	1	24062	Knob Spindle Index
5	2	24048	Cam Nut Toolslide	42	1	TPI31658	Pin Tension 3/16X5/8
6	2	27006	Lockplate Tailstock and Toolslide	43	1	DNNO8	M8 Brass Dome Nut
7	2	K1225	Screw C/Sunk M12X25 A/H Socket	44	3	G0810	Grubscrew M8X10 Cup Point
8	1	55027	Sleeve Camshaft Tailstock DVR	45	1	EC72	Circlip External 72mm
9	1	TP131658	Bissel / Tension Pin 3/16 in. x 5/8	46	1	24122	Flange, Motor Mount combined Metric & NEMA
10	1	55153	Lock Arms	47	1	24050	Stud M12 x 60 Motor Mount
11	1	24040	Keeper Plate - Hardened Steel	48	2	NN12	Nut Hex Nyloc M12 ZP
12	1	55029	Lever (Bent) Locking Quill	49	1	24130	Pulley Motor
13	1	24065	Handle Handwheel	50	1	584J6	Belt Poly Vee
14	1	24043	Handwheel, Tailstock	51	1	24055	M5 x 10 Knob (guard cover)
15	1	55037	Pin Dowell 6X16	52	6	MP05010	Screw Pan Head Pozi M5 x 10 ZP
16	1	55028	Quill Tailstock	53	1	24049	Tee- Bar Motor Mount
17	1	55026	Shaft Lock Quil	54	1	24046	Cam Motor
18	3	G0610	Grubscrew M6X10 Cup Point	55	1	24051	Stud M12 x 75 Motor Mount
19	1	55025	Camshaft Tailstock DVR	56	2	24127	Swivel Pin
20	1	24023	Detent Pin D12	57	1	24128A	Sheetmetal Main Cover
21	2	24060	Compression Spring	58	1	24128B	Sheetmetal Hinge Pin
22	1	NHZ8	NUT HEX M8 ZP	59	2	24128C	Sheetmetal Guard Hinge
23	1	55176	Handle Detent Pin	60	1	24128D	Sheetmetal Lid
24	1	55081	Operating Bar 1/2 400mm Long	61	1	24134 24135	Motor 115V Motor 230V
25	1	55048	Pin Lock	62	8	CM5010193	Screw C/SUNK M6X20, 10.5 Head Dia, Brand
26	1	24118	Main Bed	63	1	55017	Tailstock
27	1	24009	Toolslide	64	7	FW10	Washer Flat Fender M10X32X1.6 ZP
28	1	BNMZ12090	M12 x 90 Eng Bolt	65	1	24129	Spindle Index Knob
29	5	FW12	Flat Washer ZP	66	1	24126	Spindle Headstock 1624 Y 1 1/4X8 TP
30	1	24020	Camshaft Toolslide	(4)	1	24137	Spindle Headstock 1624 4 M33X3.5RH
31	2	865913	Ball Knob 3/4 in. DIA with M6 thread	67	1	LHB	Handwheel
32	1	24026	Teelock Body	68	1	SZ0812	Screw Set M8X12 ZP
33	1	25001	TeeLock Arm M10 DIA x 85 with M6 threads	69	1	FFW08	Washer Fender M8 ZP
34	2	HP-16	Plug Hole	70	4	FW8	Washer Flat M8 x 16ZP
35	1	24120	Toolrest	71	1	24131	Label Speed Indicator
36	1	24125	Headstock				
37	2	6207LLB	6207-RSI Bearing				

Accessories

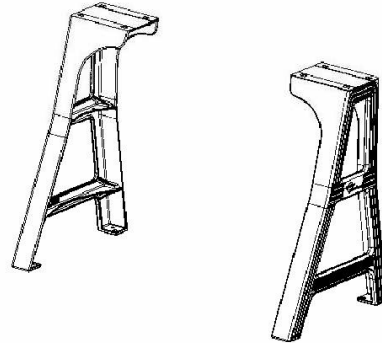
Add On Bed Extension

Extend the bed of your Nova 1624 II Woodlathe for greater capacity for turning between centers. Each bed unit adds 516 mm (20.3 in.)



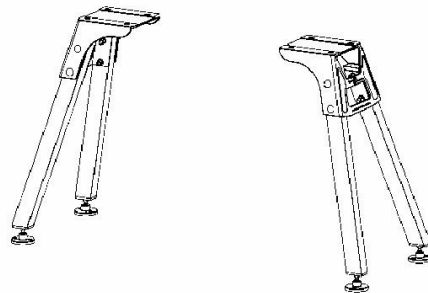
Lathe Cast Iron Stand

The stand pieces are cast from a high grade of Cast iron with extremely good section thickness and CAD generated internal gussets at all critical points to withstand extremely high stresses with practically no distortion. Cast iron has always been the material of choice for wood lathe construction because of its inherent mass and excellent modulus of vibration dampening. The cast iron stand has been purposely designed to be heavy, solid and robust keeping this in mind.



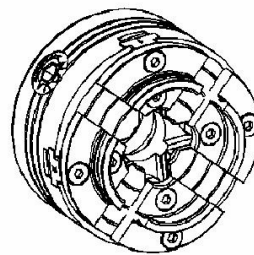
1624 Hybrid Stand

The 1624 hybrid stand is a combination of cast iron and rectangular hollow section. Compared to its original predecessor, the hybrid was designed to be light weight and style.



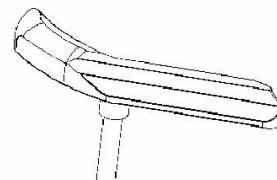
SuperNova2 Chuck

A next-generation, self-centering chuck to securely hold round and square work pieces for centerless turning. The special Tuff Lock gearing delivers amazing holding power in both the contraction and expansion mode. It has an open-back for easy cleaning and can be tightened one-handed with an articulated key. It includes a screw chuck. A wide variety of optional jaws are available to hold almost any work piece.



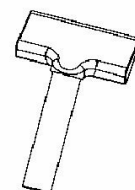
Bowl Toolrest

A curved toolrest which gives you better chisel support on both the outside and inside of a bowl. Because of the curve you are able to position your chisel support closer to the bowl.



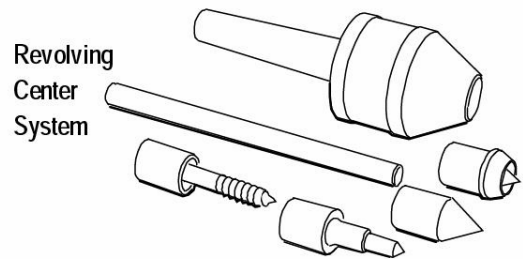
Small Toolrest

A small 100 mm (4 in.) toolrest for turning small work pieces or reaching into recessed areas.



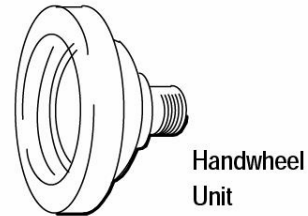
Revolving Center System

A multi-function live center system to expand your options when turning between centers. It includes quick change tapers: a hollow cup center point, threaded center, cone center, and an extension center. Made with three bearings and precision machined for a high quality finish.



Handwheel Unit

The handwheel is mounted on the outboard end of the headstock spindle so you can manually position work or to slow it down. The vacuum coupler can also be added to this unit to make a vacuum holding option.

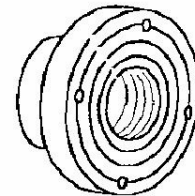


Accessories

Faceplates

The faceplates are used to mount the work piece when faceplate turning bowls or platters. The Faceplates is available in 80 mm (3 in.)

A vacuum faceplate is also available. The 80 mm (3 in.) faceplate is made of solid steel. This faceplate has a small contact area to allow maximum freedom while shaping.

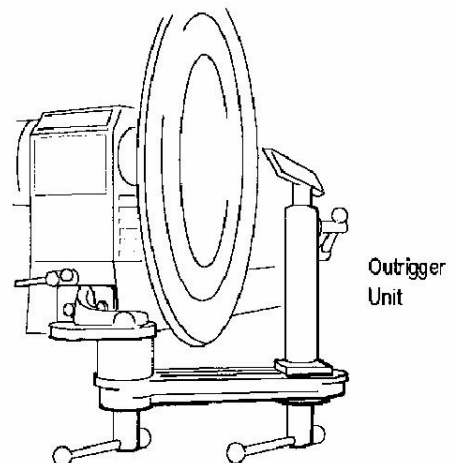


Vacuum Coupler

The Vacuum Coupler (not shown) fits onto the Handwheel Unit. It provides a secure attachment for your vacuum cleaner hose. For those turners who are interested in vacuum chucking, this is a simple system.

Outrigger Unit

Extend the bowl turning capacity of the Nova 1624 II Woodlathe to up to 740 mm (29 in.) in diameter. This unit is made from cast iron, is easy to position and control, and mounts to the headstock end of the lathe.



For further details about the NOVA lathe accessories please contact your local retailer for more information, or contact us for a free product catalogue. This catalogue can also be downloaded from our website - at www.teknatool.com.

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Teknatool Warranty

Teknatool Five Year Limited Warranty

This Teknatool product is backed by a FIVE YEAR warranty from the date of purchase. Teknatool International Ltd will repair or replace, at its expense and option, this Teknatool product which in normal use has proven to be defective in workmanship or material, provided that the customer returns the product prepaid to an authorized Teknatool service center with proof of purchase of the product within TWO YEARS and provides Teknatool with reasonable opportunity to verify the alleged defect by inspection. Furthermore, Teknatool International Ltd. extends this two year period for three additional years replacement parts only warranty, excluding labor and transport costs, Drive belts and other normal wear items are excluded. Provided the aforementioned conditions are met. Motors and electronic controls are not covered under this warranty; these are warranted by their respective manufacturer. Where the motor is part of the lathe package it is covered by a 1 year warranty.

Teknatool will not be responsible for any asserted defect which has resulted from normal wear, misuse, abuse, or repair or alteration made by anyone other than an authorized service facility or representative. Under no circumstances will Teknatool International Ltd. be liable for incidental, special, indirect, and consequential damages or expenses, including loss of profits or loss of operations. This warranty is Teknatool International Ltd. sole warranty. There are no other warranties, whether written or verbal, whether expressed or implied by law, trade, custom, or otherwise, whether of merchantability, fitness for purpose, or otherwise, except for remedies available to customers under the Consumer Guarantees Act or other legislation.

OVERSEAS CUSTOMERS: Our Teknatool Distributors and agents will issue their own warranty to cover this product. Terms may vary from those stated above; please check with you local agent.

In North America warranty covers Continental USA only. For Alaska and Hawaii and other areas, warranty covers replacement of parts only and excludes transport costs.

Register your warranty with NOVA online.

Visit our website on www.teknatool.com to register your warranty today!



Nova 1624 II Woodlathe Manual

Publication Code: 111-0516-008

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7.0 Voltage Differences In Model 1624II
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Model(s)	Voltage	Power	Currency	Tonnage	Note
1624II	230V	1.5 HP	AC	72Kg	without Motor
1624II	115V	1.5 HP	AC	72Kg	without Motor

8.0 Hazards List

The significant hazards are set out in the following listing based on EN ISO 12100. Also shown are the sections references in this European Standard in which the safety requirements and/or measures or rules are described for showing the conformity to the safety requirements.

	EN 12100		Present	
			Yes	No
1	Mechanical hazards due to: 1) machine's parts or working pieces a) shape; b) related position; c) mass and balancing (potential energy of the element which can fall down under gravity effect); d) mass and speed (kinetic energy of the element which can move under controlled and uncontrolled movement); 2) energy accumulation into the machine due to: e) elastic element (springs); f) fluid and gas under pressure; g) vacuum effect;		X	
1.1	Crushing hazard		X	
1.2	Shearing hazard		X	
1.3	Cutting or severing hazard		X	
1.4	Entanglement hazard		X	
1.5	Drawing-in or trapping hazard		X	
1.6	Impact hazard		X	
1.7	Stabbing or puncture hazard		X	
1.8	Friction or abrasion hazard		X	
1.9	High pressure fluid or gas ejection hazard		X	
1.10	Parts ejection		X	
1.11	Lack of stability		X	
1.12	Slip, trip, fall related to the machine		X	
2	Electrical hazard due to			
2.1	Direct and indirect electrical contact between people and live parts		X	
2.2	Electrostatic phenomena		X	
2.3	Thermal radiation or other phenomena such as projection of molten particles, and chemical effects from short circuits, overloads, etc.	.	X	
2.4	External influences	.	X	
3	Thermal hazards i.e. resulting in			
3.1	Burns and scalds, by a possible contact of persons, by flames or explosions and also by the radiator of heat source	.	X	
3.2	Health-damaging effects by hot or cold work environment		X	
4	Hazards generated by noise, resulting i.e. in:			
4.1	Hearing losses (deafness), other physiological disorder (i.e. loss of balance, loss of awareness, etc.)		X	
4.2	Interference with speech communication, acoustic signal, etc.		X	
5	Hazards generated by vibration (resulting in a variety of neurological and vascular disorders)		X	
6	Hazards generated by radiation			
6.1	Radiation at low frequency, radio frequency, microwaves, electric arcs	.		X
6.2	Infrared-ray, light, UV-ray, lasers			X
6.3	X-ray, γ -ray			X
6.4	α -ray, β -ray, electron or ion beam, neutron beam			X
7	Hazards generated by materials and substances processed, used or exhausted by machinery i.e.			
7.1	Hazards resulting from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts	.	X	
7.2	Fire or explosion hazards	.	X	
7.3	Biological and micro-biological (viral or bacterial) hazards		X	
8	Hazards generated by neglecting ergonomic principles in machine design (mismatch of machinery with human characteristics and abilities) caused i.e. by			
8.1	Unhealthy postures or excessive efforts.		X	
8.2	Inadequate consideration of human hand-arm or foot-leg anatomy		X	
8.3	Neglected use of PPE		X	
8.4	Inadequate area lighting		X	
8.5	Mental overload or underload, stress, etc.		X	
8.6	Human error		X	
9	Hazards combination		X	
10	Hazards caused by failure of energy supply, breaking down of machinery parts and other functional disorders, i.e.			
10.1	Failure, malfunction of control system (unexpected start up, unexpected overrun)		X	
10.2	Unexpected ejection of machine parts or fluids.		X	
10.3	Control malfunctioning		X	

10.4	Error of fitting		X	
10.5	Overturn, unexpected loss of machine stability		X	
11	Hazardous due to means/devices related to the safety missing or in wrong position			
11.1	Missing guards		X	
11.2	Missing safety devices		X	
11.3	Starting and stopping devices		X	
11.4	Safety sign		X	
11.5	Information and warning means		X	
11.6	Energy disconnecting devices		X	
11.7	Emergency devices		X	
11.8	Working piece feeding		X	
11.9	Maintenance equipment		X	
11.10	Gas evacuation		X	
	Hazards due to mobility			
12	Inadequate lighting		X	
13	Instability		X	
14	Neglected ergonomic of the control position			
14.1	Hazards due to dangerous environment (contact with moving parts, exhaust, etc.)		X	
14.2	Inadequate visibility by the operators		X	
14.3	Inadequate seating		X	
14.4	Inadequate controls		X	
14.5	Starting in machine with engine		X	
14.6	Road traffic		X	
14.7	Pedestrian control		X	
15	Mechanical hazards			
15.1	Uncontrolled movement		X	
15.2	Parts ejection		X	
15.3	Roll over		X	
15.4	Falling objects		X	
15.5	Inadequate access		X	
15.6	Towing		X	
15.7	Batteries			X
16	Hazards due to lifting operation			
16.1	Lack of stability		X	
16.2	Derailment		X	
16.3	Loss of mechanical strength of the machine		X	
16.4	Uncontrolled movement		X	
16.5	Falling loads		X	
17	Inadequate view		X	
18	Lighting		X	
19	Overloading		X	

9.0 Essential Health and Safety Requirements(Annex I machinery directive 2006/42/EC)

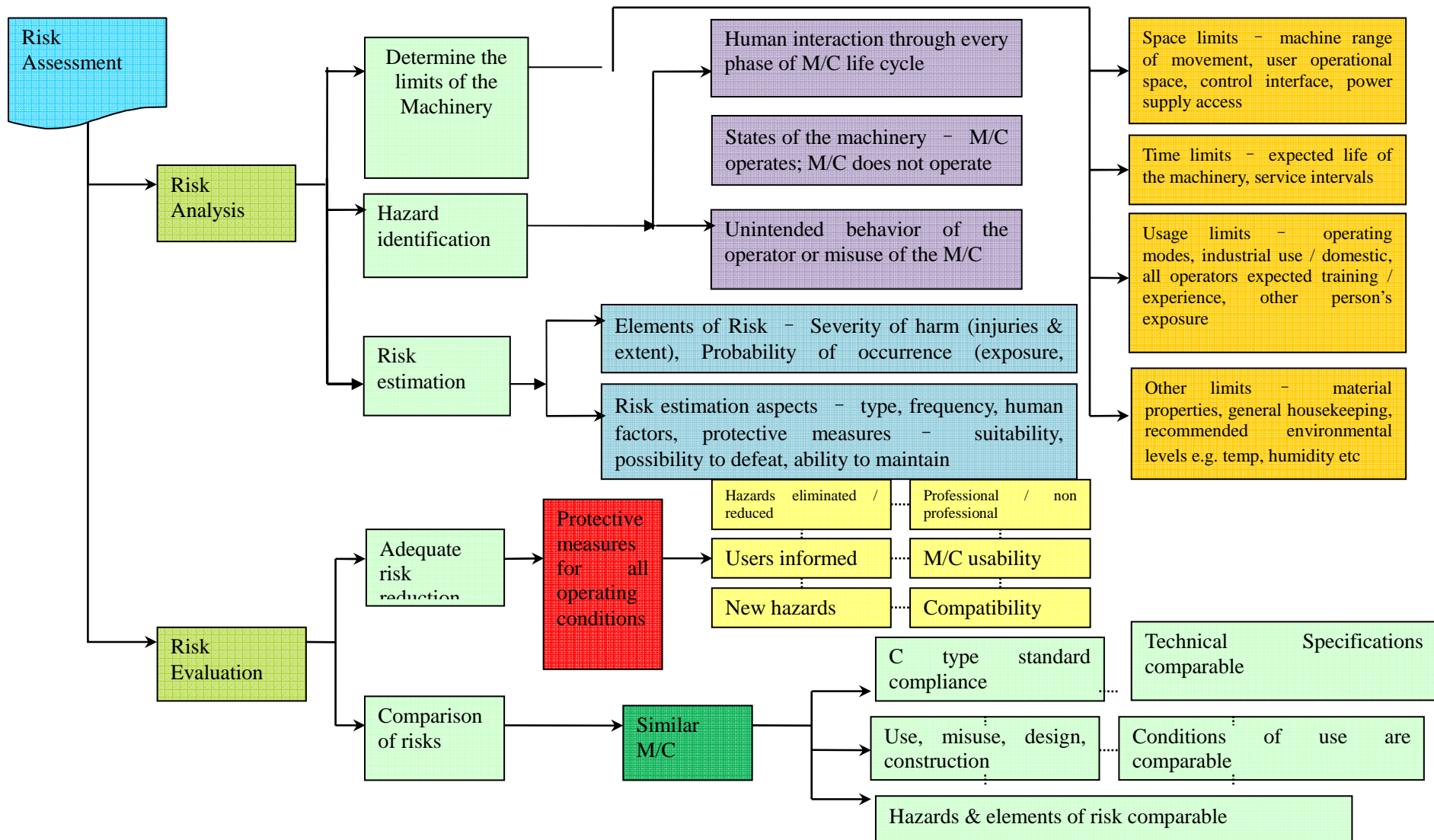
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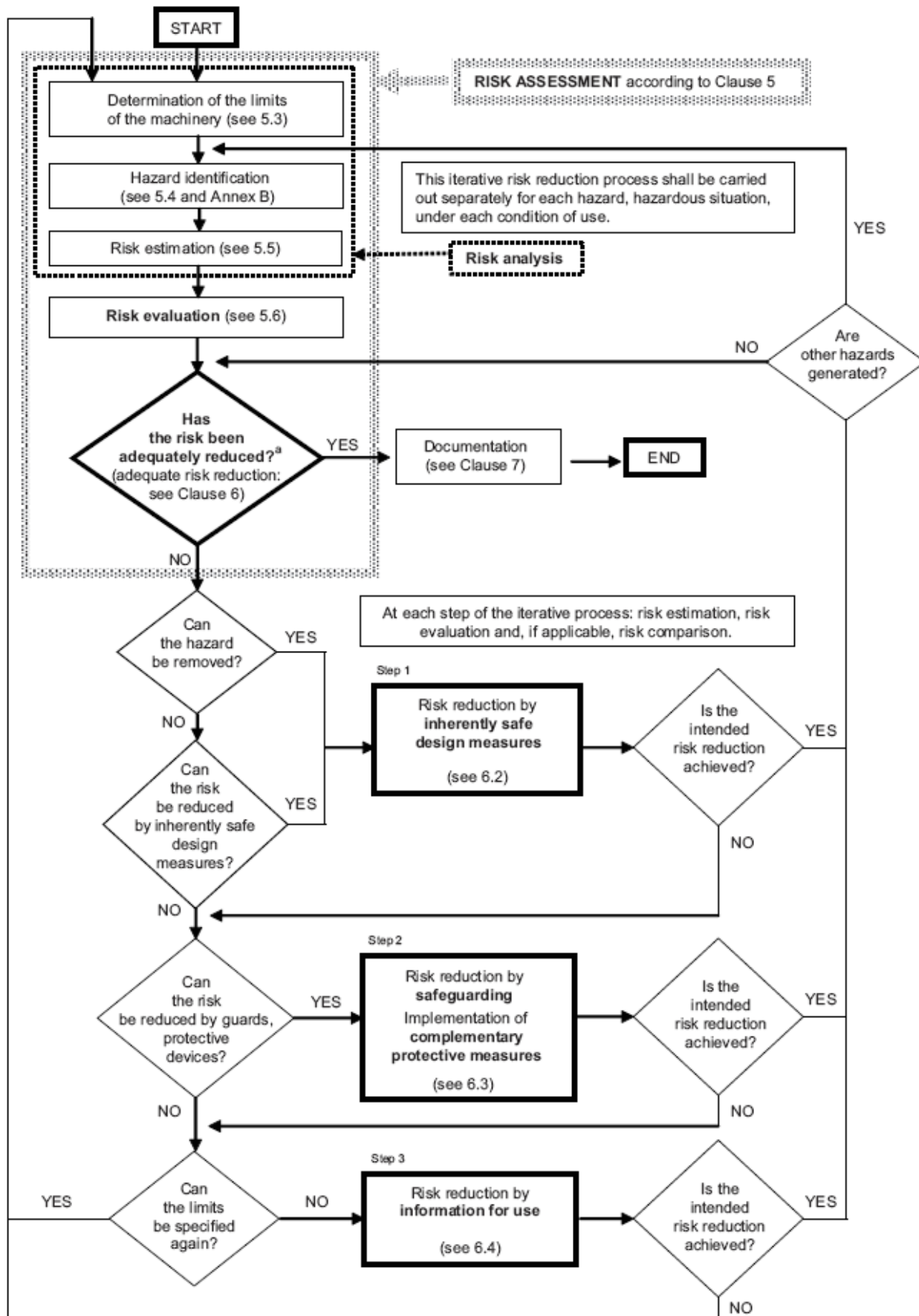
Ref.	E. H. S. R.	A	NA	Meet the requirement?
1.1	General remarks	X		Y
1.1.1	Definition	X		Y
1.1.2	Principles of safety integration	X		Y
1.1.3	Materials and products	X		Y
1.1.4	Lighting	X		Y
1.1.5	Design of machinery to facilitate its handling	X		Y
1.2	Controls			
1.2.1	Safety and reliability of control systems	X		Y
1.2.2	Control devices	X		Y
1.2.3	Starting	X		Y
1.2.4	Stopping device (normal stopping, emergency stop)	X		Y
1.2.5	Mode selection	X		Y
1.2.6	Failure of the power supply	X		Y
1.2.7	Failure of the control circuit	X		Y
1.2.8	Software		X	
1.3	Protection against mechanical hazards			
1.3.1	Stability	X		Y
1.3.2	Risk of break-up during operation	X		Y
1.3.3	Risks due to falling or ejected objects	X		
1.3.4	Risks due to surfaces, edges or angles	X		Y
1.3.5	Risks related to combined machinery	X		Y
1.3.6	Risks relating to variations in the rotational speed of tools	X		
1.3.7	Prevention of risks related to moving parts	X		Y
1.3.8	Choice of protection against risks related to moving parts (transmission parts, moving parts directly involved in the process, etc.)	X		Y
1.4	Required characteristics of guards and protection devices	X		Y
1.4.1	General requirements	X		Y
1.4.2	Special requirements for guards	X		Y
1.4.2.1	Fixed guards	X		Y
1.4.2.2	Movable guards	X		Y
1.4.2.3	Adjustable guards restricting access	X		
1.4.3	Special requirements for protection devices	X		Y
1.5	Protection against other hazards	X		Y
1.5.1	Electricity supply	X		Y
1.5.2	Static electricity	X		Y
1.5.3	Energy supply other than electricity	X		Y
1.5.4	Errors of fitting	X		Y
1.5.5	Extreme temperatures	X		Y
1.5.6	Fire	X		
1.5.7	Explosion		X	
1.5.8	Noise	X		Y
1.5.9	Vibration	X		Y
1.5.10	Radiation	X		Y
1.5.11	External radiation	X		Y
1.5.12	Laser equipment	X		Y
1.5.13	Emissions of dust, gases, etc.	X		Y
1.5.14	Risk of being trapped in a machine	X		Y
1.5.15	Risk of slipping, tripping or falling	X		Y
1.6	Maintenance			
1.6.1	Machinery maintenance	X		Y
1.6.2	Access to operating position and servicing points	X		Y
1.6.3	Isolation of energy sources	X		Y
1.6.4	Operator intervention	X		Y
1.6.5	Cleaning of internal parts	X		Y
1.7	Indicators	X		Y
1.7.0	Information devices	X		Y
1.7.1	Warning devices	X		Y
1.7.2	Warning of residual risks	X		Y
1.7.3	Marking	X		Y
1.7.4	Instructions	X		Y

10.0 Risk Evaluation Report According to EN ISO 12100:2010

Machinery Information	
Machine	NOVA Wood Lathe
Variants	1624II
Manufacturers Experience	More than 10 years
Known accidents for this type of machinery	
Machinery C type standards	/
Other relevant standards	EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010, EN 349:1993+A1:2008, EN ISO 14120:2015, EN ISO 13857:2008, EN 13850:2015

Expected Use and Limits of Use	
The Machinery is intended for the sole purpose of	This machine models are for industrial use
Machinery is to be used in the following sector (Industrial / Non Industrial / Domestic)	Industrial
Machinery is intended to be operated by	Skilled
Are there any physical limiting factors?	Yes
What are the physical limiting factors ?	
Anticipated level of training of Machinery installer(s)	Skilled
Anticipated level of training of Machinery operator(s)	Skilled
Anticipated level of training of Machinery maintainer(s)	Skilled
Anticipated level of training of other Machinery operator(s)	Skilled
Are there other persons exposed to the Machinery hazards?	Yes
Will operators be safety trained?	Yes
Are members of the public exposed to the Machinery hazards?	No
Mass and dimensions of the machinery	Please check the specifications of the machine
Maximum speed of the machinery (Linear / Rotational modes of travel)	/
Machinery is designed for a foreseen life (Years)	8-10 years
The machinery uses the following energy sources (Air, Water, Electricity, Hydraulic)	Electricity
















Risk Assessment Strategy									
To implement risk assessment and risk reduction the designer shall take the following actions, in the order given (see Figure 1):									
a) Determine the limits of the machinery, which include the intended use and any reasonably foreseeable misuse thereof;									
b) Identify the hazards and associated hazardous situations;									
c) Estimate the risk for each identified hazard and hazardous situation;									
d) Evaluate the risk and take decisions about the need for risk reduction;									
The final step is related to risk reduction.									
e) Eliminate the hazard or reduce the risk associated with the hazard by means of protective measures.									
Follow the above steps to analyze the risks associated with machinery.									
Risk assessment is always followed where possible risk reduction and iteration of the process can be required to eliminate hazards as far as practicable and to implement protective measures to reduce risks.									
Protective Measures									
Protective measures are the measures implemented by the designer and the user, protective measures designed into the product are generally more effective and tend to be cheaper to implement.									
The objective is to achieve the most practicable risk reduction taking into account the following:									
a) Safety of the machine in all the phases of the life cycle									
b) Ability of the machine to perform its function									
c) The usability of the machine									
d) The manufacturing, operational and dismantling cost of the machine									
Risk reduction									
Following a risk assessment risk reduction may be required. This can be achieved by the elimination of the hazard or by separately or simultaneously reducing each of the elements that determine the associated risk.									
a) Severity of harm from the hazard,									
b) Probability of the occurrence of that harm.									
All protective measures that are intended to meet this objective shall be applied using the “Three Step Method”.									
<i>Step 1: Inherently safe design measures</i>									
Inherently safe design measures eliminate hazards or reduce the associated risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine.									
NOTE 1: This stage is the only one at which hazards can be eliminated, thus avoiding the need for additional protective measures such as safeguarding or complementary protective measures.									


<i>Step 2: Safeguarding and/or complementary protective measures</i>									
Taking into account the intended use and the reasonably foreseeable misuse, appropriately selected safeguarding and complementary protective measures can be used to reduce risk when it is not practicable to eliminate a hazard, or reduce its associated risk sufficiently, using inherently safe design measures.									
<i>Step 3: Information for use</i>									
Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures, the residual risks shall be identified in the information for use. The information for use shall include, but not be limited to, the following:									
	Operating procedures for the use of the machinery consistent with the expected ability of personnel who use the machinery or other persons who can be exposed to the hazards associated with the machinery.								
	The recommended safe working practices for the use of the machinery and the related training requirements adequately described.								
	Sufficient information, including warning of residual risks for the different phases of the life of the machinery.								
	The description of any recommended personal protective equipment, including detail as to its need as well as to training needed for its use.								
Information for use shall not be a substitute for the correct application of inherently safe design measures, safeguarding or complementary protective measures.									
NOTE 2: Adequate protective measures associated with each of the operating modes and intervention procedures reduce the possibility of operators being induced to use hazardous intervention techniques in case of technical difficulties.									
Prior to beginning work the first time, the operators are expected to have read and understood the safety section of the instructions that accompany the machinery, and to be familiar with the location and operation of each control, and to have received appropriate training / competence assessment.									

Risk Estimation						
Hazards should be assessed at all phases of the machine life i.e. construction, transportation, assembly, installation, commissioning, use, maintenance, dismantling & disposal.						
Risk is a function of the combination of the severity of harm and the probability of occurrence of that harm. Information taken from the determined limits of the machinery will allow the risk assessor to correctly estimate the risks.						
The severity of harm is estimated by considering the <i>severity of injury</i> or damage to health and the <i>extent of the harm</i> . The probability of occurrence is itself a function of the <i>exposure of person(s)</i> to the hazard, the <i>occurrence of a hazardous event</i> and the <i>possibility to avoid</i> or limit the harm.						
Severity of Harm						
When completing risk assessments, the risk from the most likely severity of harm that is likely to occur from each identified hazard shall be considered and the highest foreseeable severity shall also be taken into account, even if the probability is low. The severity of harm can be distinguished in better detail by considering the severity of injury and the extent of that harm .						
Probability of Occurrence of that harm						
This is a combination of factors that can be split into the Frequency of Exposure and Possibility of Avoidance . The frequency of exposure takes into account the <i>frequency of access</i> , <i>the nature of access</i> , <i>the number of persons</i> requiring access to the hazard zone and the <i>time spend within the hazard zone</i> . Also there are other element to identification of possibility of avoidance which considers the machines history (reliability / known problems) and the type of machine by using comparison of risks to similar machines. Each factor must be considered when "scoring" the frequency of exposure during the examination of the machinery.						
The possibility of avoidance considers the skill of the operators / persons exposed to the harm, how quickly the hazardous situation develops and how easy it is for the operator / persons exposed to the harm to identify a risk.						
The risk score is calculated by multiplying: severity of injury x extent of harm, frequency of exposure x possibility of avoidance using the following scoring system:						

	Rating	Description	Score
Severity of Injury	High	irreversible e.g. loss of limb, or fatality	3
SOI	Medium	recoverable e.g. broken bone or deep cuts	2
	Low	reversible, minor cuts and bruises	1
Extent of Harm	Several	Multiple persons exposed to hazard	2
EOH	One	Single person exposed to hazardous situation	1
Frequency of Exposure	High	frequent e.g. more than once every 10 minutes	3
FOE	Medium	regularly e.g. once per hour	2
	Low	infrequent e.g. once per week	1
Possibility of Avoidance	High	obvious and slow moving	1
POA	Medium	can get out of the way with normal reactions	2
	Low	hazard not obvious and moving fast	3
Note: The scoring for Possibility of Avoidance is reversed from the other 2 categories.			
For each hazard the objective is to get to a risk score of 4 or less.			
Once the risk has been assessed, appropriate elimination and reduction measures should be taken and the risk rating recalculated.			
Risk reduction can be done by separately or simultaneously reducing each of the elements which determine the risk, SOI, EOH, FOE and POA. The measures taken should be re-evaluated to check if they have introduced any new hazards.			
The risk assessment process should be repeated until an acceptable risk level is achieved. This called an “iterative” process.			





Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
1			Mechanical													
1.1	1.3.7	6.2.2.1 6.2.2.2	Crushing 													
1.2	1.3.4	6.2.2.1 6.2.2.2	Cutting or severing 	Hand may get cut in moving parts	2	1	2	2	8	Set up warning sign	2	1	2	1	4	
1.3	1.3.7	6.2.2.1 6.2.2.2	Drawing-in or trapping 													
1.4	1.3.7	6.2.2.1 6.2.2.2	Entanglement 	Cloths may entangle in wheels	2	1	2	2	8	Set up warning sign Covering wheels by fenders	2	1	2	1	4	
1.5	1.3.4	6.2.2.1 6.2.2.2	Friction or abrasion 	Not applicable												

1.6	1.3.3	6.2.2.1 6.2.2.2	Impact 													
				Not applicable												
1.7	1.3.2	6.2.10	Injection (e.g. high pressure fluid) 													
1.8	1.3.7	6.2.2.1	Shearing 													
				Not applicable												
1.10	1.5.15	6.3.5.6	Slipping, tripping and falling 	Not applicable												
					2	1	2	2	8		2	1	2	1	4	
1.11	1.3.4	6.2.2.1	Stabbing puncture 													
				Not applicable												
1.12	1.1.7 1.1.13	6.2.3	Suffocation 													
				Not applicable												
1.13	1.3.3	6.2.3 6.3.1	Falling objects or ejected													

1.14	1.3.1	6.2.6 6.3.2.6	Stability	Not applicable												
1.15	1.3.2	6.2.3	Break up of machine													
1.16	1.1.5	6.2.2.1	Run over (e.g. transportation) 	Not applicable												

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
2			Electrical													
2.1	1.5.1	6.2.9	Contact electrocution													
				Not applicable												
2.2	1.5.2	6.2.9	Indirect contact - electrocution													
				Not applicable												
2.3	1.5.1	6.2.9	Approach to electrical parts													
				Not applicable												
2.4	1.5.5	6.2.9	Electrical burns													
				If electrical cabinet burn may be cause fire	2	2	2	1	8	No overload, Installed the protective guards on the terminals, affix the warning signs	2	1	1	1	2	The warning sings and cautions have been provided in the manual.
2.5	1.5.2	6.2.9	Electrostatic phenomena													
				Not applicable												



2.6	1.5.10	6.2.3	Effects on medical implants	Not applicable												
2.7	1.5.6	6.3.5.4	Fire	Not applicable												
2.8	1.3.3	6.2.3 6.3.1	Projection of molten particles	Not applicable												
2.9	1.1.6	6.2.8	Shock (e.g. after incident)	If person touch the parts of the inner electric parts or motors may be cause injury during operation	1	1	2	2		The ground terminal fitted. The safety guard used. Affix the warning signs	1	1	1	1	1	The electric warning signs have been provided in the manual.
									4							
2.10	1.5.15	6.3.5.6	Falling / being thrown (e.g. during electrocution)	Not applicable												



Hazard ID #	EHS R	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
3			Thermal													
3.1	1.5.5	6.2.3	Burn 													
3.2	1.1.6	6.2.8	Dehydration													
3.3	1.1.6	6.2.8	Discomfort 													
3.4	1.5.5	6.2.9	Frostbite 													
3.5	1.5.5	6.2.3	Injuries by the radiation of heat sources													
3.6	1.5.5	6.2.3	Scald 													


Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
4			Noise													
4.1	1.5.8	6.2.2.2	Permanent hearing loss													
4.2	1.5.8	6.2.2.2	Tinnitus													
4.3	1.5.8	6.2.2.2 6.2.8	Interference of speech													
4.4	1.1.6	6.2.8	Loss of awareness													
4.5	1.1.6	6.2.8	Loss of balance													
4.6	1.1.6	6.2.8	Discomfort													
4.7	1.1.6	6.2.8	Stress													

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
5			Vibration													
5.1	1.5.9	6.2.3 6.3.4.3	Handheld													
				Not applicable												
5.2	1.5.9	6.2.3 6.3.4.3	Whole body													
5.3	1.5.9	6.2.3 6.3.4.3	Discomfort													
5.4	1.5.9	6.2.3 6.3.4.3	Low-back morbidity													
5.5	1.5.9	6.2.3 6.3.4.3	Neurological disorder													
5.6	1.5.9	6.2.3 6.3.4.3	Osteo-articular disorder													

5.7	1.5.9	6.2.3 6.3.4.3	Trauma of the spine													
5.8	1.5.9	6.2.3 6.3.4.3	Vascular disorder													

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
6			Radiation													
6.1	1.5.10	6.2.2.2 6.2.3	Ionizing													
				Not applicable												
6.2	1.5.11	6.3.4.5	Low frequency electromagnetic													
6.3	1.5.10	6.2.3 6.3.4.5	Optical (e.g. infrared,ultraviolet) 													
6.4	1.5.12	6.2.3 6.3.4.5	Laser 													
6.5	1.5.10	6.2.3 6.3.4.5 6.3.5.1	Radio frequency electromagnetic													

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
7			Material													
7.1	1.1.3 1.5.13	6.2.2.2 6.2.3 6.2.4	Breathing / suffocation (aerosols, dust, fibres, fluids, gas) 													
				Not applicable												
7.2	1.1.3 1.5.13	6.2.2.2 6.2.3	Cancer (biological / microbiological agents)													
				Not applicable												
7.3	1.1.3	6.2.2.2 6.2.3	Corrosion													
7.4	1.1.3	6.2.2.2 6.2.3	Effects of reproduction capability													
				Not applicable												
7.5	1.1.3	6.2.2.2 6.2.4 6.3.1	Explosion 													
				Not applicable												
7.6	1.1.3	6.2.2.2 6.2.3	Fire													

		6.2.4		If contact the fire may be cause fire risk	2	2	1	1	4	No smoking and any other fire nearly the machine	2	1	1	1	2	The machine is forbidden using in fire conditions. In addition, forbid any fire near the machine.
7.7	1.1.3	6.2.2.2 6.2.3	Infection / sensitization / mutation	Not applicable												
7.8	1.1.3 1.5.13	6.2.2.2 6.2.3	Poisoning													

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
8			Ergonomic													
8.1	1.1.6	6.2.8	Discomfort - unhealthy postures													
				Long operation time may cause discomfort during operation	2	1	1	1	2	Skilled operator	1	1	1	1	1	The operator should be skilled. Has been provided in the instruction manual
8.2	1.1.6	6.2.8	Musculoskeletal disorder - inadequate consideration of anatomy													
				Not applicable												
8.3	1.1.6 1.2.2	6.2.8	Fatigue													
8.4	1.1.6	6.2.8	Stress													
				Not applicable												
8.5	1.1.6	6.3.2.1	Mental overload / underload													
				Not applicable												

8.6	1.1.4	6.2.7	Inadequate lighting	local													
					Can't operate safe during operation	2	2	1	1	4	Provide adequate lighting if the light unfavourable the operation should be stopped.	1	1	1	1	1	The user should be provided adequate light.The warnings has been provided in instruction manual
8.7	1.2.2	6.2.11.8 6.3.2.1	Human error														
				Can't operate safe during operation	2	2	2	1	8	Skilled operator	2	1	1	1	2	The operator should be skilled. The warning sings have been provided in the instruction manual	
8.8	1.1.6 1.2.2	6.2.11.8	Inadequate controls	manual													
					Not applicable												

Hazard ID #	EHS R	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SO I	EO H	FO E	PO A	RIS K		SO I	EO H	FO E	PO A	RIS K	Users Must be Warned of Residual Risks
9			Environmental													
9.1	1.5.6 1.5.7	6.3.2.1 6.4.5.1	Dust / fog													
				Not applicable												
9.2	1.5.16	6.2.11.1 1	Lightning													
9.3	1.3.2	6.2.3 6.3.4.5	Water / moisture													
9.4	1.3.2	6.2.3 6.3.4.5	Pollution													
9.5	1.5.5	6.4.5.1	Temperature													
9.6	1.3.2	6.3.2.1	Snow / ice													

				Not applicable												
9.7	1.3.1	6.2.6	Wind	Not applicable												
9.8	1.1.7	6.4.5.1 6.3.5.3	Lack of oxygen	Not applicable												

Hazard ID #	EHSR	EN 12100 Clause	Generic Hazards	Actual Hazard - inc location, activity & persons at risk	Risk Estimation					Measures taken to eliminate or reduce risk	Risk Re-estimation					Residual Risks - information provided & warning labels
					SOI	EOH	FOE	POA	RISK		SOI	EOH	FOE	POA	RISK	Users Must be Warned of Residual Risks
10			Combination													
10.1			Repetitive activity + effort + high environmental temperature	Not applicable												

Conclusions: From risk evaluation results that if the machine is used under normal safety condition and following what is written in the use and maintenance manual, there are not situation with strong risk. For each dangerous situation some warning and precaution are listed in the manual, which allow the operators to work with low risk, also in the manual there is a list of safety advices to reduce the risks.

11.0 General Test Report

INFORMATION	
Applicant Name:	Teknatool International Limited
Address:	7D Dallan Place, Rosedale, Auckland, 0632, NZ
Manufacturer Name:	Qingdao GRC Co., Ltd.
Address:	Yangjialin, Beiguan Street Office, Jiaozhou, Qingdao City, Shandong Province, China

PROJECT INFORMATION	
Product name:	NOVA Wood Lathe
Model(s)	1624II
Standard/Edition	EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010
Requested Service	<input checked="" type="checkbox"/> Full or partial pre-test for the following certification <input type="checkbox"/> CE- MD <input type="checkbox"/> CE- LVD <input type="checkbox"/> CE- EMC <input type="checkbox"/> Others _____

SAMPLE RECORDS		
Sample	Quantity	Description
1624II	1	Complete ,Well for testing
Conclusion: The sample(s) were tested according to the standard(s) specified above and found COMPLIANCE with the applicable requirements...		

Testing Introduction

Test item particulars: Equipment mobility.....Potable 1 Practical tests for Type Testing Procedure 2 Practical tests for fitness for purpose test when 1624II has been type tested	
Test case verdicts Test case does not apply to the test object.....: N/A Test item does meet the requirement.....: P(Pass) Test item does not meet the requirement.....: F(Fail)	
General remarks The test results presented in this report relate only to the object tested. This report shall not be reproduced except in full without the written approval of the testing laboratory. The test results presented in this report relate only to the item(s) tested, "(see remark #)" refers to a remark appended to the report, "(see Annex #)" refers to an annex appended to the report. Throughout this report a comma is used as the decimal separator.	

Clause	Requirement-Test	Result	Verdict
EN ISO 12100:2010			
6	Risk reduction		
	The objective of risk reduction can be achieved by the elimination of hazards, or by separately or simultaneously reducing each of the two elements that determine the associated risk: —severity of harm from the hazard under consideration; —probability of occurrence of that harm. All protective measures intended for reaching this objective shall be applied in the following sequence, referred to as the three-step method (see also Figures 1 and 2). Step 1: Inherently safe design measures Step 2: Safeguarding and/or complementary protective measures Step 3: Information for use	P	
6.2 Inherently safe design measures			
6.2.1	General		
	Inherently safe design measures are the first and most important step in the risk reduction process. This is because protective measures inherent to the characteristics of the machine are likely to remain effective, whereas experience has shown that even well-designed safeguarding can fail or be violated and information for use may not be followed. Inherently safe design measures are achieved by avoiding hazards or reducing risks by a suitable choice of design features for the machine itself and/or interaction between the exposed persons and the machine.	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
6.2.2 Consideration of geometrical factors and physical aspects			
6.2.2.1	Geometrical factors		
	<p>Such factors include the following.</p> <p>a) The form of machinery is designed to maximize direct visibility of the working areas and hazard zones from the control position — reducing blind spots, for example — and choosing and locating means of indirect vision where necessary (mirrors, etc.) so as to take into account the characteristics of human vision, particularly when safe operation requires permanent direct control by the operator, for example:</p> <ul style="list-style-type: none"> —the travelling and working area of mobile machines; —the zone of movement of lifted loads or of the carrier of machinery for lifting persons; —the area of contact of the tool of a hand-held or hand-guided machine with the material being worked. <p>The design of the machine shall be such that, from the main control position, the operator is able to ensure that there are no exposed persons in the danger zones.</p> <p>b) The form and the relative location of the mechanical components parts: for instance, crushing and shearing hazards are avoided by increasing the minimum gap between the moving parts, such that the part of the body under consideration can enter the gap safely, or by reducing the gap so that no part of the body can enter it (see ISO 13854 and ISO 13857).</p> <p>c) Avoiding sharp edges and corners, protruding parts: in so far as their purpose allows, accessible parts of the machinery shall have no sharp edges, no sharp angles, no rough surfaces, no protruding parts likely to cause injury, and no openings which can “trap” parts of the body or clothing. In particular, sheet metal edges shall be deburred, flanged or trimmed, and open ends of tubes which can cause a “trap” shall be capped.</p> <p>d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).</p>	P	
6.2.2.2	Physical aspects		
	<p>Such aspects include the following:</p> <p>a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard;</p> <p>b) limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;</p> <p>c) limiting the emissions by acting on the characteristics of the source using measures for reducing</p> <ol style="list-style-type: none"> 1) noise emission at source (see ISO/TR 11688-1), 2) the emission of vibration at source, such as redistribution or addition of mass and changes of process parameters [for example, frequency and/or amplitude of movements (for hand-held and hand-guided machinery, see CR 1030-1)], 3) the emission of hazardous substances, including the use of less hazardous substances or dust-reducing processes (granules instead of powders, milling instead of grinding), and 4) radiation emissions, including, for example, avoiding the use of hazardous radiation sources, limiting the power of radiation to the lowest level sufficient for the proper functioning of the machine, designing the source so that the beam is concentrated on the target, increasing the distance between the source and the operator or providing for remote operation of the machinery [measures for reducing emission of non-ionizing radiation are given in 6.3.4.5 (see also EN 12198-1 and EN 12198-3)]. 	P	
6.2.3	Taking into account general technical knowledge of machine design		
	<p>This general technical knowledge can be derived from technical specifications for design (standards, design codes, calculation rules, etc.), which should be used to cover</p> <p>a) mechanical stresses such as</p> <ul style="list-style-type: none"> —stress limitation by implementation of correct calculation, construction and fastening methods as regards, for example, bolted assemblies and welded assemblies, —stress limitation by overload prevention (bursting disk, pressure-limiting valves, breakage points, torque-limiting devices, etc.), —avoiding fatigue in elements under variable stresses (notably cyclic stresses), and —static and dynamic balancing of rotating elements, <p>b) materials and their properties such as</p> <ul style="list-style-type: none"> —resistance to corrosion, ageing, abrasion and wear, —hardness, ductility, brittleness, —homogeneity, —toxicity, and —flammability, and <p>c) emission values for</p> <ul style="list-style-type: none"> —noise, —vibration, 	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>—hazardous substances, and</p> <p>—radiation.</p> <p>When the reliability of particular components or assemblies is critical for safety (for example, ropes, chains, lifting accessories for lifting loads or persons), stress limits shall be multiplied by appropriate working coefficients.</p>		
6.2.4	Choice of appropriate technology		
	<p>One or more hazards can be eliminated or risks reduced by the choice of the technology to be used in certain applications such as the following:</p> <p>a) on machines intended for use in explosive atmospheres, using</p> <p>—appropriately selected pneumatic or hydraulic control system and machine actuators,</p> <p>—intrinsically safe electrical equipment (see IEC 60079-11);</p> <p>b) for particular products to be processed (for example, by a solvent), by using equipment that ensures the temperature will remain far below the flash point;</p> <p>c) the use of alternative equipment to avoid high noise levels, such as</p> <p>—electrical instead of pneumatic equipment,</p> <p>—in certain conditions, water-cutting instead of mechanical equipment.</p>	N/A	
6.2.5	Applying principle of positive mechanical action		
	<p>Positive mechanical action is achieved when a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements. An example of this is positive opening operation of switching devices in an electrical circuit (see IEC 60947-5-1 and ISO 14119).</p>	P	
6.2.6	Provisions for stability		
	<p>Machines shall be designed so that they have sufficient stability to allow them to be used safely in their specified conditions of use. Factors to be taken into account include</p> <p>—the geometry of the base,</p> <p>—the weight distribution, including loading,</p> <p>—the dynamic forces due to movements of parts of the machine, of the machine itself or of elements held by the machine which can result in an overturning moment,</p> <p>—vibration,</p> <p>—oscillations of the centre of gravity,</p> <p>—characteristics of the supporting surface in case of travelling or installation on different sites (ground conditions, slope, etc.), and</p> <p>—external forces, such as wind pressure and manual forces.</p> <p>Stability shall be considered in all phases of the life cycle of the machine, including handling, travelling, installation, use, dismantling, disabling and scrapping.</p> <p>Other protective measures for stability relevant to safeguarding are given in 6.3.2.6.</p>	P	
6.2.7	Provisions for maintainability		
	<p>When designing a machine, the following maintainability factors shall be taken into account to enable maintenance of the machine:</p> <p>—accessibility, taking into account the environment and the human body measurements, including the dimensions of the working clothes and tools used;</p> <p>—ease of handling, taking into account human capabilities;</p> <p>—limitation of the number of special tools and equipment.</p>	P	
6.2.8	Observing ergonomic principles		
	<p>Ergonomic principles shall be taken into account in designing machinery so as to reduce the mental or physical stress of, and strain on, the operator. These principles shall be considered when allocating functions to operator and machine (degree of automation) in the basic design. NOTE Also improved are the performance and reliability of operation and hence the reduction in the probability of errors at all stages of machine use.</p> <p>Account shall be taken of body sizes likely to be found in the intended user population, strengths and postures, movement amplitudes, frequency of cyclic actions (see ISO 10075 and ISO 10075-2).</p> <p>All elements of the operator-machine interface, such as controls, signalling or data display elements shall be designed to be easily understood so that clear and unambiguous interaction between the operator and the machine is possible. See EN 614-1, EN 13861 and IEC 61310-1. The designer's attention is particularly drawn to following ergonomic aspects of machine design.</p> <p>a) Avoid the necessity for stressful postures and movements during the use of the machine (for example, providing facilities to adjust the machine to suit the various operators).</p> <p>b) Design machines, especially hand-held and mobile machines, so as to enable them to be operated easily, taking into account human effort, actuation of controls and hand, arm and leg anatomy.</p>	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>c) Limit as far as possible noise, vibration and thermal effects such as extreme temperatures.</p> <p>d) Avoid linking the operator's working rhythm to an automatic succession of cycles.</p> <p>e) Provide local lighting on or in the machine for the illumination of the working area and of adjusting, setting-up and frequent maintenance zones when the design features of the machine and/or its guards render the ambient lighting inadequate. Flicker, dazzling, shadows and stroboscopic effects shall be avoided if they can cause a risk. If the position or the lighting source has to be adjusted, its location shall be such that it does not cause any risk to persons making the adjustment.</p> <p>f) Select, locate and identify manual controls (actuators) so that</p> <ul style="list-style-type: none"> —they are clearly visible and identifiable, and appropriately marked where necessary (see 6.4.4), —they can be safely operated without hesitation or loss of time and without ambiguity (for example, a standard layout of controls reduces the possibility of error when an operator changes from a machine to another one of similar type having the same pattern of operation), —their location (for push-buttons) and their movement (for levers and hand wheels) are consistent with their effect (see IEC 61310-3), and —their operation cannot cause additional risk. <p>See also ISO 9355-3.</p>		
6.2.9	Electrical hazards		
	For the design of the electrical equipment of machines, IEC 60204-1 gives general provisions about disconnection and switching of electrical circuits and for protection against electric shock. For requirements related to specific machines, see corresponding IEC standards (for example, IEC 61029, IEC 60745 or IEC 60335).	P	
6.2.10	Pneumatic and hydraulic hazard		
	<p>Pneumatic and hydraulic equipment of machinery shall be designed so that</p> <ul style="list-style-type: none"> —the maximum rated pressure cannot be exceeded in the circuits (using, for example, pressure-limiting devices), —no hazard results from pressure fluctuations or increases, or from loss of pressure or vacuum, —no hazardous fluid jet or sudden hazardous movement of the hose (whiplash) results from leakage or component failures, —air receivers, air reservoirs or similar vessels (such as in gas-loaded accumulators) comply with the applicable design standard codes or regulations for these elements, —all elements of the equipment, especially pipes and hoses, are protected against harmful external effects, —as far as possible, reservoirs and similar vessels (for example, gas-loaded accumulators) are automatically depressurized when isolating the machine from its power supply (see 6.3.5.4) and, if not possible, means are provided for their isolation, local depressurizing and pressure indication (see also ISO 14118:2000, Clause 5), and —all elements which remain under pressure after isolation of the machine from its power supply are provided with clearly identified exhaust devices, and there is a warning label drawing attention to the necessity of depressurizing those elements before any setting or maintenance activity on the machine. 	P	
6.2.11 Applying inherently safe design measures to control systems			
6.2.11.1	General		
	<p>The design measures of the control system shall be chosen so that their safety-related performance provides a sufficient amount of risk reduction (see ISO 13849-1 or IEC 62061). The correct design of machine control systems can avoid unforeseen and potentially hazardous machine behavior.</p> <p>Typical causes of hazardous machine behavior are</p> <ul style="list-style-type: none"> —an unsuitable design or modification (accidental or deliberate) of the control system logic, —a temporary or permanent defect or failure of one or several components of the control system, —a variation or a failure in the power supply of the control system, and —inappropriate selection, design and location of the control devices. <p>Typical examples of hazardous machine behaviour are</p> <ul style="list-style-type: none"> —unexpected start-up (see ISO 14118), —uncontrolled speed change, —failure to stop moving parts, —dropping or ejection of part of the machine or of a workpiece clamped by the machine, and —machine action resulting from inhibition (defeating or failure) of protective devices. 	N/A	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>In order to prevent hazardous machine behaviour and to achieve safety functions, the design of control systems shall comply with the principles and methods presented in this subclause (6.2.11) and in 6.2.12.</p> <p>These principles and methods shall be applied singly or in combination as appropriate to the circumstances (see ISO 13849-1, IEC 60204-1 and IEC 62061).</p> <p>Control systems shall be designed to enable the operator to interact with the machine safely and easily. This requires one or several of the following solutions:</p> <ul style="list-style-type: none"> —systematic analysis of start and stop conditions; —provision for specific operating modes (for example, start-up after normal stop, restart after cycle interruption or after emergency stop, removal of the work pieces contained in the machine, operation of a part of the machine in case of a failure of a machine element); —clear display of the faults; —measures to prevent accidental generation of unexpected start commands (for example, shrouded start device) likely to cause dangerous machine behavior (see ISO 14118:2000, Figure 1); —maintained stop commands (for example, interlock) to prevent restarting that could result in dangerous machine behavior (see ISO 14118:2000, Figure 1). <p>An assembly of machines may be divided into several zones for emergency stopping, for stopping as a result of protective devices and/or for isolation and energy dissipation. The different zones shall be clearly defined and it shall be obvious which parts of the machine belong to which zone. Likewise, it shall be obvious which control devices (for example, emergency stop devices, supply disconnecting devices) and/or protective devices belong to which zone. The interfaces between zones shall be designed such that no function in one zone creates hazards in another zone which has been stopped for an intervention.</p> <p>Control systems shall be designed to limit the movements of parts of the machinery, the machine itself, or work pieces and/or loads held by the machinery, to the safe design parameters (for example, range, speed, acceleration, deceleration, load capacity). Allowance shall be made for dynamic effects (swinging of loads, etc.).</p> <p>For example:</p> <ul style="list-style-type: none"> —the travelling speed of mobile pedestrian controlled machinery other than remote-controlled shall be compatible with walking speed; —the range, speed, acceleration and deceleration of movements of the person-carrier and carrying vehicle for lifting persons shall be limited to non-hazardous values, taking into account the total reaction time of the operator and the machine; —the range of movements of parts of machinery for lifting loads shall be kept within specified limits. <p>When the machinery contains various elements that can be operated independently, the control system shall be designed to prevent risks arising out of a lack of coordination (for example, collision prevention system).</p>		
6.2.11.2	Starting of an internal power source/switching on an external power supply		
	<p>The starting of an internal power source or switching-on of an external power supply shall not result in a hazardous situation.</p> <p>For example:</p> <ul style="list-style-type: none"> —starting the internal combustion engine shall not lead to movement of a mobile machine; —connection to mains electricity supply shall not result in the starting of working parts of a machine. <p>See IEC 60204-1:2005, 7.5 (see also Annexes A and B).</p>	N/A	
6.2.11.3	Starting/stopping of a mechanism		
	<p>The primary action for starting or accelerating the movement of a mechanism should be performed by the application of an increase of voltage or fluid pressure, or — if binary logic elements are considered — by passage from state 0 to state 1 (where state 1 represents the highest energy state).</p> <p>The primary action for stopping or slowing down should be performed by removal or reduction of voltage or fluid pressure, or — if binary logic elements are considered — by passage from state 1 to state 0 (where state 1 represents the highest energy state).</p> <p>In certain applications, such as high-voltage switchgear, this principle cannot be followed, in which case other measures should be applied to achieve the same level of confidence for the stopping or slowing down.</p> <p>When, in order for the operator to maintain permanent control of deceleration, this principle is not observed (for example, a hydraulic braking device of a self-propelled mobile machine), the machine shall be equipped with a means of slowing and stopping in case of failure of the main braking system.</p>	P	
6.2.11.4	Restart after power interruption		
	If a hazard could be generated, the spontaneous restart of a machine when it is re-energized	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	after power interruption shall be prevented (for example, by use of a self-maintained relay, contactor or valve).		
6.2.11.5	Interruption of power supply		
	<p>Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met:</p> <ul style="list-style-type: none"> —the stopping function of the machinery shall remain; —all devices whose permanent operation is required for safety shall operate in an effective way to maintain safety (for example, locking, clamping devices, cooling or heating devices, power-assisted steering of self-propelled mobile machinery); —parts of machinery or workpieces and/or loads held by machinery which are liable to move as a result of potential energy shall be retained for the time necessary to allow them to be safely lowered. 	P	
6.2.11.6	Use of automatic monitoring		
	<p>Automatic monitoring is intended to ensure that a safety function or functions implemented by a protective measure do not fail to be performed if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed such that hazards are generated.</p> <p>Automatic monitoring either detects a fault immediately or carries out periodic checks so that a fault is detected before the next demand upon the safety function. In either case, the protective measure can be initiated immediately or delayed until a specific event occurs (for example, the beginning of the machine cycle).</p> <p>The protective measure may be, for example,</p> <ul style="list-style-type: none"> —the stopping of the hazardous process, —preventing the restart of this process after the first stop following the failure, or —the triggering of an alarm. 	N/A	
6.2.11.7 Safety functions implemented by programmable electronic control systems			
6.2.11.7.1	General		
	<p>A control system that includes programmable electronic equipment (for example, programmable controllers) can, where appropriate, be used to implement safety functions at machinery. Where a programmable electronic control system is used, it is necessary to consider its performance requirements in relation to the requirements for the safety functions. The design of the programmable electronic control system shall be such that the probability of random hardware failures and the likelihood of systematic failures that can adversely affect the performance of the safety-related control function(s) is sufficiently low. Where a programmable electronic control system performs a monitoring function, the system behavior on detection of a fault shall be considered (see also the IEC 61508 series for further guidance).</p> <p>NOTE Both ISO 13849-1 and IEC 62061, specific to machinery safety, provide guidance applicable to programmable electronic control systems.</p> <p>The programmable electronic control system should be installed and validated to ensure that the specified performance [for example, safety integrity level (SIL) in IEC 61508] for each safety function has been achieved. Validation comprises testing and analysis (for example, static, dynamic or failure analysis) to show that all parts interact correctly to perform the safety function and that unintended functions do not occur.</p>	P	
6.2.11.7.2	Hardware aspects		
	<p>The hardware (including, for example, sensors, actuators and logic solvers) shall be selected, and/or designed and installed, to meet both the functional and performance requirements of the safety function(s) to be performed, in particular, by means of</p> <ul style="list-style-type: none"> —architectural constraints (the configuration of the system, its ability to tolerate faults, its behavior on detection of a fault, etc.), —selection, and/or design, of equipment and devices with an appropriate probability of dangerous random hardware failure, and —the incorporation of measures and techniques within the hardware so as to avoid systematic failures and control systematic faults. 	P	
6.2.11.7.3	Software aspects		
	<p>The software, including internal operating software (or system software) and application software, shall be designed so as to satisfy the performance specification for the safety functions (see also IEC 61508-3).</p> <p>Application software should not be reprogrammable by the user. This may be achieved by use of embedded software in a non-reprogrammable memory [for example, micro-controller, application-specific integrated circuit (ASIC)].</p> <p>When the application requires reprogramming by the user, the access to the software dealing with safety functions should be restricted (for example, by locks or passwords for the authorized persons).</p>	N/A	
6.2.11.8	Principles relating to manual control		
	These are as follows.	N/A	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>a) Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8, item f).</p> <p>b) A stop control device shall be placed near each start control device. Where the start/stop function is performed by means of a hold-to-run control, a separate stop control device shall be provided when a risk can result from the hold-to-run control device failing to deliver a stop command when released.</p> <p>c) Manual controls shall be located out of reach of the danger zones (see IEC 61310-3), except for certain controls where, of necessity, they are located within a danger zone, such as emergency stop or teach pendant.</p> <p>d) Whenever possible, control devices and control positions shall be located so that the operator is able to observe the working area or hazard zone.</p> <p>1) The driver of a ride-on mobile machine shall be able to actuate all control devices required to operate the machine from the driving position, except for functions which can be controlled more safely from other positions.</p> <p>2) On machinery intended for lifting persons, controls for lifting and lowering and, if appropriate, for moving the carrier shall generally be located in the carrier. If safe operation requires controls to be situated outside the carrier, the operator in the carrier shall be provided with the means of preventing hazardous movements.</p> <p>e) If it is possible to start the same hazardous element by means of several controls, the control circuit shall be so arranged that only one control is effective at a given time. This applies especially to machines which can be manually controlled by means of, among others, a portable control unit (such as a teach pendant), with which the operator can enter danger zones.</p> <p>f) Control actuators shall be designed or guarded so that their effect, where a risk is involved, cannot occur without intentional operation (see ISO 9355-1, ISO 9355-3 and ISO 447).</p> <p>g) For machine functions whose safe operation depends on permanent, direct control by the operator, measures shall be implemented to ensure the presence of the operator at the control position (for example, by the design and location of control devices).</p> <p>h) For cableless control, an automatic stop shall be performed when correct control signals are not received, including loss of communication (see IEC 60204-1).</p>		
6.2.11.9	Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance		
	<p>Where, for setting, teaching, process changeover, fault-finding, cleaning or maintenance of machinery, a guard has to be displaced or removed and/or a protective device has to be disabled, and where it is necessary for the purpose of these operations for the machinery or part of the machinery to be put into operation, the safety of the operator shall be achieved using a specific control mode which simultaneously</p> <p>a) disables all other control modes,</p> <p>b) permits operation of the hazardous elements only by continuous actuation of an enabling device, a two-hand control device or a hold-to-run control device,</p> <p>c) permits operation of the hazardous elements only in reduced risk conditions (for example, reduced speed, reduced power/force, step-by-step, for example, with a limited movement control device), and</p> <p>d) prevents any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.</p> <p>NOTE For some special machinery other protective measures can be appropriate. This control mode shall be associated with one or more of the following measures:</p> <p>—restriction of access to the danger zone as far as possible;</p> <p>—emergency stop control within immediate reach of the operator;</p> <p>—portable control unit (teach pendant) and/or local controls (allowing sight of the controlled elements).</p> <p>See IEC 60204-1.</p>	N/A	
6.2.11.10	Selection of control and operating modes		
	<p>If machinery has been designed and built to allow for its use in several control or operating modes requiring different protective measures and/or work procedures (for example, to allow for adjustment, setting, maintenance, inspection), it shall be fitted with a mode selector which can be locked in each position. Each position of the selector shall be clearly identifiable and shall exclusively allow one control or operating mode.</p> <p>The selector may be replaced by another selection means which restricts the use of certain functions of the machinery to certain categories of operators (for example, access codes for certain numerically controlled functions).</p>	P	
6.2.11.11	Applying measures to achieve electromagnetic compatibility (EMC)		
	For guidance on electromagnetic compatibility, see IEC 60204-1 and IEC 61000-6.	P	
6.2.11.12	Provision of diagnostic systems to aid fault-finding		
	<p>Diagnostic systems to aid fault-finding should be included in the control system so that there is no need to disable any protective measure.</p> <p>NOTE Such systems not only improve availability and maintainability of machinery, they also reduce the exposure of maintenance staff to hazards.</p>	N/A	
6.2.12 Minimizing probability of failure of safety functions			

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
6.2.12.1	General		
	Safety of machinery is not only dependent on the reliability of the control systems but also on the reliability of all parts of the machine. The continued operation of the safety functions is essential for the safe use of the machine. This can be achieved by the measures given in 6.2.12.2 to 6.2.12.4.	P	
6.2.12.2	Use of reliable components		
	“Reliable components” means components which are capable of withstanding all disturbances and stresses associated with the usage of the equipment in the conditions of intended use (including the environmental conditions), for the period of time or the number of operations fixed for the use, with a low probability of failures generating a hazardous malfunctioning of the machine. Components shall be selected taking into account all factors mentioned above (see also 6.2.13). NOTE 1 “Reliable components” is not a synonym for “well-tried components” (see ISO 13849-1:2006, 6.2.4). NOTE 2 Environmental conditions for consideration include impact, vibration, cold, heat, moisture, dust, corrosive and/or abrasive substances, static electricity and magnetic and electric fields. Disturbances which can be generated by those conditions include insulation failures and temporary or permanent failures in the function of control system components.	P	
6.2.12.3	Use of “oriented failure mode” components		
	“Oriented failure mode” components or systems are those in which the predominant failure mode is known in advance and which can be used so that the effect of such a failure on the machine function can be predicted. NOTE In some cases, it will be necessary to take additional measures to limit the negative effects of such a failure. The use of such components should always be considered, particularly in cases where redundancy (see 6.2.12.4) is not employed.	N/A	
6.2.12.4	Duplication (or redundancy) of components or subsystems		
	In the design of safety-related parts of the machine, duplication (or redundancy) of components may be used so that, if one component fails, another component or components continue to perform the respective function(s), thereby ensuring that the safety function remains available. In order to allow the proper action to be initiated, component failure shall be detected by automatic monitoring (see 6.2.11.6) or in some circumstances by regular inspection, provided that the inspection interval is shorter than the expected lifetime of the components. Diversity of design and/or technology can be used to avoid common cause failures (for example, from electromagnetic disturbance) or common mode failures.	N/A	
6.2.13	Limiting exposure to hazards through reliability of equipment		
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring intervention, thereby reducing exposure to hazards. This applies to power systems (operative part, see Annex A) as well as to control systems, and to safety functions as well as to other functions of machinery. Safety-related components (for example, certain sensors) of known reliability shall be used. The elements of guards and of protective devices shall be especially reliable, as their failure can expose persons to hazards, and also because poor reliability would encourage attempts to defeat them.	P	
6.2.14	Limiting exposure to hazards through mechanization or automation of loading (feeding)/unloading (removal) operations		
	Mechanization and automation of machine loading/unloading operations and, more generally, of handling operations — of workpieces, materials or substances — limits the risk generated by these operations by reducing the exposure of persons to hazards at the operating points. Automation can be achieved by, for example, robots, handling devices, transfer mechanisms and air-blast equipment. Mechanization can be achieved by, for example, feeding slides, push-rods and hand-operated indexing tables. While automatic feeding and removal devices have much to offer in preventing accidents to machine operators, they can create danger when any faults are being corrected. Care shall be taken to ensure that the use of these devices does not introduce further hazards, such as trapping or crushing, between the devices and parts of the machine or workpieces/materials being processed. Suitable safeguards (see 6.3) shall be provided if this cannot be ensured. Automatic feeding and removal devices with their own control systems and the control system of the associated machine shall be interconnected after thorough study of how all safety functions are performed in all the control and operation modes of the entire equipment.	P	
6.2.15	Limiting exposure to hazards through location of setting and maintenance points outside danger zones		
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones.	P	
6.3 Safeguarding and complementary protective measures			
6.3.1	General		
	Guards and protective devices shall be used to protect persons whenever an inherently safe design measure does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (for example, emergency stop equipment) may have to be implemented. NOTE The different kinds of guards and protective devices are defined in 3.27 and 3.28.	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	Certain safeguards may be used to avoid exposure to more than one hazard. EXAMPLE A fixed guard preventing access to a zone where a mechanical hazard is present used to reduce noise levels and collect toxic emissions.		
6.3.2 Selection and implementation of guards and protective devices			
6.3.2.1	General		
	<p>This subclause gives guidelines for the selection and the implementation of guards and protective devices the primary purpose of which is to protect persons against hazards generated by moving parts, according to the nature of those parts (see Figure 4) and to the need for access to the danger zone(s).</p> <p>The exact choice of a safeguard for a particular machine shall be made on the basis of the risk assessment for that machine.</p> <p>In selecting an appropriate safeguard for a particular type of machinery or hazard zone, it shall be borne in mind that a fixed guard is simple and shall be used where the access of an operator into a danger zone is not required during the normal operation (operation without malfunction) of the machinery.</p> <p>As the need for frequency of access increases, this inevitably leads to the fixed guard not being replaced. This requires the use of an alternative protective measure (movable interlocking guard, sensitive protective equipment).</p> <p>A combination of safeguards can sometimes be required. For example, where, in conjunction with a fixed guard, a mechanical loading (feeding) device is used to feed a workpiece into a machine, thereby removing the need for access to the primary hazard zone, a trip device can be required to protect against the secondary drawing-in or shearing hazard between the mechanical loading (feeding) device, when reachable, and the fixed guard.</p> <p>Consideration shall be given to the enclosure of control positions or intervention zones to provide combined protection against several hazards including</p> <ul style="list-style-type: none"> a) hazards from falling or ejected objects, using, for example, protection in the form of a falling object protection structure (FOPS), b) emission hazards (protection against noise, vibration, radiation, substances hazardous to health, etc.), c) hazards due to the environment (protection against heat, cold, foul weather, etc.), d) hazards due to tipping over or rolling over of machinery, using, for example, protection in the form of roll-over or tip-over protection structures (ROPS and TOPS). <p>The design of enclosed work stations, such as cabs and cabins, shall take into account ergonomic principles concerning visibility, lighting, atmospheric conditions, access, posture.</p>	P	
6.3.2.2	Where access to the hazard zone is not required during normal operation		
	<p>Where access to the hazard zone is not required during normal operation of the machinery, safeguards should be selected from the following:</p> <ul style="list-style-type: none"> a) fixed guards (see also ISO 14120); b) interlocking guards with or without guard locking (see also 6.3.3.2.3, ISO 14119 and ISO 14120); c) self-closing guards (see ISO 14120:2002, 3.3.2); d) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496) or pressure-sensitive protective devices (see ISO 13856). 	P	
6.3.2.3	Where access to the hazard zone is required during normal operation		
	<p>Where access to the hazard zone is required during normal operation of the machinery, safeguards should be selected from the following:</p> <ul style="list-style-type: none"> a) interlocking guards with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this document); b) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496); c) adjustable guards; d) self-closing guards (see ISO 14120:2002, 3.3.2); e) two-hand control devices (see ISO 13851); f) interlocking guards with a start function (control guard) (see 6.3.3.2.5). 	P	
6.3.2.4	Where access to the hazard zone is required for machine setting, teaching, process changeover, fault-finding, cleaning or maintenance		
	<p>production operator also ensure the protection of personnel carrying out setting, teaching, process changeover, fault-finding, cleaning or maintenance, without hindering them in the performance of their task.</p> <p>Such tasks shall be identified and considered in the risk assessment as parts of the use of the machine (see 5.2).</p> <p>NOTE Isolation and energy dissipation for machine shut-down (see 6.3.5.4, and also ISO 14118:2000, 4.1 and Clause 5) ensure the highest level of safety when carrying out tasks (especially maintenance and repair tasks) that do not require the machine to remain connected to its power supply.</p>	P	
6.3.2.5 Selection and implementation of sensitive protective equipment¹⁾			
6.3.2.5.1 Selection	Due to the great diversity of the technologies on which their detection function is based, all types of sensitive protective equipment are far from being equally suitable for safety applications. The following provisions are intended to provide the designer with criteria for	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>selecting, for each application, the most suitable device(s). Types of sensitive protective equipment include</p> <ul style="list-style-type: none"> —light curtains, —scanning devices, for example, laser scanners, —pressure-sensitive mats, and —trip bars, trip wires. <p>Sensitive protective equipment can be used</p> <ul style="list-style-type: none"> —for tripping purposes, —for presence sensing, —for both tripping and presence sensing, or —to re-initiate machine operation — a practice subject to stringent conditions. <p>NOTE Some types of sensitive protective equipment can be unsuitable either for presence sensing or for tripping purposes. The following characteristics of the machinery, among others, can preclude the sole use of sensitive protective equipment:</p> <ul style="list-style-type: none"> —tendency for the machinery to eject materials or component parts; —necessity to guard against emissions (noise, radiation, dust, etc.); —erratic or excessive machine stopping time; —inability of a machine to stop part-way through a cycle. 		
6.3.2.5.2	Implementation		
	<p>Consideration should be given to</p> <ol style="list-style-type: none"> a) the size, characteristics and positioning of the detection zone (see ISO 13855, which deals with the positioning of some types of sensitive protective equipment), b) the reaction of the device to fault conditions (see IEC 61496 for electrosensitive protective equipment), c) the possibility of circumvention, and d) detection capability and its variation over the course of time (as a result, for example, of its susceptibility to different environmental conditions such as the presence of reflecting surfaces, other artificial light sources and sunlight or impurities in the air). <p>NOTE 1 IEC 61496 defines the detection capability of electrosensitive protective equipment. Sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that</p> <ul style="list-style-type: none"> —a command is given as soon as a person or part of a person is detected, —the withdrawal of the person or part of a person detected does not, by itself, restart the hazardous machine function(s), and therefore the command given by the sensitive protective equipment is maintained by the control system until a new command is given, —restarting the hazardous machine function(s) results from the voluntary actuation by the operator of a control device placed outside the hazard zone, where this zone can be observed by the operator, —the machine cannot operate during interruption of the detection function of the sensitive protective equipment, except during muting phases, and —the position and the shape of the detection field prevents, possibly together with fixed guards, a person or part of a person from entering or being present in the hazard zone without being detected. <p>NOTE 2 Muting is the temporary automatic suspension of a safety function(s) by safety-related parts of the control system (see ISO 13849-1). For detailed consideration of the fault behaviour of, for example, active optoelectronic protective devices, IEC 61496 should be taken into account.</p>	P	
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation		
	<p>In this exceptional application, the starting of the machine cycle is initiated by the withdrawal of a person or of the detected part of a person from the sensing field of the sensitive protective equipment, without any additional start command, hence deviating from the general requirement given in the second point of the dashed list in 6.3.2.5.2, above. After switching on the power supply, or when the machine has been stopped by the tripping function of the sensitive protective equipment, the machine cycle shall be initiated only by voluntary actuation of a start control.</p> <p>Cycle initiation by sensitive protective equipment shall be subject to the following conditions:</p> <ol style="list-style-type: none"> a) only active optoelectronic protective devices (AOPDs) complying with IEC 61496 series shall be used; b) the requirements for an AOPD used as a tripping and presence-sensing device (see IEC 61496) are satisfied — in particular, location, minimum distance (see ISO 13855), detection capability, reliability and monitoring of control and braking systems; 	P	

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	<p>c) the cycle time of the machine is short and the facility to re-initiate the machine upon clearing of the sensing field is limited to a period commensurate with a single normal cycle;</p> <p>d) entering the sensing field of the AOPD(s) or opening interlocking guards is the only way to enter the hazard zone;</p> <p>e) if there is more than one AOPD safeguarding the machine, only one of the AOPDs is capable of cycle re-initiation;</p> <p>f) with regard to the higher risk resulting from automatic cycle initiation, the AOPD and the associated control system comply with a higher safety-related performance than under normal conditions.</p> <p>NOTE 1 The hazard zone as referred to in d) is any zone where the hazardous function (including ancillary equipment and transmission elements) is initiated by clearing of the sensing field.</p> <p>NOTE 2 See also IEC/TS 62046.</p>		
6.3.2.6	Protective measures for stability		
	<p>If stability cannot be achieved by inherently safe design measures such as weight distribution (see 6.2.6), it shall be maintained by the use of protective measures such as</p> <ul style="list-style-type: none"> —anchorage bolts, —locking devices, —movement limiters or mechanical stops, —acceleration or deceleration limiters, —load limiters, and —alarms warning of the approach to stability or tipping limits. 	P	
6.3.2.7	Other protective devices		
	<p>error of the operator can generate a hazardous situation, this machine shall be equipped with the necessary devices to enable the operation to remain within specified limits, in particular</p> <ul style="list-style-type: none"> —when the operator has insufficient visibility of the hazard zone, —when the operator lacks knowledge of the actual value of a safety-related parameter (distance, speed, mass, angle, etc.), and — when hazards can result from operations other than those controlled by the operator. <p>The necessary devices include</p> <ul style="list-style-type: none"> a) devices for limiting parameters of movement (distance, angle, velocity, acceleration), b) overloading and moment limiting devices, c) devices to prevent collisions or interference with other machines, d) devices for preventing hazards to pedestrian operators of mobile machinery or other pedestrians, e) torque limiting devices, and breakage points to prevent excessive stress of components and assemblies, f) devices for limiting pressure or temperature, g) devices for monitoring emissions, h) devices to prevent operation in the absence of the operator at the control position, i) devices to prevent lifting operations unless stabilizers are in place, j) devices to limit inclination of the machine on a slope, and k) devices to ensure that components are in a safe position before travelling. <p>Automatic protective measures triggered by such devices that take operation of the machinery out of the control of the operator (for example, automatic stop of hazardous movement) should be preceded or accompanied by a warning signal to enable the operator to take appropriate action (see 6.4.3).</p>	P	
6.3.3 Requirements for design of guards and protective devices			
6.3.3.1	General requirements		
	<p>Guards and protective devices shall be designed to be suitable for the intended use, taking into account mechanical and other hazards involved. Guards and protective devices shall be compatible with the working environment of the machine and designed so that they cannot be easily defeated. They shall provide the minimum possible interference with activities during operation and other phases of machine life, in order to reduce any incentive to defeat them.</p> <p>NOTE For additional information, see ISO 14120, ISO 13849-1, ISO 13851, ISO 14119, ISO 13856, IEC 61496 and IEC 62061.</p> <p>Guards and protective devices shall</p> <ul style="list-style-type: none"> a) be of robust construction, b) not give rise to any additional hazard, c) not be easy to bypass or render non-operational, d) be located at an adequate distance from the danger zone (see ISO 13855 and ISO 13857), e) cause minimum obstruction to the view of the production process, and f) enable essential work to be carried out for the installation and/or replacement of tools and for maintenance by allowing access only to the area where the work has to be carried out — if possible, without the guard having to be removed or protective device 	P	

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	having to be disabled. For openings in the guards, see ISO 13857.		
6.3.3.2 Requirements for guards			
6.3.3.2.1	Functions of guards		
	The functions that guards can achieve are —prevention of access to the space enclosed by the guard, and/or —containment/capture of materials, workpieces, chips, liquids which can be ejected or dropped by the machine, and reduction of emissions (noise, radiation, hazardous substances such as dust, fumes, gases) that can be generated by the machine. Additionally, they could need to have particular properties relating to electricity, temperature, fire, explosion, vibration, visibility (see ISO 14120) and operator position ergonomics (for example, usability, operator's movements, postures, repetitive movements).	P	
6.3.3.2.2	Requirements for fixed guards		
	Fixed guards shall be securely held in place either —permanently (for example by welding), or —by means of fasteners (screws, nuts) making removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120). NOTE A fixed guard can be hinged to assist in its opening.	P	
6.3.3.2.3	Requirements for movable guards		
	Movable guards which provide protection against hazards generated by moving transmission parts shall a) as far as possible when open remain fixed to the machinery or other structure (generally by means of hinges or guides), and b) be interlocking (with guard locking when necessary) (see ISO 14119). See Figure 4. Movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that —moving parts cannot start up while they are within the operator's reach and the operator cannot reach moving parts once they have started up, with this able to be achieved by interlocking guards, with guard locking when necessary, —they can be adjusted only by an intentional action, such as the use of a tool or a key, and —the absence or failure of one of their components either prevents starting of the moving parts or stops them, with this able to be achieved by automatic monitoring (see 6.2.11.6). See Figure 4 and ISO 14119.	P	
6.3.3.2.4	Requirements for adjustable guards		
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed. Manually adjustable guards shall be —designed so that the adjustment remains fixed during a given operation, and —readily adjustable without the use of tools.	P	
6.3.3.2.5	Requirements for interlocking guards with a start function (control guards)		
	An interlocking guard with a start function may only be used provided that a) all requirements for interlocking guards are satisfied (see ISO 14119), b) the cycle time of the machine is short, c) the maximum opening time of the guard is preset to a low value (for example, equal to the cycle time) and, when this time is exceeded, the hazardous function(s) cannot be initiated by the closing of the interlocking guard with a start function and resetting is necessary before restarting the machine, d) the dimensions or shape of the machine do not allow a person, or part of a person, to stay in the hazard zone or between the hazard zone and the guard while the guard is closed (see ISO 14120), e) all other guards, whether fixed (removable type) or movable, are interlocking guards, f) the interlocking device associated with the interlocking guard with a start function is designed such that —for example, by duplication of position detectors and use of automatic monitoring (see 6.2.11.6) — its failure cannot lead to an unintended/unexpected start-up, and g) the guard is securely held open (for example, by a spring or counterweight) such that it cannot initiate a start while falling by its own weight.	P	
6.3.3.2.6	Hazards from guards		
	Care shall be taken to prevent hazards which could be generated by —the guard construction (sharp edges or corners, material, noise emission, etc.), —the movements of the guards (shearing or crushing zones generated by power-operated guards and by heavy guards which are liable to fall).	P	
6.3.3.3	Technical characteristics of protective devices		
	Protective devices shall be selected or designed and connected to the control system such that correct implementation of their safety function(s) is ensured. Protective devices shall be selected on the basis of their having met the appropriate product standard (for example, IEC 61496 for active optoelectronic protective devices) or shall be designed according to one or several of the principles formulated in ISO 13849-1 or IEC 62061. Protective devices shall be installed and connected to the control system so that they cannot be	P	

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	easily defeated.		
6.3.3.4	Provisions for alternative types of safeguards		
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it is known that it will be necessary to change the safeguards because of the range of work to be carried out.	P	
6.3.4	Safeguarding to reduce emissions		
6.3.4.1	General		
	If the measures for the reduction of emissions at source specified in 6.2.2.2 are not adequate, the machine shall be provided with additional protective measures (see 6.3.4.2 to 6.3.4.5).	P	
6.3.4.2	Noise		
	Additional protective measures against noise include —enclosures (see ISO 15667), —screens fitted to the machine, and —silencers (see ISO 14163).	P	91.4dB(A)
6.3.4.3	Vibration		
	Additional protective measures against vibration include —vibration isolators, such as damping devices placed between the source and the exposed person, —resilient mounting, and —suspended seats. For measures for vibration isolation of stationary industrial machinery see EN 1299.	N/A	
6.3.4.4	Hazardous substances		
	Additional protective measures against hazardous substances include —encapsulation of the machine (enclosure with negative pressure), —local exhaust ventilation with filtration, —wetting with liquids, and —special ventilation in the area of the machine (air curtains, cabins for operators). See ISO 14123-1.	NE	
6.3.4.5	Radiation		
	Additional protective measures against radiation include —use of filtering and absorption, and —use of attenuating screens or guards.	N/A	
6.3.5	Complementary protective measures		
6.3.5.1	General		
	Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use, could have to be implemented as required by the intended use and the reasonably foreseeable misuse of the machine. Such measures include, but are not limited to, those dealt with in 6.3.5.2 to 6.3.5.6.	P	
6.3.5.2	Components and elements to achieve emergency stop function		
	If, following a risk assessment, a machine needs to be fitted with components and elements to achieve an emergency stop function for enabling actual or impending emergency situations to be averted, the following requirements apply: —the actuators shall be clearly identifiable, clearly visible and readily accessible; —the hazardous process shall be stopped as quickly as possible without creating additional hazards, but if this is not possible or the risk cannot be reduced, it should be questioned whether implementation of an emergency stop function is the best solution; —the emergency stop control shall trigger or permit the triggering of certain safeguard movements where necessary. NOTE For more detailed provisions, see ISO 13850. Once active operation of the emergency stop device has ceased following an emergency stop command, the effect of this command shall be sustained until it is reset. This reset shall be possible only at the location where the emergency stop command has been initiated. The reset of the device shall not restart the machinery, but shall only permit restarting. More details for the design and selection of electrical components and elements to achieve the emergency stop function are provided in IEC 60204.	P	
6.3.5.3	Measures for the escape and rescue of trapped persons		
	Measures for the escape and rescue of trapped persons may consist, among others, of —escape routes and shelters in installations generating operator-trapping hazards, —arrangements for moving some elements by hand, after an emergency stop, —arrangements for reversing the movement of some elements, —anchorage points for descender devices, —means of communication to enable trapped operators to call for help.	P	
6.3.5.4	Measures for isolation and energy dissipation		
	Machines shall be equipped with the technical means to achieve isolation from power supply(ies) and dissipation of stored energy by means of the following actions: a) isolating (disconnecting, separating) the machine (or defined parts of the machine) from all power supplies; b) locking (or otherwise securing) all the isolating units in the isolating position; c) dissipating or, if this is not possible or practicable, restraining (containing) any stored energy	P	

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	<p>which can give rise to a hazard;</p> <p>d) verifying, by means of safe working procedures, that the actions taken according to a), b) and c) above have produced the desired effect.</p> <p>See ISO 14118:2000, Clause 5, and IEC 60204-1:2005, 5.5 and 5.6.</p>		
6.3.5.5	Provisions for easy and safe handling of machines and their heavy component parts		
	<p>Machines and their component parts which cannot be moved or transported by hand shall be provided or be capable of being provided with suitable attachment devices for transport by means of lifting gear.</p> <p>These attachments may be, among others,</p> <ul style="list-style-type: none"> —standardized lifting appliances with slings, hooks, eyebolts, or tapped holes for appliance fixing, —appliances for automatic grabbing with a lifting hook when attachment is not possible from the ground, —fork locating devices for machines to be transported by a lift truck, —lifting and stowing gear and appliances integrated into the machine. <p>Parts of machinery which can be removed manually in operation shall be provided with means for their safe removal and replacement.</p> <p>See also 6.4.4 c), item 3).</p>	P	
6.3.5.6	Measures for safe access to machinery		
	<p>Machinery shall be so designed as to enable operation and all routine tasks relating to setting and/or maintenance to be carried out as far as possible by a person remaining at ground level. Where this is not possible, machines shall have built-in platforms, stairs or other facilities to provide safe access for those tasks; however, care should be taken to ensure that such platforms or stairs do not give access to danger zones of machinery.</p> <p>The walking areas shall be made from materials which remain as slip resistant as practicable under working conditions and, depending on the height from the ground, shall be provided with suitable guard-rails (see ISO 14122-3).</p> <p>In large automated installations, particular attention shall be given to safe means of access, such as walkways, conveyor bridges or crossover points.</p> <p>Means of access to parts of machinery located at height shall be provided with collective means of protection against falls (for example, guard-rails for stairways, stepladders and platforms and/or safety cages for ladders).</p> <p>As necessary, anchorage points for personal protective equipment against falls from height shall also be provided (for example, in carriers of machinery for lifting persons or with elevating control stations).</p> <p>Openings shall, whenever possible, open towards a safe position. They shall be designed to prevent hazards due to unintended opening.</p> <p>The necessary aids for access shall be provided (steps, handholds, etc.). Control devices shall be designed and located to prevent their being used as aids for access.</p> <p>When machinery for lifting goods and/or persons includes landings at fixed levels, these shall be equipped with interlocking guards for preventing falls when the platform is not present at a level. Movement of the lifting platform shall be prevented while the guards are open.</p> <p>For detailed provisions see ISO 14122.</p>	P	
6.4 Information for use			
6.4.1	General requirements		
6.4.1.1	<p>Drafting information for use is an integral part of the design of a machine (see Figure 2). Information for use consists of communication links, such as texts, words, signs, signals, symbols or diagrams, used separately or in combination to convey information to the user. Information for use is intended for professional and/or non-professional users.</p> <p>NOTE See also IEC 62079 for structuring and presentation of information for use.</p>	P	
6.4.1.2	<p>Information shall be provided to the user about the intended use of the machine, taking into account, notably, all its operating modes.</p> <p>The information shall contain all directions required to ensure safe and correct use of the machine. With this in view, it shall inform and warn the user about residual risk.</p> <p>The information shall indicate, as appropriate,</p> <ul style="list-style-type: none"> —the need for training, —the need for personal protective equipment, and —the possible need for additional guards or protective devices (see Figure 2, Footnote d). <p>It shall not exclude uses of the machine that can reasonably be expected from its designation and description and shall also warn about the risk which would result from using the machine in other ways than the ones described in the information, especially considering its reasonably foreseeable misuse.</p>	P	
6.4.1.3	<p>Information for use shall cover, separately or in combination, transport, assembly and installation, commissioning, use of the machine (setting, teaching/programming or process changeover, operation, cleaning, fault-finding and maintenance) and, if necessary, dismantling, disabling and scrapping.</p>	P	
6.4.2	Location and nature of information for use		
	<p>Depending on the risk, the time when the information is needed by the user and the machine design, it shall be decided whether the information — or parts thereof — are to be given</p> <p>a) in/on the machine itself (see 6.4.3 and 6.4.4),</p>	P	

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	b) in accompanying documents (in particular instruction handbook, see 6.4.5), c) on the packaging, d) by other means such as signals and warnings outside the machine. Standardized phrases shall be considered where important messages such as warnings are given (see also IEC 62079).		
6.4.3	Signals and warning devices		
	Visual signals, such as flashing lights and audible signals such as sirens may be used to warn of an impending hazardous event such as machine start-up or overspeed. Such signals may also be used to warn the operator before the triggering of automatic protective measures (see 6.3.2.7). It is essential that these signals a) be emitted before the occurrence of the hazardous event, b) be unambiguous, c) be clearly perceived and differentiated from all other signals used, and d) be clearly recognized by the operator and other persons. The warning devices shall be designed and located such that checking is easy. The information for use shall prescribe regular checking of warning devices. The attention of designers is drawn to the possibility of “sensorial saturation”, which can result from too many visual and/or acoustic signals and which can also lead to defeating the warning devices. NOTE Consultation of the user on this subject is often necessary.	P	
6.4.4	Markings, signs (pictograms) and written warnings		
	Machinery shall bear all markings which are necessary a) for its unambiguous identification, including at least 1) the name and address of the manufacturer, 2) the designation of series or type, and 3) the serial number, if any, b) in order to indicate its compliance with mandatory requirements, comprising 1) marking, and 2) written indications, such as the authorized representative of the manufacturer, designation of the machinery, year of construction, and intended use in potentially explosive atmospheres), c) for its safe use, for example, 1) maximum speed of rotating parts, 2) maximum diameter of tools, 3) mass (in kilograms) of the machine itself and/or of removable parts, 4) maximum working load, 5) necessity of wearing personal protective equipment, 6) guard adjustment data, and 7) frequency of inspection. Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine. Signs or written warnings indicating only “Danger” shall not be used. Markings, signs and written warnings shall be readily understandable and unambiguous, especially as regards the part of the function(s) of the machine to which they are related. Readily understandable signs (pictograms) should be used in preference to written warnings. Signs and pictograms should only be used if they are understood in the culture in which the machinery is to be Used. Written warnings shall be drawn up in the language(s) of the country in which the machine will be used for the first time and, on request, in the language(s) understood by operators. NOTE In some countries the use of specific language(s) is covered by legal requirements. Markings shall comply with recognized standards (for example, ISO 2972 or ISO 7000, for pictograms, symbols and colors in particular). See IEC 60204-1 as regards marking of electrical equipment. See ISO 4413 and ISO 4414 for hydraulic and pneumatic equipment.	P	
6.4.5	Accompanying documents (in particular — instruction handbook)		
6.4.5.1	Contents		
	The instruction handbook or other written instructions (for example, on the packaging) shall contain, among others, the following: a) information relating to transport, handling and storage of the machine, such as 1) storage conditions for the machine, 2) dimensions, mass value(s), position of the centre(s) of gravity, and 3) indications for handling (for example, drawings indicating application points for lifting equipment); b) information relating to installation and commissioning of the machine, such as 1) fixing/anchoring and dampening of noise and vibration requirements, 2) assembly and mounting conditions, 3) space needed for use and maintenance, 4) permissible environmental conditions (for example, temperature, moisture, vibration, electromagnetic radiation), 5) instructions for connecting the machine to power supply (particularly on protection against electrical overloading),	P	

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	6) advice on waste removal/disposal, and 7) if necessary, recommendations related to protective measures which have to be implemented by the user — for example, additional safeguards (see Figure 2, Footnote d), safety distances, safety signs and signals; c) information relating to the machine itself, such as 1) detailed description of the machine, its fittings, guards and/or protective devices, 2) the comprehensive range of applications for which the machine is intended, including prohibited usages, if any, taking into account variations of the original machine if appropriate, 3) diagrams (especially schematic representation of safety functions), 4) data on noise and vibration generated by the machine, and on radiation, gases, vapours and dust emitted by it, with reference to the measuring methods (including measurement uncertainties) used, 5) technical documentation of electrical equipment (see IEC 60204), and 6) documents attesting that the machine complies with mandatory requirements; d) information relating to the use of the machine, such as that related to or describing 1) intended use, 2) manual controls (actuators), 3) setting and adjustment, 4) modes and means for stopping (especially emergency stop), 5) risks which could not be eliminated by the protective measures implemented by the designer, 6) particular risks which can be generated by certain applications, by the use of certain fittings, and about specific safeguards necessary for such applications, 7) reasonably foreseeable misuse and prohibited applications, 8) fault identification and location, for repair and for restarting after an intervention, and 9) personal protective equipment needed to be used and the training that is required; e) information for maintenance, such as 1) the nature and frequency of inspections for safety functions, 2) specification of the spare parts to be used when these can affect the health and safety of operators, 3) instructions relating to maintenance operations which require a definite technical knowledge or particular skills and hence need to be carried out exclusively by skilled persons (for example, maintenance staff, specialists), 4) instructions relating to maintenance actions (replacement of parts, etc.) which do not require specific skills and hence may be carried out by users (for example, operators), and 5) drawings and diagrams enabling maintenance personnel to carry out their task rationally (especially fault-finding tasks); f) information relating to dismantling, disabling and scrapping; g) information for emergency situations, such as 1) the operating method to be followed in the event of accident or breakdown, 2) the type of fire-fighting equipment to be used, and 3) a warning of possible emission or leakage of hazardous substance(s) and, if possible, an indication of means for fighting their effects; h) maintenance instructions provided for skilled persons [item e) 3) above] and maintenance instructions provided for unskilled persons [item e) 4) above], that need to appear clearly separated from each other.		
6.4.5.2	Production of instruction handbook		
	The following applies to the production and presentation of the instruction handbook. a) The type font and size of print shall ensure the best possible legibility. Safety warnings and/or cautions should be emphasized by the use of colors, symbols and/or large print. b) The information for use shall be given in the language(s) of the country in which the machine will be used for the first time and in the original version. If more than one language is to be used, each should be readily distinguished from another, and efforts should be made to keep the translated text and relevant illustration together. NOTE In some countries the use of specific language(s) is covered by legal requirements. c) Whenever helpful to the understanding, text should be supported by illustrations. These illustrations should be supplemented with written details enabling, for example, manual controls (actuators) to be located and identified. They should not be separated from the accompanying text and should follow sequential operations. d) Consideration should be given to presenting information in tabular form where this will aid understanding. Tables should be adjacent to the relevant text. e) The use of colors should be considered, particularly in relation to components requiring quick identification. f) When information for use is lengthy, a table of contents and/or an index should be provided. g) Safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.	P	
6.4.5.3	Drafting and editing information for use		
	The following applies to the drafting and editing of information for use.	P	

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	<p>a) Relationship to model: the information shall clearly relate to the specific model of machine and, if necessary, other appropriate identification (for example, by serial number).</p> <p>b) Communication principles: when information for use is being prepared, the communication process “see – think – use” should be followed in order to achieve the maximum effect and should follow sequential operations. The questions, “How?” and “Why?” should be anticipated and the answers provided.</p> <p>c) Information for use shall be as simple and as brief as possible, and should be expressed in consistent terms and units with a clear explanation of unusual technical terms.</p> <p>d) When it is foreseen that a machine will be put to non-professional use, the instructions should be written in a form that is readily understood by the non-professional user. If personal protective equipment is required for the safe use of the machine, clear advice should be given, for example, on the packaging as well as on the machine, so that this information is prominently displayed at the point of sale.</p> <p>e) Durability and availability of the documents: documents giving instructions for use should be produced in durable form (i.e. they should be able to survive frequent handling by the user). It can be useful to mark them “keep for future reference”. Where information for use is kept in electronic form (CD, DVD, tape, hard disk, etc.), information on safety-related issues that need immediate action shall always be backed up with a hard copy that is readily available.</p>		
7 Documentation of risk assessment and risk reduction			
	<p>The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation of</p> <p>a) the machinery for which the risk assessment has been made (for example, specifications, limits, intended use);</p> <p>b) any relevant assumptions that have been made (loads, strengths, safety factors, etc.);</p> <p>c) the hazards and hazardous situations identified and the hazardous events considered in the risk assessment;</p> <p>d) the information on which risk assessment was based (see 5.2):</p> <p>1) the data used and the sources (accident histories, experience gained from risk reduction applied to similar machinery, etc.);</p> <p>2) the uncertainty associated with the data used and its impact on the risk assessment;</p> <p>e) the risk reduction objectives to be achieved by protective measures;</p> <p>f) the protective measures implemented to eliminate identified hazards or to reduce risk;</p> <p>g) residual risks associated with the machinery;</p> <p>h) the result of the risk assessment (see Figure 1);</p> <p>i) any forms completed during the risk assessment.</p> <p>Standards or other specifications used to select protective measures referred to in f) above should be referenced.</p> <p>NOTE No requirement is given in this International Standard to deliver the risk assessment documentation together with the machine. See ISO/TR 14121-2 for information on documentation.</p>	P	

EN 60204-1:2006+A1:2009+AC:2010			
4.1	General		
	<p>This part of IEC 60204 is intended to apply to electrical equipment used with a wide variety of machines and with a group of machines working together in a co-coordinated manner.</p> <p>The risks associated with the hazards relevant to the electrical equipment shall be assessed as part of the overall requirements for risk assessment of the machine. This will determine the adequate risk reduction and the necessary protective measures for persons who can be exposed to those hazards, while still maintaining an acceptable level of performance of the machine and its equipment.</p>	P	
4.2 Selection of equipment			
4.2.1	General		
	<p>Electrical components and devices shall:</p> <p>—be suitable for their intended use; and</p> <p>—conform to relevant IEC standards where such exist; and</p> <p>—be applied in accordance with the supplier’s instructions risk assessment of the machine.</p>	P	
4.2.2	Electrical equipment in compliance with the EN 60439 series		
	<p>Depending upon the machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the machine that are in compliance with EN 60439-1 and, as necessary, other relevant parts of the EN 60439 series (see also Annex F).</p>	P	
4.3 Electrical supply			
4.3.1	General		
	<p>The electrical equipment shall be designed to operate correctly with the conditions of the supply:</p> <p>—as specified in 4.3.2 or 4.3.3, or</p> <p>—as otherwise specified by the user (see Annex B), or as specified by the supplier in the case of a special source of supply such as an on-board generator.</p>	P	
4.3.2	AC supplies		
	<p>Voltage:</p> <p>Steady state voltage: 0,9 to 1,1 of nominal voltage.</p>	P	<p>AC:380V</p> <p>Sum_{2nd-5th}</p>

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	Frequency: 0,99 to 1,01 of nominal frequency continuously; 0,98 to 1,02 short time. Harmonics: Harmonic distortion not exceeding 10 % of the total r.m.s. voltage between live conductors for the sum of the 2nd through to the 5th harmonic. An additional 2 % of the total r.m.s. voltage between live conductors for the sum of the 6th through to the 30th harmonic is permissible. Voltage unbalance: Neither the voltage of the negative sequence component nor the voltage of the zero sequence components in three-phase supplies exceeding 2 % of the positive sequence component. Voltage interruption: Supply interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions. Voltage dips: Voltage dips not exceeding 20 % of the peak voltage of the supply for more than one cycle with more than 1 s between successive dips.		harmonic $\leq 10\%$ Sum _{6nd-30th} harmonic $\leq 2\%$ 50Hz Voltage unbalance $\leq 2\%$ Voltage interruption $\leq 3\text{ms}$ Rms* 0.707 Voltage dips $\leq 20\%$
4.3.3	DC supplies		
	From batteries, Voltage 0,85 to 1,15 of nominal voltage 0,7 to 1,2 of nominal voltage in the case of battery-operated vehicles . Voltage interruption: Not exceeding 5 ms From converting equipment: Voltage: 0,9 to 1,1 of nominal voltage. Voltage interruption: Not exceeding 20 ms with more than 1 s between successive interruptions. Ripple (peak-to-peak): Not exceeding 0,15 of nominal voltage.	N/A	
4.3.4	Special supply systems		
	For special supply systems such as on-board generators, the limits given in 4.3.2 and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with those conditions.	P	
4.4 Physical environment and operating conditions			
4.4.1	General		
	The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of EN 60204. When special conditions apply or the limits specified are exceeded, an agreement between user and supplier (see 4.1) is recommended (see Annex B).	P	
4.4.3	Ambient air temperature		
	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation between air temperatures of +5 °C and +40 °C. For very hot environments (for example hot climates, steel mills, paper mills) and for cold environments, additional measures are recommended (see Annex B).	P	35%~85% Safety instruction
4.4.4	Humidity		
	The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (for example 90 % at 20 °C). Harmful effects of occasional condensation shall be avoided by design of the equipment or where necessary, by additional measures (for example built-in heaters, air conditioners, drain holes).	P	Safety instruction
4.4.5	Altitude		
	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.	P	up to 1000 m above m.s.l.
4.4.6	Contaminants		
	Electrical equipment shall be adequately protected against the ingress of solids and liquids The electrical equipment shall be adequately protected against contaminants (for example dust, acids, corrosive gases, salts) that can be present in the physical environment in which the electrical equipment is to be installed (see Annex B).	P	Safety instruction
4.4.7	Ionizing and non-ionizing radiation		
	When equipment is subject to radiation (for example microwave, ultraviolet, lasers, X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation. A special agreement is recommended between the supplier and the user	P	Safety instruction
4.4.8	Vibration, shock, and bump		
	Undesirable effects of vibration, shock and bump (including those generated by the machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment, by mounting it away from the machine, or by provision of anti-vibration mountings. A special agreement is recommended between the supplier and the user	P	Safety instruction

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	(see Annex B).		
4.5	Transportation and storage		
	Electrical equipment shall be designed to withstand, or suitable precautions shall be taken to protect against, the effects of transportation and storage temperatures within a range of -25 °C to +55 °C and for short periods not exceeding 24 h at up to +70 °C. Suitable means shall be provided to prevent damage from humidity, vibration, and shock. A special agreement can be necessary between the supplier and the user (see Annex B).	P	Safety instruction
4.6	Provisions for handling		
	Heavy and bulky electrical equipment that has to be removed from the machine for transport or that is independent of the machine, shall be provided with suitable means for handling by cranes or similar equipment.	P	Safety instruction
4.7	Installation		
	Electrical equipment shall be installed in accordance with the electrical equipment supplier's Instructions.	P	Safety instruction
5 Incoming supply conductor terminations and devices for disconnecting and switching off			
5.1	Incoming supply conductor terminations		
	It is recommended that, where practicable, the electrical equipment of a machine is connected to a single incoming supply. Where another supply is necessary for certain parts of the equipment (for example, electronic equipment that operates at a different voltage), that supply should be derived, as far as is practicable, from devices (for example, transformers, converters) forming part of the electrical equipment of the machine. For large complex machinery comprising a number of widely-spaced machines working together in a coordinated manner, there can be a need for more than one incoming supply depending upon the site supply arrangements (see 5.3.1). Unless a plug is provided with the machine for the connection to the supply (see 5.3.2 e), it is recommended that the supply conductors are terminated at the supply disconnecting device where a neutral conductor is used it shall be clearly indicated in the technical documentation of the machine, such as in the installation diagram and in the circuit diagram, and a separate insulated terminal, labeled N in accordance with 16.1, shall be provided for the neutral conductor (see also Annex B). There shall be no connection between the neutral conductor and the protective bonding circuit inside the electrical equipment nor shall a combined PEN terminal be provided. Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the power supply to the machine for TN-C systems. All terminals for the incoming supply connection shall be clearly identified in accordance with IEC 60445 and 16.1. For the identification of the external protective conductor terminal, see 5.2. See 17.8 for the provision of instructions for maintenance.	P	
5.2	Terminal for connection to the external protective earthing system		
	For each incoming supply, a terminal shall be provided in the vicinity of the associated phase conductor terminals for connection of the machine to the external protective earthing system or to the external protective conductor, depending upon the supply distribution system. The terminal shall be of such a size as to enable the connection of an external protective copper conductor with a cross-sectional area in accordance with Table	P	Earth Resistance 2.5Ω, Connected with copper wire S=25mm ²
5.3 Supply disconnecting (isolating) device			
5.3.1	General		
	A supply disconnecting device shall be provided: —for each incoming source of supply to a machine(s); —for each on-board power supply. The supply disconnecting device shall disconnect (isolate) the electrical equipment of the machine from the supply when required (for example for work on the machine, including the electrical equipment). When two or more supply disconnecting devices are provided, protective interlocks for their correct operation shall also be provided in order to prevent a hazardous situation, including damage to the machine or to the work in progress.	P	A supply disconnecting devi ce has been provi ded
5.3.2	Type		
	The supply disconnecting device shall be one of the following types: a) switch-disconnect or, with or without fuses, in accordance with IEC 60947-3, utilization category AC-23B or DC-23B; b) disconnect or, with or without fuses, in accordance with IEC 60947-3, that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnect; c) a circuit-breaker suitable for isolation in accordance with IEC 60947-2; d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1 as well as a utilization category defined in the product standard as appropriate for on-load switching of motors or other inductive loads; e) a plug/socket combination for a flexible cable supply.	P	
5.3.3	Requirements		
	When the supply disconnecting device is one of the types specified in 5.3.2 a) to d) it shall fulfill all of the following requirements:	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>—isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position marked with "O" and "I" (symbols IEC 60417-5008 (DB:2002-10) and IEC 60417-5007 (DB:2002-10), see 10.2.2);— have a visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied;</p> <p>—have an external operating means (for example handle), (exception: power-operated switchgear need not be operable from outside the enclosure where there are other means to open it). Where the external operating means is not intended for emergency operations, it is recommended that it be colored BLACK or GREY (see 10.7.4 and 10.8.4);</p> <p>—be provided with a means permitting it to be locked in the OFF (isolated) position (for example by padlocks). When so locked, remote as well as local closing shall be prevented;</p> <p>—disconnect all live conductors of its power supply circuit. However, for TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory;</p> <p>—have a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor.</p> <p>When the supply disconnecting device is a plug/socket combination, it shall fulfill the following requirements: have the switching capability, or be interlocked with a switching device that has a breaking capacity, sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor.</p> <p>When the interlocked switching device is electrically operated (for example a contactor) it</p> <p>—shall have an appropriate utilization category.</p> <p>Where the supply disconnecting device is a plug/socket combination, a switching device with an appropriate utilization category shall be provided for switching the machine on and off.</p> <p>This can be achieved by the use of the interlocked switching device described above.</p>		isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position
5.3.4	Operating means		
	The operating means (for example, a handle) of the supply disconnecting device shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level. An upper limit of 1,7 m is recommended.	P	1.7m
5.3.5	Excepted circuits		
	<p>The following circuits need not be disconnected by the supply disconnecting device:</p> <p>—lighting circuits for lighting needed during maintenance or repair;</p> <p>—plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment (for example hand drills, test equipment);</p> <p>—under voltage protection circuits that are only provided for automatic tripping in the event of supply failure;</p> <p>—circuits supplying equipment that should normally remain energized for correct operation (for example temperature controlled measuring devices, product (work in progress) heaters, program storage devices);</p> <p>—control circuits for interlocking.</p> <p>It is recommended, however, that such circuits be provided with their own disconnecting device.</p> <p>Where such a circuit is not disconnected by the supply disconnecting device:</p> <p>—permanent warning label(s) in accordance with 16.1 shall be appropriately placed in proximity to the supply disconnecting device;</p> <p>—a corresponding statement shall be included in the maintenance manual, and one or more of the following shall apply;</p> <p>—a permanent warning label in accordance with 16.1 is affixed in proximity to each excepted circuit, or</p> <p>—the excepted circuit is separated from other circuits, or</p> <p>—the conductors are identified by colour taking into account the recommendation of 13.2.4.</p>	P	
5.4	Devices for switching off for prevention of unexpected start-up		
	Devices for switching off for the prevention of unexpected start-up shall be provided (for example where, during maintenance, a start-up of the machine or part of the machine can create a hazard). Such devices shall be appropriate and convenient for the intended use, shall be suitably placed, and readily identifiable as to their function and purpose (for example by a durable marking in accordance with 16.1 where necessary).	P	
5.5	Devices for disconnecting electrical equipment		
	<p>be carried out when it is de-energized and isolated. Such devices shall be:</p> <p>—appropriate and convenient for the intended use;</p> <p>—suitably placed;</p> <p>—readily identifiable as to which part(s) or circuit(s) of the equipment is served (for example by durable marking in accordance with 16.1 where necessary).</p> <p>Means shall be provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations (see also 5.6). The supply disconnecting device (see 5.3) may, in some cases, fulfil that function. However where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of a number of machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device shall be</p>	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	provided for each part, or for each machine, requiring separate isolation. In addition to the supply disconnecting device, the following devices that fulfil the isolation function may be provided for this purpose: —devices described in 5.3.2; —disconnectors, withdrawable fuse links and withdrawable links only if located in an electrical operating area (see 3.15) and relevant information is provided with the electrical equipment (see 17.2 b)9) and b)12)).		
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		
	The devices described in 5.4 and 5.5 that are located outside an enclosed electrical operating area shall be equipped with means to secure them in the OFF position (disconnected state), (for example by provisions for padlocking, trapped key interlocking). When so secured, remote as well as local reconnection shall be prevented. Where a non-lockable disconnecting device (for example withdrawable fuse-links withdrawable links) other means of protection against reconnection (for example warning labels in accordance with 16.1) may be provided. However, when a plug/socket combination according to 5.3.2 e) is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing in the disconnected state need not be provided.	P	Using system of safety for electro-sensitivity
6 Protection against electric shock			
6.1	General		
	The electrical equipment shall provide protection of persons against electric shock from: —direct contact (see 6.2 and 6.4); —indirect contact (see 6.3 and 6.4). The measures for this protection given in 6.2, 6.3, and, for PELV, in 6.4, are a recommended selection from IEC 60364-4-41. Where those recommended measures are not practicable, for example due to the physical or operational conditions, other measures from IEC 60364-4-41 may be used.	P	
6.2 Protection against direct contact			
6.2.1	General		
	For each circuit or part of the electrical equipment, the measures of either 6.2.2 or 6.2.3 and where applicable, 6.2.4 shall be applied. Exception: where those measures are not appropriate, other measures for protection against direct contact (for example by using barriers, by placing out of reach, using obstacles, using construction or installation techniques that prevent access) as defined in IEC 60364-4-41 may be applied (see 6.2.5 and 6.2.6). When the equipment is located in places open to all persons, which can include children measures of either 6.2.2 with a minimum degree of protection against direct contact corresponding to IP4X or IPXXD (see IEC 60529), or 6.2.3 shall be applied.	P	IP4X
6.2.2	Protection by enclosures		
	Live parts shall be located inside enclosures that conform to the relevant requirements of Clauses 4, 11, and 14 and that provide protection against direct contact of at least IP2X or IPXXB (see IEC 60529). Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against direct contact provided by the top surfaces shall be IP4X or IPXXD Opening an enclosure (i.e. opening doors, lids, covers, and the like) shall be possible only under one of the following conditions: a: b: c:	P	IP22
6.2.3	Protection by insulation of live parts		
	Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction. Such insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions	P	IP42
6.2.4	Protection against residual voltages		
	Live parts having a residual voltage greater than 60 V after the supply has been disconnected shall be discharged to 60 V or less within a time period of 5 s after disconnection of the supply voltage provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 µC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure containing the capacitances. In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time shall not exceed 1 s, otherwise such conductors shall be protected against direct contact to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning device (for example a warning notice in accordance with 16.1) shall be applied	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
6.2.5	Protection by barriers		
	For protection by barriers, 412.2 of IEC 60364-4-41 shall apply.	P	
6.2.6	Protection by placing out of reach or protection by obstacles		
	For protection by placing out of reach, 412.4 of IEC 60364-4-41 shall apply. For protection by obstacles, 412.3 of IEC 60364-4-41 shall apply. For conductor wire systems or conductor bar systems with a degree of protection less than IP2X, see 12.7.1.	P	IP22,
6.3 Protection against indirect contact			
6.3.1	General		
	Protection against indirect contact (3.29) is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts. For each circuit or part of the electrical equipment, at least one of the measures in accordance with 6.3.2 to 6.3.3 shall be applied: —measures to prevent the occurrence of a touch voltage (6.3.2); or —automatic disconnection of the supply before the time of contact with a touch voltage can become hazardous (6.3.3).	P	
6.3.2 Prevention of the occurrence of a touch voltage		P	
6.3.2.1	General		
	Measures to prevent the occurrence of a touch voltage include the following: —provision of class II equipment or by equivalent insulation; —electrical separation.	P	
6.3.2.2	Protection by provision of class II equipment or by equivalent insulation		
	This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation. This protection is provided by one or more of the following: —class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140); —switchgear and control gear assemblies having total insulation in accordance with IEC 60439-1; —supplementary or reinforced insulation in accordance with 413.2 of IEC 60364-4-41.	P	
6.3.2.3	Protection by electrical separation		
	Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that circuit. For this type of protection, the requirements of 413.5 of IEC 60364-4-41 apply.	P	
6.3.3	Protection by automatic disconnection of supply		
	This measure consists of the interruption of one or more of the line conductors by the automatic operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within which the touch voltage is not hazardous. Interruption times are given in Annex A.	P	
6.4 Protection by the use of PELV			
6.4.1	General requirements		
	The use of PELV (Protective Extra-Low Voltage) is to protect persons against electric shock from indirect contact and limited area direct contact (see 8.2.5). PELV circuits shall satisfy all of the conditions:	P	
6.4.2	Sources for PELV		
	The source for PELV shall be one of the following: —a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6; —a source of current providing a degree of safety equivalent to that of the safety isolating transformer (for example a motor generator with winding providing equivalent isolation); —an electrochemical source (for example a battery) or another source independent of a higher voltage circuit (for example a diesel-driven generator); —an electronic power supply conforming to appropriate standards specifying measures to be taken to ensure that, even in the case of an internal fault, the voltage at the outgoing terminals cannot exceed the values specified in 6.4.1.	P	
7 Protection of equipment			
7.1	General		
	This Clause details the measures to be taken to protect equipment against the effects of: —overcurrent arising from a short circuit; —overload and/or loss of cooling of motors; —abnormal temperature; —loss of or reduction in the supply voltage; —overspeed of machines/machine elements; —earth fault/residual current; —incorrect phase sequence; —overvoltage due to lightning and switching surges.	P	
7.2 Overcurrent protection			
7.2.1	General		
	Overcurrent protection shall be provided where the current in a machine circuit can exceed either the rating of any component or the current carrying capacity of the conductors whichever is the	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	lesser value. The ratings or settings to be selected are detailed in 7.2.10.		
7.2.2	Supply conductors		
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the overcurrent protective device for the supply conductors to the electrical equipment (see Annex B). The supplier of the electrical equipment shall state on the installation diagram the data necessary for selecting the overcurrent protective device (see 7.2.10 and 17.4).	P	
7.2.3	Power circuits		
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10 shall be applied to each live conductor. The following conductors, as applicable, shall not be disconnected without disconnecting all associated live conductors: —the neutral conductor of a.c. power circuits; —the earthed conductor of d.c. power circuits; —d.c. power conductors bonded to exposed conductive parts of mobile machines. Where the cross-sectional area of the neutral conductor is at least equal to or equivalent to that of the phase conductors, it is not necessary to provide over current detection for the neutral conductor nor a disconnecting device for that conductor. For a neutral conductor with a cross-sectional area smaller than that of the associated phase conductors, the measures detailed in 524 of IEC 60364-5-52 shall apply. In IT systems, it is recommended that the neutral conductor is not used. However, where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43 shall apply.	P	
7.2.4	Control circuits		
	Conductors of control circuits directly connected to the supply voltage and of circuits supplying control circuit transformers shall be protected against over current in accordance with 7.2.3. Conductors of control circuits supplied by a control circuit transformer or d.c. supply shall be protected against over current (see also 9.4.3.1): —in control circuits connected to the protective bonding circuit, by inserting an over current protective device into the switched conductor; —in control circuits not connected to the protective bonding circuit; —where the same cross sectional area conductors are used in all control circuits, by inserting an over current protective device into the switched conductor, and; —where different cross sectional areas conductors are used in different sub-circuits, by inserting an overcurrent protective device into both switched and common conductors of each sub-circuit.	P	
7.2.5	Socket outlets and their associated conductors		
	Overcurrent protection shall be provided for the circuits feeding the general purpose socket outlets intended primarily for supplying power to maintenance equipment. Overcurrent protective devices shall be provided in the unearthed live conductors of each circuit feeding such socket outlets.	N/A	
7.2.6	Lighting circuits		
	All unearthed conductors of circuits supplying lighting shall be protected against the effects of short circuits by the provision of over current devices separate from those protecting other circuits.	P	
7.2.7	Transformers		
	Transformers shall be protected against over current in accordance with the manufacturer's instructions. Such protection shall (see also 7.2.10): —avoid nuisance tripping due to transformer magnetizing inrush currents; —avoid a winding temperature rise in excess of the permitted value for the insulation class of transformer when it is subjected to the effects of a short circuit at its secondary terminals. The type and setting of the over current protective device should be in accordance with the recommendations of the transformer supplier.	P	
7.2.8	Location of over current protective devices		
	An over current protective device shall be located at the point where a reduction in the cross-sectional area of the conductors or another change reduces the current-carrying capacity of the conductors, except where all the following conditions are satisfied: —the current carrying capacity of the conductors is at least equal to that of the load; —the part of the conductor between the point of reduction of current-carrying capacity and the position of the over current protective device is no longer than 3 m; —the conductor is installed in such a manner as to reduce the possibility of a short-circuit for example, protected by an enclosure or duct.	P	
7.2.9	Overcurrent protective devices		
	The rated short-circuit breaking capacity shall be at least equal to the prospective fault current at the point of installation. Where the short-circuit current to an over current protective device can include additional currents other than from the supply (for example from motors from power factor correction capacitors), those currents shall be taken into consideration. A lower breaking capacity is permitted where another protective device (for example the over current protective device for the supply conductors (see 7.2.2) having the necessary breaking capacity is installed on the supply side. In that case, the characteristics of the two devices shall be co-coordinated so that the let-through energy (I^2t) of the two devices in series does not exceed that which can be withstood without damage to the over current protective device on the load side and to the conductors protected by that device (see Annex A of IEC 60947-2).	P	Using fuses wire as protective device

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	Where fuses are provided as over current protective devices, a type readily available in the country of use shall be selected, or arrangements shall be made for the supply of spare parts.		
7.2.10	Rating and setting of overcurrent protective devices		
	<p>The rated current of fuses or the setting current of other over current protective devices shall be selected as low as possible but adequate for the anticipated over currents (for example during starting of motors or energizing of transformers). When selecting those protective devices, consideration shall be given to the protection of switching devices against damage due to over currents (for example welding of the switching device contacts).</p> <p>The rated current or setting of an over current protective device is determined by the current carrying capacity of the conductors to be protected in accordance with 12.4, D.2 and the maximum allowable interrupting time t in accordance with Clause D.3, taking into account the needs of co-ordination with other electrical devices in the protected circuit.</p>	P	
7.3 Protection of motors against overheating			
7.3.1	General		
	<p>Protection of motors against overheating shall be provided for each motor rated at more than 0,5 kW.</p> <p>Exceptions:</p> <p>In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can respond.</p> <p>Protection of motors against overheating can be achieved by:</p> <ul style="list-style-type: none"> —overload protection (7.3.2), —over-temperature protection (7.3.3), or —current-limiting protection (7.3.4). <p>Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine or to the work in progress.</p>	P	
7.3.2	Overload protection		
	<p>Where overload protection is provided, detection of overload(s) shall be provided in each live conductor except for the neutral conductor. However, where the motor overload detection is not used for cable overload protection (see also Clause D.2), the number of overload detection devices may be reduced at the request of the user (see also Annex B). For motors having single-phase or d.c. power supplies, detection in only one unearthed live conductor is permitted.</p> <p>Where overload protection is achieved by switching off, the switching device shall switch off all live conductors. The switching of the neutral conductor is not necessary for overload protection.</p> <p>Where motors with special duty ratings are required to start or to brake frequently (for example, motors for rapid traverse, locking, rapid reversal, sensitive drilling) it can be difficult to provide overload protection with a time constant comparable with that of the winding to be protected. Appropriate protective devices designed to accommodate special duty motors or over-temperature protection (see 7.3.3) can be necessary.</p> <p>For motors that cannot be overloaded (for example torque motors, motion drives that either are protected by mechanical overload protection devices or are adequately dimensioned) overload protection is not required.</p>	P	
7.3.3	Over-temperature protection		
	<p>The provision of motors with over-temperature protection (see IEC 60034-11) is recommended in situations where the cooling can be impaired (for example dusty environments). Depending upon the type of motor, protection under stalled rotor or loss of phase conditions is not always ensured by over-temperature protection, and additional protection should then be provided.</p> <p>Over-temperature protection is also recommended for motors that cannot be overloaded (for example torque motors, motion drives that are either protected by mechanical overload protection devices or are adequately dimensioned), where the possibility of over-temperature exists (for example due to reduced cooling).</p>	P	
7.3.4	Current limiting protection		
	Where protection against the effects of overheating in three phase motors is achieved by current limitation, the number of current limitation devices may be reduced from 3 to 2 (see 7.3.2). For motors having single phase a.c or d.c. power supplies, current limitation in only one unearthed live conductor is permitted.	P	
7.4	Abnormal temperature protection		
	Resistance heating or other circuits that are capable of attaining or causing abnormal temperatures (for example, due to short-time rating or loss of cooling medium) and therefore can cause a hazardous situation shall be provided with suitable detection to initiate an appropriate control response.	P	
7.5	Protection against supply interruption or voltage reduction and subsequent restoration		
	Where a supply interruption or a voltage reduction can cause a hazardous situation, damage to the machine, or to the work in progress, under voltage protection shall be provided by, for example, switching off the machine at a predetermined voltage level Where the operation of the machine can allow for an interruption or a reduction of the voltage for a short time period, delayed under voltage protection may be provided. The operation of the under voltage device shall not impair the operation of any stopping control of the machine.	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	Upon restoration of the voltage or upon switching on the incoming supply, automatic or unexpected restarting of the machine shall be prevented where such a restart can cause a hazardous situation. Where only a part of the machine or of the group of machines working together in a coordinated manner is affected by the voltage reduction or supply interruption, the under voltage protection shall initiate appropriate control responses to ensure co-ordination.		
7.6	Motor overspeed protection		
	Cause a hazardous situation taking into account measures in accordance with 9.3.2. Overspeed protection shall initiate appropriate control responses and shall prevent automatic restarting. The overspeed protection should operate in such a manner that the mechanical speed limit of the motor or its load is not exceeded.	P	
7.7	Earth fault/residual current protection		
	In addition to providing over current protection for automatic disconnection as described in 6.3, earth fault/residual current protection can be provided to reduce damage to equipment due to earth fault currents less than the detection level of the over current protection. The setting of the devices shall be as low as possible consistent with correct operation of the equipment.	P	Using copper wire connect to the earth system.
7.8	Phase sequence protection		
	Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine, protection shall be provided.	P	L1
7.9	Protection against over voltages due to lightning and to switching surges		
	Protective devices can be provided to protect against the effects of overvoltage due to lightning or to switching surges. Where provided: —devices for the suppression of over voltages due to lightning shall be connected to the incoming terminals of the supply disconnecting device. —devices for the suppression of over voltages due to switching surges shall be connected across the terminals of all equipment requiring such protection.	P	
8 Equipment potential bonding			
8.1	General		
	This Clause provides requirements for both protective bonding and functional bonding.	P	
8.2 Protective bonding circuit			
8.2.1	General		
	The protective bonding circuit consists of: —PE terminal(s) (see 5.2); —the protective conductors in the equipment of the machine including sliding contacts where they are part of the circuit; —the exposed conductive parts and conductive structural parts of the electrical equipment; —those extraneous conductive parts which form the structure of the machine. All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses that can be caused by earth-fault	P	
8.2.2	Protective conductors		
	Protective conductors shall be identified in accordance with 13.2.2. Copper conductors are preferred. Where a conductor material other than copper is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm ² in cross-sectional area. The cross-sectional area of protective conductors shall be determined in accordance with the requirements of: —543 of IEC 60364-5-54; or —7.4.3.1.7 of IEC 60439-1, as appropriate. This requirement is met in most cases where the relationship between the cross-sectional area of the phase conductors associated with that part of the equipment and the cross-sectional area of the associated protective conductor is in accordance with Table 1 (see 5.2) See also 8.2.8.	P	20 mm ²
8.2.3	Continuity of the protective bonding circuit		
	All exposed conductive parts shall be connected to the protective bonding circuit in accordance with 8.2.1. Exception: see 8.2.5. Where a part is removed for any reason (for example routine maintenance), the protective bonding circuit for the remaining parts shall not be interrupted. Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and conductors of aluminum or aluminum alloys are used, particular consideration should be given to the possibility of electrolytic corrosion. Metal ducts of flexible or rigid construction and metallic cable sheaths shall not be used as protective conductors. Nevertheless, such metal ducts and the metal sheathing of all connecting cables (for example cable armoring, lead sheath) shall be connected to the protective bonding circuit. Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured and a protective conductor (see 8.2.2) is recommended. Otherwise fastenings, hinges or sliding contacts designed to have a low resistance shall be used	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	(see 18.2.2, Test 1). The continuity of the protective conductor in cables that are exposed to damage (for example flexible trailing cables) shall be ensured by appropriate measures (for example monitoring). For requirements for the continuity of the protective conductor using conductor wires conductor bars and slip-ring assemblies, see 12.7.2.		
8.2.4	Exclusion of switching devices from the protective bonding circuit		
	The protective bonding circuit shall not incorporate a switching device or an over current protective device (for example switch, fuse). No means of interruption of the protective bonding conductor shall be provided. Exception: links for test or measurement purposes that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area. Where the continuity of the protective bonding circuit can be interrupted by means of removable current collectors or plug/socket combinations, the protective bonding circuit shall be interrupted by a first make last break contact. This also applies to removable or withdrawable plug-in units	P	
8.2.5	Parts that need not be connected to the protective bonding circuit		
	It is not necessary to connect exposed conductive parts to the protective bonding circuit where those parts are mounted so that they do not constitute a hazard because: —they cannot be touched on large surfaces or grasped with the hand and they are small in size (less than approximately 50 mm); or —they are located so that either contact with live parts, or an insulation failure, is unlikely. This applies to small parts such as screws, rivets, and nameplates and to parts inside an enclosure, irrespective of their size (for example electromagnets of contactors or relays and mechanical parts of devices) (see also 410.3.3.5 of IEC 60364-4-41).	P	
8.2.6	Protective conductor connecting points		
	All protective conductors shall be terminated in accordance with 13.1.1. The protective conductor connecting points shall have no other function and are not intended, for example to attach or connect appliances or parts. Each protective conductor connecting point shall be marked or labelled as such using the symbol IEC 60417-5019 or with the letters PE, the graphical symbol being preferred, or by use of the bicolour combination GREEN-AND-YELLOW, or by any combination of these.	P	
8.2.7	Mobile machines		
	On mobile machines with on-board power supplies, the protective conductors, the conductive structural parts of the electrical equipment, and those extraneous conductive parts which form the structure of the machine shall all be connected to a protective bonding terminal to provide protection against electric shock. Where a mobile machine is also capable of being connected to an external incoming power supply, this protective bonding terminal shall be the connection point for the external protective conductor.	P	
8.2.8	Additional protective bonding requirements for electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.		
	Where electrical equipment has an earth leakage current (for example adjustable speed electrical power drive systems and information technology equipment) that is greater than 10 mA a.c. or d.c. in any incoming supply, one or more of the following conditions for the associated protective bonding circuit shall be satisfied: a) the protective conductor shall have a cross-sectional area of at least 10 mm ² Cu or 16 mm ² Al, through its total run; b) where the protective conductor has a cross-sectional area of less than 10 mm ² Cu or 16 mm ² Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm ² Cu or 16 mm ² Al. c) automatic disconnection of the supply in case of loss of continuity of the protective conductor. To prevent difficulties associated with electromagnetic disturbances, the requirements of 4.4.2 also apply to the installation of duplicate protective conductors. In addition, a warning label shall be provided adjacent to the PE terminal, and where necessary on the nameplate of the electrical equipment. The information provided under 17.2 b)1) shall include information about the leakage current and the minimum cross-sectional area of the external protective conductor.	P	12 mm ² Copper wire
8.3	Functional bonding		
	Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1. For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances, see 4.4.2.	P	
8.4	Measures to limit the effects of high leakage current		
	The effects of high leakage current can be restricted to the equipment having high leakage current by connection of that equipment to a dedicated supply transformer having separate windings. The protective bonding circuit shall be connected to exposed conductive parts of the equipment and, in addition, to the secondary winding of the transformer. The protective conductor(s) between the equipment and the secondary winding of the transformer shall comply with one or more of the arrangements described in 8.2.8.	P	<10 µmA
9 Control circuits and control functions			

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict

9.1 Control circuits

9.1.1 Control circuit supply

	Where control circuits are supplied from an a.c. source, control transformers shall be used for supplying the control circuits. Such transformers shall have separate windings. Where several transformers are used, it is recommended that the windings of those transformers be connected in such a manner that the secondary voltages are in phase. Where d.c. control circuits derived from an a.c. supply are connected to the protective bonding circuit (see 8.2.1), they shall be supplied from a separate winding of the a.c. control circuit transformer or by another control circuit transformer. Transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices (for example interlock device, start/stop control station).	P	
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9.1.2 Control circuit voltages

	The nominal value of the control voltage shall be consistent with the correct operation of the control circuit. The nominal voltage shall not exceed 277 V when supplied from a transformer.	P	
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9.1.3 Protection

	Control circuits shall be provided with over current protection in accordance with 7.2.4 and 7.2.10.	P	
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9.2 Control functions

9.2.1 Start functions

	Start functions shall operate by energizing the relevant circuit	P	
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9.2.2 Stop functions

	There are three categories of stop functions as follows: —stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – see 3.56); —stop category 1: a controlled stop (see 3.11) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved; —stop category 2: a controlled stop with power left available to the machine actuators.	P	category 0
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9.2.3 Operating modes

	Each machine can have one or more operating modes determined by the type of machine and its application. When a hazardous situation can result from a mode selection unauthorized and/or inadvertent selection shall be prevented by suitable means (for example key operated switch, access code). Mode selection by itself shall not initiate machine operation. A separate actuation of the start control shall be required. For each specific operating mode, the relevant safety functions and/or protective measures shall be implemented. Indication of the selected operating mode shall be provided (for example the position of a mode selector, the provision of an indicating light, a visual display indication).	P	
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9.2.4 Suspension of safety functions and/or protective measures

	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes), protection shall be ensured by: —disabling all other operating (control) modes	P	
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9.2.5 Operation

9.2.5.1 General

	The necessary safety functions and/or protective measures (for example interlocks (see 9.3) shall be provided for safe operation. Measures shall be taken to prevent movement of the machine in an unintended or unexpected manner after any stopping of the machine (for example due to locked-off condition, power supply fault, battery replacement, lost signal condition with cableless control). Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.	P	
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9.2.5.2 Start

	The start of an operation shall be possible only when all of the relevant safety functions and/or protective measures are in place and are operational except for conditions as described in 9.2.4. On those machines (for example mobile machines) where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations shall be by hold-to-run controls, together with enabling devices, as appropriate. Suitable interlocks shall be provided to secure correct sequential starting. In the case of machines requiring the use of more than one control station to initiate a start each of these control stations shall have a separate manually actuated start control device. The conditions to initiate a start shall be: —all required conditions for machine operation shall be met, and —all start control devices shall be in the released (off) position, then —all start control devices shall be actuated concurrently (see 3.6).	P	
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9.2.5.3 Stop

	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine. Stop functions shall override related start functions (see 9.2.5.2). Where required, facilities to connect protective devices and interlocks shall be provided. If such a protective device or interlock causes a stop of the machine, it may be necessary for that condition	P	
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Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	to be signaled to the logic of the control system. The reset of the stop function shall not initiate any hazardous situation. Where more than one control station is provided, stop commands from any control station shall be effective when required by the risk assessment of the machine.		
9.2.5.4 Emergency operations (emergency stop, emergency switching off)			
9.2.5.4.1	General		
	Switching off functions of the emergency operations listed in Annex E, both of which are, in this part of IEC 60204, initiated by a single human action. Once active operation of an emergency stop (see 10.7) or emergency switching off (see 10.8) actuator has ceased following a command, the effect of this command shall be sustained until it is reset. This reset shall be possible only by a manual action at that location	P	
9.2.5.4.2	Emergency stop		
	Given in ISO 13850. The emergency stop shall function either as a stop category 0 or as a stop category 1 (see 9.2.2). The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine. In addition to the requirements for stop (see 9.2.5.3), the emergency stop function has the following requirements: —it shall override all other functions and operations in all modes; —power to the machine actuators that can cause a hazardous situation(s) shall be either removed immediately (stop category 0) or shall be controlled in such a way to stop the hazardous motion as quickly as possible (stop category 1) without creating other hazards; —reset shall not initiate a restart.	P	CATEGORY 0
9.2.5.4.3	Emergency switching off		
	The functional aspects of emergency switching off are given in 536.4 of IEC 60364-5-53. Emergency switching off should be provided where: —protection against direct contact (for example with conductor wires, conductor bars, slip ring assemblies, control gear in electrical operating areas) is achieved only by placing out of reach or by obstacles (see 6.2.6); or —there is the possibility of other hazards or damage caused by electricity. Emergency switching off is accomplished by switching off the relevant incoming supply by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply. When a machine cannot tolerate this stop category 0 stop, it may be necessary to provide other measures, for example protection against direct contact so that emergency switching off is not necessary.	P	CATEGORY 0
9.2.5.5	Monitoring of command actions		
	Movement or action of a machine or part of a machine that can result in a hazardous situation shall be monitored by providing, for example, over travel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices.	P	
9.2.6 Other control functions			
9.2.6.1	Hold-to-run controls		
	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation.	P	
9.2.6.2	Two-hand control		
	Three types of two-hand control are defined in ISO 13851, the selection of which is determined by the risk assessment. These shall have the following features: Type I: this type requires: —the provision of two control devices and their concurrent actuation by both hands; —continuous concurrent actuation during the hazardous situation; —machine operation shall cease upon the release of either one or both of the control devices when hazardous situations are still present. A Type I two-hand control device is not considered to be suitable for the initiation of hazardous operation. Type II: a type I control requiring the release of both control devices before machine operation can be reinitiated. Type III: a type II control requiring concurrent actuation of the control devices as follows: —it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0,5 s; —where this time limit is exceeded, both control devices shall be released before machine operation can be initiated.	N/A	
9.2.6.3	Enabling control		
	Enabling control (see also 10.9) is a manually activated control function interlock that: a) when activated allows a machine operation to be initiated by a separate start control and b) when de-activated —initiates a stop function in accordance with 9.2.5.3, and —prevents initiation of machine operation. Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It should not be possible to defeat the enabling function by simple means.	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
9.2.6.4	Combined start and stop controls		
	Push-buttons and similar control devices that, when operated, alternately initiate and stop motion shall only be provided for functions which cannot result in a hazardous situation.	P	
9.2.7 Cableless control			
9.2.7.1	General		
	This sub clause deals with the functional requirements of control systems employing cableless (for example radio, infra-red) techniques for transmitting commands and signals between a machine control system and operator control station(s). Means shall be provided to readily remove or disconnect the power supply of the operator control station (see also 9.2.7.3). Means (for example key operated switch, access code) shall be provided, as necessary, to prevent unauthorized use of the operator control station. Each operator control station shall carry an unambiguous indication of which machine(s) is (are) intended to be controlled by that operator control station.	P	
9.2.7.2	Control limitation		
	Measures shall be taken to ensure that control commands: —affect only the intended machine; —affect only the intended functions. Measures shall be taken to prevent the machine from responding to signals other than those from the intended operator control station(s). Where necessary, means shall be provided so that the machine can only be controlled from operator control stations in one or more predetermined zones or locations.	P	
9.2.7.3	Stop		
	Cableless control stations shall include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation. The actuating means to initiate this stop function shall not be marked or labelled as an emergency stop device (see 10.7). Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It should not be possible to defeat the enabling function by simple means. A machine which is equipped with cableless control shall have a means of automatically initiating the stopping of the machine and of preventing a potentially hazardous operation, in the following situations: —when a stop signal is received; —when a fault is detected in the cableless control system; —when a valid signal (which includes a signal that communication is established and maintained) has not been detected within a specified period of time (see Annex B), except when a machine is executing a pre-programmed task taking it outside the range of the cableless control where no hazardous situation can occur.	P	
9.2.7.4	Use of more than one operator control station		
	Where a machine has more than one operator control station, including one or more cableless control stations, measures shall be provided to ensure that only one of the control stations can be enabled at a given time. An indication of which operator control station is in control of the machine shall be provided at suitable locations as determined by the risk assessment of the machine. Exception: a stop command from any one of the control stations shall be effective when required by the risk assessment of the machine.	P	
9.2.7.5	Battery-powered operator control stations		
	A variation in the battery voltage shall not cause a hazardous situation. If one or more potentially hazardous motions are controlled using a battery-powered cableless operator control station, a clear warning shall be given to the operator when a variation in battery voltage exceeds specified limits. Under those circumstances, the cableless operator control station shall remain functional long enough for the operator to put the machine into a nonhazardous situation.	P	
9.3 Protective interlocks			
9.3.1	Reclosing or resetting of an interlocking safeguard		
	The reclosing or resetting of an interlocking safeguard shall not initiate hazardous machine operation	P	
9.3.2	Exceeding operating limits		
	Where an operating limits (for example speed, pressure, position) can be exceeded leading to a hazardous situation, means shall be provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.	P	
9.3.3	Operation of auxiliary functions		
	The correct operation of auxiliary functions shall be checked by appropriate devices (for example pressure sensors). Where the non-operation of a motor or device for an auxiliary function (for example lubrication, supply of coolant, swarf removal) can cause a hazardous situation, or cause damage to the machine or to the work in progress, appropriate interlocking shall be provided.	P	
9.3.4	Interlocks between different operations and for contrary motions		
	All contactors, relays, and other control devices that control elements of the machine and that can cause a hazardous situation when actuated at the same time (for example those which initiate	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	contrary motion), shall be interlocked against incorrect operation. Reversing contactors (for example those controlling the direction of rotation of a motor) shall be interlocked in such a way that in normal service no short circuit can occur when switching. Where, for safety or for continuous operation, certain functions on the machine are required to be interrelated, proper co-ordination shall be ensured by suitable interlocks. For a group of machines working together in a co-coordinated manner and having more than one controller provision shall be made to co-ordinate the operations of the controllers as necessary. Where a failure of a mechanical brake actuator can result in the brake being applied when the associated machine actuator is energized and a hazardous situation can result, interlocks shall be provided to switch off the machine actuator.		
9.3.5	Reverse current braking		
	Where braking of a motor is accomplished by current reversal, measures shall be provided to prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress. For this purpose, a device operating exclusively as a function of time is not permitted. Control circuits shall be so arranged that rotation of a motor shaft, for example manually shall not result in a hazardous situation.	P	
9.4 Control functions in the event of failure			
9.4.1	General requirements		
	Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress, appropriate measures shall be taken to minimize the probability of the occurrence of such failures or disturbances. The required measures and the extent to which they are implemented, either individually or in combination depend on the level of risk associated with the respective application (see 4.1).	P	
9.4.2 Measures to minimize risk in the event of failure			
9.4.2.1	Use of proven circuit techniques and components		
	These measures include but are not limited to: —bonding of control circuits to the protective bonding circuit for functional purposes (see 9.4.3.1 and Figure 2); —connection of control devices in accordance with 9.4.3.1; —stopping by de-energizing (see 9.2.2); —the switching of all control circuit conductors to the device being controlled (see 9.4.3.1); —switching devices having direct opening action (see IEC 60947-5-1); —circuit design to reduce the possibility of failures causing undesirable operations.	P	
9.4.2.2	Provisions of partial or complete redundancy		
	By providing partial or complete redundancy, it is possible to minimize the probability that one single failure in the electrical circuit can result in a hazardous situation. Redundancy can be effective in normal operation (on-line redundancy) or designed as special circuits that take over the protective function (off-line redundancy) only where the operating function fails. Where off-line redundancy which is not active during normal operation is provided, suitable measures shall be taken to ensure that those control circuits are available when required.	P	
9.4.2.3	Provision of diversity		
	The use of control circuits having different principles of operation, or using different types of components or devices can reduce the probability of hazards resulting from faults and/or failures. Examples include: —the combination of normally open and normally closed contacts operated by interlocking guards; —the use of different types of control circuit components in the circuit; —the combination of electromechanical and electronic equipment in redundant configurations. The combination of electrical and non-electrical systems (for example mechanical, hydraulic, pneumatic) may perform the redundant function and provide the diversity.	P	Directly using diversity
9.4.2.4	Provision for functional tests		
	Functional tests may be carried out automatically by the control system, or manually by inspection or tests at start-up and at predetermined intervals or a combination as appropriate (see also 17.2 and 18.6).	P	
9.4.3 Protection against maloperation due to earth faults, voltage interruptions and loss of circuit continuity			
9.4.3.1	Earth faults		
	Earth faults on any control circuit shall not cause unintentional starting, potentially hazardous motions, or prevent stopping of the machine. Methods to meet these requirements include but are not limited to the following: Method a) Method b) Method c)	P	Method a
9.4.3.2	Voltage interruptions		
	The requirements detailed in 7.5 shall apply. Where the control system uses a memory device(s), proper functioning in the event of power failure shall be ensured (for example by using a non-volatile memory) to prevent any loss of memory that can result in a hazardous situation.	P	
9.4.3.3	Loss of circuit continuity		
	Where the loss of continuity of safety-related control circuits depending upon sliding contacts can	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	result in a hazardous situation, appropriate measures shall be taken (for example by duplication of the sliding contacts).		
10 Operator interface and machine-mounted control devices			
10.1 General			
10.1.1	General device requirements		
	<p>This Clause contains requirements for devices mounted outside or partially outside control enclosures.</p> <p>As far as is practicable, those devices shall be selected, mounted, and identified or coded in accordance with relevant parts of IEC 61310.</p> <p>The possibility of inadvertent operation shall be minimized by, for example, positioning of devices, suitable design, and provision of additional protective measures. Particular consideration shall be given to the selection, arrangement, programming and use of operator input devices such as touch screens, keypads and keyboards, for the control of hazardous machine operations. See IEC 60447.</p>	P	
10.1.2	Location and mounting		
	<p>As far as is practicable, machine-mounted control devices shall be:</p> <ul style="list-style-type: none"> —readily accessible for service and maintenance; —mounted in such a manner as to minimize the possibility of damage from activities such as material handling. <p>The actuators of hand-operated control devices shall be selected and installed so that:</p> <ul style="list-style-type: none"> —they are not less than 0,6 m above the servicing level and are within easy reach of the normal working position of the operator; —the operator is not placed in a hazardous situation when operating them. <p>The actuators of foot-operated control devices shall be selected and installed so that:</p> <ul style="list-style-type: none"> —they are within easy reach of the normal working position of the operator; —the operator is not placed in a hazardous situation when operating them. 	P	0.8M
10.1.3	Protection		
	<p>The degree of protection (see IEC 60529) together with other appropriate measures shall afford protection against:</p> <ul style="list-style-type: none"> —the effects of aggressive liquids, vapours, or gases found in the physical environment or used on the machine; —the ingress of contaminants (for example swarf, dust, particulate matter). <p>In addition, the operator interface control devices shall have a minimum degree of protection against direct contact of IPXXD (see IEC 60529).</p>	P	
10.1.4	Position sensors		
	<p>Position sensors (for example position switches, proximity switches) shall be so arranged that they will not be damaged in the event of over travel.</p> <p>Position sensors in circuits with safety-related control functions shall have direct opening action (see IEC 60947-5-1) or shall provide similar reliability (see 9.4.2).</p>	P	
10.1.5	Portable and pendant control stations		
	<p>Portable and pendant operator control stations and their control devices shall be so selected and arranged as to minimize the possibility of inadvertent machine operations caused by shocks and vibrations (for example if the operator control station is dropped or strikes an obstruction) (see also 4.4.8).</p>	P	
10.2 Push-buttons			
10.2.1	Colors		
	<p>Push-button actuators shall be color-coded in accordance with Table 2 (see also 9.2 and Annex B). The colors for START/ON actuators should be WHITE, GREY, BLACK or GREEN with a preference for WHITE. RED shall not be used.</p> <p>The color RED shall be used for emergency stop and emergency switching off actuators.</p> <p>The colors for STOP/OFF actuators should be BLACK, GREY, or WHITE with a preference for BLACK. GREEN shall not be used. RED is permitted, but it is recommended that RED is not used near an emergency operation device.</p> <p>WHITE, GREY, or BLACK are the preferred colors for push-button actuators that alternately act as START/ON and STOP/OFF push-buttons. The colors RED, YELLOW, or GREEN shall not be used (see also 9.2.6).</p> <p>WHITE, GREY, or BLACK is the preferred colors for push-button actuators that cause operation while they are actuated and cease the operation when they are released (for example hold-to-run). The colors RED, YELLOW, or GREEN shall not be used.</p> <p>Reset push-buttons shall be BLUE, WHITE, GREY, or BLACK. Where they also act as a STOP/OFF button, the colors WHITE, GREY, or BLACK are preferred with the main preference being for BLACK. GREEN shall not be used.</p> <p>Where the same color WHITE, GREY, or BLACK is used for various functions (for example WHITE for START/ON and for STOP/OFF actuators) a supplementary means of coding (for example shape, position, symbol) shall be used for the identification of push-button actuators.</p>	P	<p>Red: emergency stop</p> <p>Yellow: Green: start</p> <p>White: no use</p> <p>Black: stop</p>
10.2.2	Markings		
	<p>In addition to the functional identification as described in 16.3, it is recommended that pushbuttons be marked, near to or preferably directly on the actuators, with the symbols given in Table 3.</p>	P	
10.3 Indicator lights and displays			
10.3.1	General		

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	<p>Indicator lights and displays serve to give the following types of information:</p> <ul style="list-style-type: none"> —Indication: to attract the operator's attention or to indicate that a certain task should be performed. The colors RED, YELLOW, BLUE, and GREEN are normally used in this mode; for flashing indicator lights and displays, see 10.3.3. —confirmation: to confirm a command, or a condition, or to confirm the termination of a change or transition period. The colors BLUE and WHITE are normally used in this mode and GREEN may be used in some cases. <p>Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator.</p> <p>Indicator light circuits used for warning lights shall be fitted with facilities to check the operability of these lights.</p>	P	<p>Red light: emergency</p> <p>Green: normal</p>
10.3.2	Colors		
	<p>Unless otherwise agreed between the supplier and the user. Indicator lights shall be color-coded with respect to the condition (status) of the machine in accordance with Table 4.</p> <p>Indicating towers on machines should have the applicable colors in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.</p>	P	
10.3.3	Flashing lights and displays		
	<p>For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided for the following purposes:</p> <ul style="list-style-type: none"> —to attract attention; —to request immediate action; —to indicate a discrepancy between the command and actual state; —to indicate a change in process (flashing during transition). <p>It is recommended that higher frequency flashing lights or display be used for higher priority information (see IEC 60073 for recommended flashing rates and pulse/pause ratios).</p> <p>Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided</p>	P	
10.4	Illuminated push-buttons		
	<p>Illuminated push-button actuators shall be color-coded in accordance with Tables 2 and 4.</p> <p>Where there is difficulty in assigning an appropriate color, WHITE shall be used. The color RED for the emergency stop actuator shall not depend on the illumination of its light.</p>	P	
10.5	Rotary control devices		
	<p>Devices having a rotational member, such as potentiometers and selector switches, shall have means of prevention of rotation of the stationary member. Friction alone shall not be considered sufficient.</p>	P	
10.6	Start devices		
	<p>Actuators used to initiate a start function or the movement of machine elements (for example slides, spindles, carriers) shall be constructed and mounted so as to minimize inadvertent operation. However, mushroom-type actuators may be used for two-hand control (see also ISO 13851).</p>	P	
10.7 Emergency stop devices			
10.7.1	Location of emergency stop devices		
	<p>Devices for emergency stop shall be readily accessible.</p> <p>Emergency stop devices shall be located at each operator control station and at other locations where the initiation of an emergency stop can be required (exception: see 9.2.7.3).</p> <p>There can be circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station. In such cases means (for example, information for use) shall be provided to minimize confusion.</p>	P	In front of the operating table
10.7.2	Types of emergency stop device		
	<p>The types of device for emergency stop include:</p> <ul style="list-style-type: none"> —a push-button operated switch with a palm or mushroom head type; —a pull-cord operated switch; —a pedal-operated switch without a mechanical guard. <p>The devices shall have direct opening operation (see IEC 60947-5-1, Annex K).</p>	P	push-button back in manual operation
10.7.3	Color of actuators		
	<p>Actuators of emergency stop devices shall be colored RED. If a background exists immediately around the actuator, then this background shall be colored YELLOW. See also ISO 13850.</p>	P	Red in a background of yellow
10.7.4	Local operation of the supply disconnecting device to effect emergency stop		
	<p>The supply disconnecting device may be locally operated to serve the function of emergency stop when:</p> <ul style="list-style-type: none"> —it is readily accessible to the operator; and —it is of the type described in 5.3.2 a), b), c), or d). <p>When also intended for such use, the supply disconnecting device shall meet the colour requirements of 10.7.3.</p>	P	
10.8 Emergency switching off devices			
10.8.1	Location of emergency switching off devices		
	<p>Emergency switching off devices shall be located as necessary for the given application.</p> <p>Normally, those devices will be located separate from operator control stations. Where it is necessary to provide a control station with an emergency stop device and an emergency switching</p>	P	Push-Button

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	off device, means shall be provided to avoid confusion between these devices.		
10.8.2	Types of emergency switching off device		
	The types of device for emergency switching off include: —a push-button operated switch with a palm or mushroom head type of actuator; —a pull-cord operated switch. The devices shall have direct opening action (see IEC 60947-5-1, Annex K). The push-button operated switch may be in a break-glass enclosure.	P	back in manual operation
10.8.3	Color of actuators		
	Actuators of emergency switching off devices shall be colored RED. If a background exists immediately around the actuator, then this background shall be colored YELLOW. Where confusion can occur between emergency stop and emergency switching off devices means shall be provided to minimize confusion.	P	Red in a background of yellow
10.8.4	Local operation of the supply disconnecting device to effect emergency switching off		
	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and should meet the color requirements of 10.8.3.	P	
10.9	Enabling control device		
	When an enabling control device is provided as a part of a system, it shall signal the enabling control to allow operation when actuated in one position only. In any other position, operation shall be stopped or prevented. Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating. Enabling control devices shall be selected that have the following features: —designed in accordance with ergonomic principles; —for a two-position type: —position 1: off-function of the switch (actuator is not operated); —position 2: enabling function (actuator is operated). —for a three-position type: —position 1: off-function of the switch (actuator is not operated); —position 2: enabling function (actuator is operated in its mid position); —position 3: off-function (actuator is operated past its mid position); —when returning from position 3 to position 2, the enabling function is not activated.	P	Obvious to operator
11 Control gear: location, mounting, and enclosures			
11.1	General requirements		
	All control gear shall be located and mounted so as to facilitate: —its accessibility and maintenance; —its protection against the external influences or conditions under which it is intended to operate; —operation and maintenance of the machine and its associated equipment.	P	
11.2 Location and mounting			
11.2.1	Accessibility and maintenance		
	All items of control gear shall be placed and oriented so that they can be identified without moving them or the wiring. For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles). Terminals not part of control gear components or devices shall also conform to these requirements. All control gear shall be mounted so as to facilitate its operation and maintenance from the front. Where a special tool is necessary to adjust, maintain, or remove a device, such a tool shall be supplied. Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level. It is recommended that terminals be at least 0,2 m above the servicing level and be so placed that conductors and cables can be easily connected to them. No devices except devices for operating, indicating, measuring, and cooling shall be mounted on doors or on normally removable access covers of enclosures. Where control devices are connected through plug-in arrangements, their association shall be made clear by type (shape), marking or reference designation, singly or in combination (see 13.4.5). Plug-in devices that are handled during normal operation shall be provided with no interchangeable features where the lack of such a facility can result in malfunctioning. Plug/socket combinations that are handled during normal operation shall be located and mounted so as to provide unobstructed access. Test points for connection of test equipment, where provided, shall be: —mounted so as to provide unobstructed access; —clearly identified to correspond with the documentation (see 17.3); —adequately insulated; —Sufficiently spaced.	P	Input/Output indicator
11.2.2	Physical separation or grouping		
	Non-electrical parts and devices, not directly associated with the electrical equipment, shall not be located within enclosures containing control gear. Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment). Control devices mounted in the same location and connected to the supply voltage, or to both supply and	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	control voltages, shall be grouped separately from those connected only to the control voltages. Terminals shall be separated into groups for: —power circuits; —associated control circuits; —other control circuits, fed from external sources (for example for interlocking). The groups may be mounted adjacently, provided that each group can be readily identified (for example by markings, by use of different sizes, by use of barriers or by colors). When arranging the location of devices (including interconnections), the clearances and creep age distances specified for them by the supplier shall be maintained, taking into account the external influences or conditions of the physical environment.		
11.2.3	Heating effects		
	Heat generating components (for example heat sinks, power resistors) shall be so located that the temperature of each component in the vicinity remains within the permitted limit.	P	
11.3	Degrees of protection		
	The protection of control gear against ingress of solid foreign objects and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions) and shall be sufficient against dust, coolants, and swarf. Enclosures of control gear shall provide a degree of protection of at least IP22 (see IEC 60529). Exceptions: a) Where an electrical operating area is used as a protective enclosure for an appropriate degree of protection against the ingress of solid bodies and liquids. b) Where removable collectors on conductor wire or conductor bar systems are used and IP22 is not achieved, but the measures of 6.2.5 are applied.	P	Degrees of protection: IP44
11.4	Enclosures, doors and openings	P	
12 Conductors and cables			
12.1	General requirements		
	Conductors and cables shall be selected so as to be suitable for the operating conditions (for example voltage, current, protection against electric shock, grouping of cables) and external influences (for example ambient temperature, presence of water or corrosive substances mechanical stresses (including stresses during installation), fire hazards) that can exist.	P	
12.2	Conductors		
	In general, conductors shall be of copper. Where aluminum conductors are used, the cross-sectional area shall be at least 16 mm ² . To ensure adequate mechanical strength, the cross-sectional area of conductors should not be less than as shown in Table 5. However, conductors with smaller cross-sectional areas or other constructions than shown in Table 5 may be used in equipment provided adequate mechanical strength is achieved by other means and proper functioning is not impaired.	P	20mm ² .
12.3	Insulation		
	The types of insulation include (but are not limited to): —polyvinyl chloride (PVC); —rubber, natural and synthetic; —silicone rubber (SiR); —mineral; —cross-linked polyethylene (XLPE); —ethylene propylene compound (EPR). Where the insulation of conductors and cables (for example PVC) can constitute hazards due to the propagation of a fire or the emission of toxic or corrosive fumes, guidance from the cable supplier should be sought. It is important to give special attention to the integrity of a circuit having a safety-related function. The insulation of cables and conductors used, shall be suitable for a test voltage: —not less than 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c., or – not less than 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41 class III equipment). The mechanical strength and thickness of the insulation shall be such that the insulation cannot be damaged in operation or during laying, especially for cables pulled into ducts.	P	Protection degree of electrical operation box: IP44 1000V ac for 5min
12.4	Current-carrying capacity in normal service		
	The current-carrying capacity depends on several factors, for example insulation material number of conductors in a cable, design (sheath), methods of installation, grouping and ambient temperature. One typical example of the current-carrying capacities for PVC insulated wiring between enclosures and individual items of equipment under steady-state conditions is given in Table 6.	P	Protection degree of electrical operation box: IP44
12.5	Conductor and cable voltage drop		
	The voltage drop from the point of supply to the load shall not exceed 5 % of the nominal voltage under normal operating conditions. In order to conform to this requirement, it can be necessary to use conductors having a larger cross-sectional area than that derived from Table 6.	P	
12.6 Flexible cables			
12.6.1	General		
	Flexible cables shall have Class 5 or Class 6 conductors.		Class 5

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
12.6.2	Mechanical rating		
	<p>The cable handling system of the machine shall be so designed to keep the tensile stress of the conductors as low as is practicable during machine operations. Where copper conductors are used, the tensile stress applied to the conductors shall not exceed 15 N/mm² of the copper cross-sectional area. Where the demands of the application exceed the tensile stress limit of 15 N/mm², cables with special construction features should be used and the allowed maximal tensile stress should be agreed with the cable manufacturer.</p> <p>The maximum stress applied to the conductors of flexible cables with material other than copper shall be within the cable manufacturer's specification.</p>	P	Flexible cables: CE certificate provided. 2000V/5min
12.6.3	Current-carrying capacity of cables wound on drums		
	<p>Cables to be wound on drums shall be selected with conductors having a cross-sectional area such that, when fully wound on the drum and carrying the normal service load, the maximum allowable conductor temperature is not exceeded.</p> <p>For cables of circular cross-sectional area installed on drums, the maximum current-carrying capacity in free air should be derated in accordance with Table 7 (see also Clause 44 of IEC 60621-3).</p>	P	
12.7 Conductor wires, conductor bars and slip-ring assemblies			
12.7.1	Protection against direct contact		
	<p>Conductor wires, conductor bars and slip-ring assemblies shall be installed or enclosed in such a way that, during normal access to the machine, protection against direct contact is achieved by the application of one of the following protective measures:</p> <ul style="list-style-type: none"> —protection by partial insulation of live parts, or where this is not practicable; —protection by enclosures or barriers of at least IP2X (see 412.2 of IEC 60364-4-41). <p>Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X (see 412.2.2 of IEC 60364-4-41).</p> <p>Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.5.4.3 shall be applied.</p> <p>Conductor wires and conductor bars shall be so placed and/or protected as to:</p> <ul style="list-style-type: none"> —prevent contact, especially for unprotected conductor wires and conductor bars, with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains; —prevent damage from a swinging load. 	P	
12.7.2	Protective conductor circuit		
	<p>Where conductor wires, conductor bars and slip-ring assemblies are installed as part of the protective bonding circuit, they shall not carry current in normal operation. Therefore, the protective conductor (PE) and the neutral conductor (N) shall each use a separate conductor wire, conductor bar or slip-ring. The continuity of the protective conductor circuit using sliding contacts shall be ensured by taking appropriate measures (for example, duplication of the current collector continuity monitoring).</p>	P	
12.7.3	Protective conductor current collectors		
	<p>Protective conductor current collectors shall have a shape or construction so that they are not interchangeable with the other current collectors. Such current collectors shall be of the sliding contact type.</p>	P	
12.7.4	Removable current collectors with a disconnecter function		
	<p>Removable current collectors having a disconnecter function shall be so designed that the protective conductor circuit is interrupted only after the live conductors have been disconnected, and the continuity of the protective conductor circuit is re-established before any live conductor is reconnected (see also 8.2.4).</p>	P	
12.7.5	Clearances in air		
	<p>Clearances between the respective conductors and between adjacent systems, of conductor wires, conductor bars, slip-ring assemblies and their current collectors shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1.</p>	P	
12.7.6	Creepage distances		
	<p>Creepage distances between the respective conductors, between adjacent systems of conductor wires, conductor bars and slip-ring assemblies, and their current collectors shall be suitable for operation in the intended environment, for example open air (IEC 60664-1), inside buildings, protected by enclosures.</p> <p>In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply:</p> <ul style="list-style-type: none"> —unprotected conductor wires, conductor bars, and slip-ring assemblies shall be equipped with insulators with a minimum creepage distance of 60 mm; —enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars shall have a minimum creepage distance of 30 mm. <p>The manufacturer's recommendations shall be followed regarding special measures to prevent a gradual reduction in the insulation values due to unfavorable ambient conditions (for example deposits of conductive dust, chemical attack).</p>	P	
12.7.7	Conductor system sectioning		
	<p>Where conductor wires or conductor bars are arranged so that they can be divided into isolated sections, suitable design measures shall be employed to prevent the energization of adjacent sections by the current collectors themselves.</p>	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
12.7.8	Construction and installation of conductor wire, conductor bar systems and slip-ring assemblies		
	<p>Conductor wires, conductor bars and slip-ring assemblies in power circuits shall be grouped separately from those in control circuits.</p> <p>Conductor wires, conductor bars and slip-ring assemblies shall be capable of withstanding without damage, the mechanical forces and thermal effects of short-circuit currents.</p> <p>Removable covers for conductor wire and conductor bar systems laid underground or under floor shall be so designed that they cannot be opened by one person without the aid of a tool.</p> <p>Where conductor bars are installed in a common metal enclosure, the individual sections of the enclosure shall be bonded together and connected to a protective bonding conductor at several points depending upon their length. Metal covers of conductor bars laid underground or under floor shall also be bonded together and connected to a protective bonding conductor.</p> <p>The protective bonding circuit shall include the covers or cover plates of metal enclosures or under floor ducts. Where metal hinges form a part of the bonding circuit, their continuity shall be verified (see Clause 18).</p> <p>Underground and under floor conductor bar ducts shall have drainage facilities.</p>	P	
13 Wiring practices			
13.1 Connections and routing			
13.1.1	General requirements		
	All connections, especially those of the protective bonding circuit, shall be secured against accidental loosening.	P	
13.1.2	Conductor and cable runs		
	<p>Conductors and cables shall be run from terminal to terminal without splices or joints.</p> <p>Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be joints for the purpose of this Sub clause.</p> <p>Exception: Where it is impracticable to provide terminals in a junction box (for example on mobile machines, on machines having long flexible cables; cable connections exceeding a length which is not practical to be supplied by the cable manufacturer on one cable drum; repair of cable due to mechanical stresses during installation and operation), splices or joints may be used.</p> <p>Where it is necessary to connect and disconnect cables and cable assemblies, a sufficient extra length shall be provided for that purpose.</p> <p>The terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors.</p> <p>Wherever practicable, the protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop.</p>	P	
13.1.3	Conductors of different circuits		
	Conductors of different circuits may be laid side by side, may occupy the same duct (for example conduit, cable trunking system), or may be in the same multiconductor cable provided that the arrangement does not impair the proper functioning of the respective circuits. Where those circuits operate at different voltages, the conductors shall be separated by suitable barriers or shall be insulated for the highest voltage to which any conductor within the same duct can be subjected, for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems.	P	
13.1.4	Connection between pick-up and pick-up converter of an inductive power supply system		
	<p>The cable between the pick-up and the pick-up converter as specified by the manufacturer of the inductive power supply shall be:</p> <ul style="list-style-type: none"> —as short as practicable; —adequately protected against mechanical damage. 	P	
13.2 Identification of conductors			
13.2.1	General requirements		
	Each conductor shall be identifiable at each termination in accordance with the technical documentation (see Clause 17). It is recommended (for example to facilitate maintenance) that conductors be identified by number, alphanumeric, color (either solid or with one or more stripes), or a combination of color and numbers or alphanumeric. When numbers are used, they shall be Arabic; letters shall be Roman (either upper or lower case).	P	
13.2.2	Identification of the protective conductor		
	<p>The protective conductor shall be readily distinguishable by shape, location, marking, or color. When identification is by color alone, the bicolor combination GREEN-AND-YELLOW shall be used throughout the length of the conductor. This colour identification is strictly reserved for the protective conductor.</p> <p>For insulated conductors, the bicolor combination GREEN-AND-YELLOW shall be such that on any 15 mm length, one of the colors covers at least 30 % and not more than 70 % of the surface of the conductor, the other color covering the remainder of the surface.</p> <p>Where the protective conductor can be easily identified by its shape, position, or construction (for example a braided conductor, uninsulated stranded conductor), or where the insulated conductor is not readily accessible, color coding throughout its length is not necessary but the ends or accessible locations shall be clearly identified by the graphical symbol IEC 60417-5019 (DB: 2002-10) or by the bicolor combination GREEN-AND-YELLOW.</p>	P	
13.2.3	Identification of the neutral conductor		
	Where a circuit includes a neutral conductor that is identified by color alone, the color used for this conductor shall be BLUE. In order to avoid confusion with other colors, it is recommended that an	P	

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	unsaturated blue be used, called here "light blue" (see 3.2.2 of IEC 60446). Where the selected color is the sole identification of the neutral conductor, that color shall not be used for identifying any other conductor where confusion is possible. Where identification by color is used, bare conductors used as neutral conductors shall be either colored by a stripe, 15 mm to 100 mm wide in each compartment or unit and at each accessible location, or colored throughout their length.		
13.2.4	Identification by color		
	Where color-coding is used for identification of conductors (other than the protective conductor (see 13.2.2) and the neutral conductor (see 13.2.3)), the following colors may be used: BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE.	P	
13.3	Wiring inside enclosures		
	Conductors inside enclosures shall be supported where necessary to keep them in place. Non-metallic ducts shall be permitted only when they are made with a flame-retardant insulating material (see the IEC 60332 series). It is recommended that electrical equipment mounted inside enclosures be designed and constructed in such a way as to permit modification of the wiring from the front of the enclosure (see also 11.2.1). Where that is not practicable and control devices are connected from the rear of the enclosure, access doors or swing out panels shall be provided.	P	
13.4 Wiring outside enclosures			
13.4.1	General requirements		
	The means of introduction of cables or ducts with their individual glands, bushings, etc., into an enclosure shall ensure that the degree of protection is not reduced (see 11.3).	P	
13.4.2	External ducts		
	Conductors and their connections external to the electrical equipment enclosure(s) shall be enclosed in suitable ducts (i.e. conduit or cable trunking systems) as described in 13.5 except for suitably protected cables that may be installed without ducts and with or without the use of open cable trays or cable support means. Where devices such as position switches or proximity switches are supplied with a dedicated cable, their cable need not be enclosed in a duct when the cable is suitable for the purpose, sufficiently short, and so located or protected, that the risk of damage is minimized. Fittings used with ducts or multiconductor cable shall be suitable for the physical environment.	P	
13.4.3	Connection to moving elements of the machine		
	Connections to frequently moving parts shall be made using conductors in accordance with 12.2 and 12.6. Flexible cable and flexible conduit shall be so installed as to avoid excessive flexing and straining, particularly at the fittings.	P	
13.4.4	Interconnection of devices on the machine		
	Where several machine-mounted switching devices (for example position sensors, pushbuttons) are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points. Such terminals shall be conveniently placed, adequately protected, and shown on the relevant diagrams.	P	
13.4.5	Plug/socket combinations		
	Where plug/socket combinations are provided, they shall fulfill one or more of the following requirements as applicable: Exception: The following requirements do not apply to components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination. a)/b)/c)/d)/e)/f)/g)/ h)/i)/j)/k) Exception: The requirements of item k) do not apply to control functions using high frequency signals on the power supply.	P	
13.4.6	Dismantling for shipment		
	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points. Such terminals shall be suitably enclosed and plug/socket combinations shall be protected from the physical environment during transportation and storage.	P	
13.4.7	Additional conductors		
	Consideration should be given to providing additional conductors for maintenance or repair. When spare conductors are provided, they shall be connected to spare terminals or isolated in such a manner as to prevent contact with live parts.	P	
13.5 Ducts, connection boxes and other boxes			
13.5.1	General requirements		
	Ducts shall provide a degree of protection suitable for the application (see IEC 60529). All sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come in contact shall be removed from ducts and fittings. Where necessary additional protection consisting of a flame-retardant, oil-resistant insulating material shall be provided to protect conductor insulation. Drain holes of 6 mm diameter are permitted in cable trunking systems, connection boxes, and other boxes used for wiring purposes that can be subject to accumulations of oil or moisture.	P	
13.5.2	Percentage fill of ducts		

Standard: EN ISO 12100:2010, EN 60204-1:2006+A1:2009+AC:2010			
Clause	Requirement-Test	Result	Verdict
	Consideration of the percentage fill of ducts should be based on the straightness and length of the duct and the flexibility of the conductors. It is recommended that the dimensions and arrangement of the ducts be such as to facilitate the insertion of the conductors and cables.	P	
13.5.3	Rigid metal conduit and fittings		
	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material suitable for the conditions. The use of dissimilar metals in contact that can cause galvanic action should be avoided. Conduits shall be securely held in place and supported at each end, Fittings shall be compatible with the conduit and appropriate for the application. Fittings shall be threaded unless structural difficulties prevent assembly. Where threadless fittings are used, the conduit shall be securely fastened to the equipment. Conduit bends shall be made in such a manner that the conduit shall not be damaged and the internal diameter of the conduit shall not be effectively reduced.	P	
13.5.4	Flexible metal conduit and fittings		
	A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour. It shall be suitable for the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.	P	
13.5.5	Flexible non-metallic conduit and fittings		
	Flexible non-metallic conduit shall be resistant to kinking and shall have physical characteristics similar to those of the sheath of multiconductor cables. The conduit shall be suitable for use in the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.	P	
13.5.6	Cable trunking systems		
	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving or contaminating portions of the machine. Covers shall be shaped to overlap the sides; gaskets shall be permitted. Covers shall be attached to cable trunking systems by suitable means. On horizontal cable trunking systems, the cover shall not be on the bottom unless specifically designed for such installation. Where the cable trunking system is furnished in sections, the joints between sections shall fit tightly but need not be gasketed. The only openings permitted shall be those required for wiring or for drainage. Cable trunking systems shall not have opened but unused knockouts.	P	
13.5.7	Machine compartments and cable trunking systems		
	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided the compartments or cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed. Conductors run in enclosed compartments and cable trunking systems shall be so secured and arranged that they are not subject to damage.	P	
13.5.8	Connection boxes and other boxes		
	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance. Those boxes shall provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3). Those boxes shall not have opened but unused knockouts nor any other openings and shall be so constructed as to exclude materials such as dust, flying, oil, and coolant.	P	IP:33
13.5.9	Motor connection boxes		
	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (for example brakes, temperature sensors plugging switches, tachometer generators).	P	IP55
14 Electric motors and associated equipment			
14.1	General requirements		
	Electric motors should conform to the relevant parts of IEC 60034 series. The protection requirements for motors and associated equipment are given in 7.2 for over current protection, in 7.3 for overload protection, and in 7.6 for overspeed protection. As many controllers do not switch off the supply to a motor when it is at rest, care shall be taken to ensure compliance with the requirements of 5.3, 5.4, 5.5, 7.5, 7.6 and 9.4. Motor control equipment shall be located and mounted in accordance with Clause 11.	P	
14.2	Motor enclosures		
	It is recommended that motor enclosures be chosen from those included in IEC 60034-5. The degree of protection shall be at least IP23 (see IEC 60529) for all motors. More stringent requirements can be needed depending on the application and the physical environment (see 4.4). Motors incorporated as an integral part of the machine shall be so mounted that they are adequately protected from mechanical damage.	P	PROTECTION DEGREE:IP55
14.3	Motor dimensions		
	As far as is practicable, the dimensions of motors shall conform to those given in the IEC 60072 series.	P	
14.4	Motor mounting and compartments		
	Each motor and its associated couplings, belts, pulleys, or chains, shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, adjustment and alignment, lubrication, and replacement. The motor mounting arrangement shall be such that all motor hold-down means can be removed and all terminal boxes are accessible. Motors shall be so mounted that proper cooling is ensured and the temperature rise remains within	P	

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	the limits of the insulation class (see IEC 60034-1). Where practicable, motor compartments should be clean and dry, and when required, shall be ventilated directly to the exterior of the machine. The vents shall be such that ingress of swarf, dust, or water spray is at an acceptable level. There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements. Where a conduit or pipe is run into the motor compartment from another compartment not meeting the motor compartment requirements, any clearance around the conduit or pipe shall be sealed.		
14.5	Criteria for motor selection		
	The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions (see 4.4). In this respect, the points that shall be considered include: —type of motor; —type of duty cycle (see IEC 60034-1); —fixed speed or variable speed operation, (and the consequent variable influence of the ventilation); —mechanical vibration; —type of motor control; —influence of the harmonic spectrum of the voltage and/or current feeding the motor (particularly when it is supplied from a static converter) on the temperature rise; —method of starting and the possible influence of the inrush current on the operation of other users of the same power supply, taking also into account possible special considerations stipulated by the supply authority; —variation of counter-torque load with time and speed; —influence of loads with large inertia; —influence of constant torque or constant power operation; —possible need of inductive reactors between motor and converter.	P	
14.6	Protective devices for mechanical brakes		
	Operation of the overload and over current protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release) of the associated machine actuators.	P	
15 Accessories and lighting			
15.1	Accessories		
	Where the machine or its associated equipment is provided with socket-outlets that are intended to be used for accessory equipment (for example hand-held power tools, test equipment), the following apply: —the socket-outlets should conform to IEC 60309-1. Where that is not practicable, they should be clearly marked with the voltage and current ratings; —the continuity of the protective bonding circuit to the socket-outlet shall be ensured except where protection is provided by PELV; —all unearthed conductors connected to the socket-outlet shall be protected against over current and, when required, against overload in accordance with 7.2 and 7.3 separately from the protection of other circuits; —where the power supply to the socket-outlet is not disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply.	P	
15.2 Local lighting of the machine and equipment			
15.2.1	General Connections to the protective		
	The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cords. Stroboscopic effects from lights shall be avoided by the selection of appropriate luminaries. Where fixed lighting is provided in an enclosure, electromagnetic compatibility should be taken into account using the principles outlined in 4.4.2.	P	
15.2.2	Supply		
	The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50 V between conductors is recommended.	P	
15.2.3	Protection		
	Local lighting circuits shall be protected in accordance with 7.2.6.	P	
15.2.4	Fittings		
	Adjustable lighting fittings shall be suitable for the physical environment. The lamp holders shall be: —in accordance with the relevant IEC standard; —constructed with an insulating material protecting the lamp cap so as to prevent unintentional contact. Reflectors shall be supported by a bracket and not by the lamp holder. Exception: where fixed lighting is out of reach of operators during normal operation, the provisions of this Sub clause do not apply.	P	
16 Marking, warning signs and reference designations			
16.1	General		
	Warning signs, nameplates, markings, and identification plates shall be of sufficient durability to	P	

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	withstand the physical environment involved.		
16.2 Warning signs			
16.2.1	Electric shock hazard		
	Enclosures that do not otherwise clearly show that they contain electrical equipment that can give rise to a risk of electric shock shall be marked with the graphical symbol IEC 60417-5036(DB:2002-10). The warning sign shall be plainly visible on the enclosure door or cover. The warning sign may be omitted (see also 6.2.2 b)) for: —an enclosure equipped with a supply disconnecting device; —an operator-machine interface or control station; —a single device with its own enclosure (for example position sensor).	P	
16.2.2	Hot surfaces hazard		
	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures of the electrical equipment, the graphical symbol IEC 60417-5041 (DB: 2002-10) shall be used.	P	
16.3	Functional identification		
	Control devices, visual indicators, and displays (particularly those related to safety) shall be clearly and durably marked with regard to their functions either on or adjacent to the item. Such markings may be as agreed between the user and the supplier of the equipment (see Annex B). Preference should be given to the use of standard symbols given in IEC 60417- DB: 2002 and ISO 7000.	P	
16.4	Marking of equipment		
	Equipment (for example control gear assemblies) shall be legibly and durably marked in a way that is plainly visible after the equipment is installed. A nameplate giving the following information shall be attached to the enclosure adjacent to each incoming supply: —name or trade mark of supplier; —certification mark, when required; —serial number, where applicable; —rated voltage, number of phases and frequency (if a.c.), and full-load current for each supply; —short-circuit rating of the equipment; —main document number (see IEC 62023). The full-load current shown on the nameplate shall be not less than the running currents for all motors and other equipment that can be in operation at the same time under normal conditions. Where only a single motor controller is used, that information may instead be provided on the machine nameplate where it is plainly visible.	P	
16.5	Reference designations		
	All enclosures, assemblies, control devices, and components shall be plainly identified with the same reference designation as shown in the technical documentation.	P	
17 Technical documentation			
17.1	General		
	The information necessary for installation, operation, and maintenance of the electrical equipment of a machine shall be supplied in the appropriate forms, for example, drawings, diagrams, charts, tables, instructions. The information shall be in an agreed language (see also Annex B). The information provided may vary with the complexity of the electrical equipment. For very simple equipment, the relevant information may be contained in one document, provided that the document shows all the devices of the electrical equipment and enables the connections to the supply network to be made.	P	
17.2	Information to be provided		
	The information provided with the electrical equipment shall include: a) A main document (parts list or list of documents); b) Complementary documents	P	
17.3	Requirements applicable to all documentation		
	Unless otherwise agreed between manufacturer and user: —the documentation shall be in accordance with relevant parts of IEC 61082; —reference designations shall be in accordance with relevant parts of IEC 61346; —Instructions/manuals shall be in accordance with IEC 62079. —Parts lists where provided shall be in accordance with IEC 62027, class B. NOTE See item 13 of Annex B. For referencing of the different documents, the supplier shall select one of the following methods: —where the documentation consists of a small number of documents (for example less than 5) each of the documents shall carry as a cross-reference the document numbers of all other documents belonging to the electrical equipment; or —for single level main documents only (see IEC 62023), all documents shall be listed with document numbers and titles in a drawing or document list; or —all documents of a certain level (see IEC 62023) of the document structure shall be listed, with document numbers and titles, in a parts list belonging to the same level.	P	
17.4	Installation documents		
	The installation documents shall give all information necessary for the preliminary work of setting up the machine (including commissioning). In complex cases, it may be necessary to refer to the	P	

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	assembly drawings for details.		
17.5	Overview diagrams and function diagrams		
	Where it is necessary to facilitate the understanding of the principles of operation, an overview diagram shall be provided. An overview diagram symbolically represents the electrical equipment together with its functional interrelationships without necessarily showing all of the interconnections. NOTE 1 Examples of overview diagrams can be found in IEC 61082 series. Function diagrams may be provided as either part of, or in addition to, the overview diagram.	P	
17.6	Circuit diagrams		
	A circuit diagram(s) shall be provided. This diagram(s) shall show the electrical circuits on the machine and its associated electrical equipment. Any graphical symbol not shown in IEC 60617-DB:2001 shall be separately shown and described on the diagrams or supporting documents. The symbols and identification of components and devices shall be consistent throughout all documents and on the machine. Where appropriate, a diagram showing the terminals for interface connections shall be provided. That diagram may be used in conjunction with the circuit diagram(s) for simplification. The diagram should contain a reference to the detailed circuit diagram of each unit shown. Switch symbols shall be shown on the electromechanical diagrams with all supplies turned off (for example electricity, air, water, lubricant) and with the machine and its electrical equipment ready for a normal start. Conductors shall be identified in accordance with 13.2. Circuits shall be shown in such a way as to facilitate the understanding of their function as well as maintenance and fault location. Characteristics relating to the function of the control devices and components which are not evident from their symbolic representation shall be included on the diagrams adjacent to the symbol or referenced to a footnote.	P	
17.7	Operating manual		
	The technical documentation shall contain an operating manual detailing proper procedure for set-up and use of the electrical equipment. Particular attention should be given to the safety measures provided. Where the operation of the equipment can be programmed, detailed information on methods of programming, equipment required, program verification, and additional safety procedures(where required) shall be provided.	P	Operating manual
17.8	Maintenance manual		
	The technical documentation shall contain a maintenance manual detailing proper procedures for adjustment, servicing and preventive inspection, and repair. Recommendations on Maintenance/service intervals and records should be part of that manual. Where methods for the verification of proper operation are provided (for example software testing programs), the use of those methods shall be detailed.	P	Maintenance manual
17.9	Parts list		
	The parts list, where provided, shall comprise, as a minimum, information necessary for ordering spare or replacement parts (for example components, devices, software, test equipment, technical documentation) required for preventive or corrective maintenance including those that are recommended to be carried in stock by the user of the equipment.	P	

18 Verification

18.2	TABLE: Earth bonding		P
	Test Current (A)	10A	—
	Ambient (°C)	25	—
Test locations		Conductor Diameter	Voltage Drop (V)
Most unfavorable case	PE- enclosure	16mm ²	0.77
	PE- transformer	16mm ²	0.66
	PE- motor	16 mm ²	0.99
	PE- other parts	16 mm ²	0.99
18.2	TABLE:Fault loop impedance		P
	Ambient (°C)	25	—
Most unfavorable case	U ₀ (V)	380	
	I _a (A)	10	
	Z _s (Ω)	0.95	

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Clause	Requirement-Test		Result	Verdict
18.3	TABLE: Insulation Resistance Test			P
	Test Voltage (V)	1000V a.c.	—	
	Ambient (°C)	20	—	
Test locations		Insulation Resistance (MΩ)		
Most unfavorable case	PE-L1	100		
	PE-L2	100		
	PE-L3	100		
	PE-N	100		
18.4	TABLE: Dielectric Test			P
	Test Voltage (V)	1000V a.c.	—	
	Test Duration (s)	1 sec.	—	
Test locations		Observation		
Most unfavorable case	L1-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	L2-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	L2-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	N-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	L1-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	L2-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	L2-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
	N-PE	<input type="checkbox"/> Puncture <input type="checkbox"/> Flash-over		
18.5	Protection against residual voltages			
	Where appropriate, tests shall be performed to ensure compliance with 6.2.4.	P	Test Voltage (V)380AC	
18.6	Functional tests			
	The functions of electrical equipment shall be tested. The function of circuits for electrical safety shall be tested.	P		

(The End of The TCF)