Machinery Safety

Presented by Paul Laidler
TÜV SÜD UK Ltd in the UK

500+ Employees
18 UK Locations

- TÜV SÜD Product Service
- Nuclear Technologies
- TÜV NEL
- Wallace Whittle

Worldwide, there are over 16,000 staff at over 600 locations
Machinery Safety – legal requirements and responsibilities
Responsibilities

The Manufacturer

The User

Guide to application of the Machinery Directive 2006/42/EC
Single European Market

- 27 different countries
- 27 different legal systems
- All countries introduce the same laws into their own legal systems
- The Directives are adopted as Laws and must be complied with before supplying equipment into the European Economic Area (EEA).
Directives that could apply to machinery

- The Machinery Directive 2006/42/EC.
- The Low Voltage Directive 2006/95/EC.
- The EMC Directive 2004/108/EC.
- The Pressure Equipment Directive 97/23/EC.
Why do we have to comply?

Because all of the European directives are brought into UK law by the issue of Regulations that make it a criminal offence punishable by fines and imprisonment not to comply.
What are these Regulations?

- The Supply of Machinery (Safety) Regulations 2008 as amended. SI 1597.
- The Electrical Equipment (Safety) Regulations 1994 as amended. SI 3260.
Definitions of Machinery

• An assembly fitted with or intended to be fitted with a drive system other than directly applied manual or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application.

• Lifting apparatus whose only power source is directly applied manual effort.
An assembly of machines and/or partly completed machinery which, in order to achieve the same end are arranged and controlled to function as an integral whole.
Definitions of Machinery

- Interchangeable equipment is a device which, after placing into service of machinery or tractor is assembled with that machinery or tractor by the operator himself in order to change its function.
Definition of a Safety Component

- Which serves to fulfil a safety function,
- which is independently placed on the market,
- the failure and/or malfunction of which endangers the safety of persons.
Safety devices that fall under the scope of the Directive
Annex V Indicative list:

- Extraction systems.
- Guards and protection devices.
- Control devices for calling lifting appliances and anti fall devices for hoists.
- Protective devices designed to detect the presence of a person.
- Safety belts and seat harnesses.
- Hydraulic non return valves where they are used to prevent falls.
Definition of a Safety Component
• If you are creating a complex assembly by interlinking a series of existing machines you are in effect creating something new.
• Therefore who ever is carrying out the work must ensure that the whole assembly complies with the Directive.
• Regardless of the age of the machines.
• If you are altering the function or performance of a machine or complex assembly you are again creating something new and must ensure that the Directive is complied with.
These regulations also applies to in-house machinery.

a) where the manufacturer of relevant machinery himself puts that machinery into service.

b) having imported machinery from a country or territory outside the EEA, puts that machinery into service.
The Four Steps to Compliance

1. Complying with the EHSR’s
2. Compiling the Technical Construction File (TCF)
3. Raising the Declaration of Conformity
4. Affixing the CE Mark
How to Comply – EHSR’s

- The Essential Health and Safety Requirement’s laid down in the Directives are mandatory.
- They are split into six sections:

1. General.
2. Foodstuffs, Medical.
3. Mobile Machinery.
4. Lifting Equipment.
5. Underground Machinery.
6. Lifting or Moving of Persons.
• The first EHSR 1.1.2 asks us to carry out a risk assessment.
• First we must identify all the hazards, that is any thing that has the potential to cause harm.
• Then we must assess the risk, that is the likelihood of a person or persons coming into contact with the hazard and how much damage it would cause.
• 1.3.1 Stability;
Machinery and its components must be designed and constructed that they are stable enough for use without risk of overturning, falling or unexpected movement. This requirement also applies during transportation, assembly, dismantling, scrapping and any other action involving machinery.
1.4.2.1 Fixed guards;

Must be fixed with systems that can be opened only with tools. Their fixing systems must remain attached to the guards when removed.

Where possible guards must be incapable of remaining in position without their fixings.
Step 2: The Technical Construction File

Technical Product Construction File
For the Robotic Stacker and Wrapper
Serial No LA 001

DATE: June 2004
Technical File Should Consist of

• a) a construction file including:

- a general description of the machinery,

- the overall drawing of the machinery and drawings of the control circuits, as well as the pertinent descriptions and explanations necessary for understanding the operation of the machinery,

- full detailed drawings, accompanied by any calculation notes, test results, certificates, etc, required to check the conformity of the machinery with the essential health and safety requirements,
Technical File Should Consist of

Overall drawing
Technical File Should Consist of

Detailed Drawings
Technical File Should Consist of

- the documentation on risk assessment demonstrating the procedure followed, including:

- a list of the essential health and safety requirements which apply to the machinery, means explaining how the machine complies with the requirement.
EHSR Checklist

EHSR Section 1

1.1.2 Principles of Safety Integration

1. Is the machine 'fit for its function' and can it be operated and maintained without placing persons at risk when operated as intended by the manufacturer?
   - Assessments:
     - EN 126-1
     - EN 1177
     - EN 100
   - Standards:
     - Safety of industrial trucks - Part 1: Operated trucks up to and including 10000 kg capacity.
     - Safety of industrial trucks - Part 2: Historical requirements - Part 2
     - Safety of machinery

2. Have risk assessments been carried out on the completed machine?
   - Assessments:
   - Standards:

3. Have risk assessments been carried out on the completed machine?
   - Assessments:
   - Standards:

4. Is there any residual risk have warnings been provided?
   - Assessments:
   - Standards:

5. Is there any residual risk will training be available where required?
   - Assessments:
   - Standards:

6. Has the manufacturer taken into account not only the normal use of the machine but all the uses which could reasonably be expected?
   - Assessments:
   - Standards:

7. Do the operating instructions draw the users attention to the way in which the machine should not be used?
   - Assessments:
   - Standards:

8. Has the machine design taken into account ergonomic principles to minimise the discomfort, fatigue, and psychological stress faced by the operator?
   - Assessments:
   - Standards:

(See Risk Assessments)
Technical File Should Consist of

- the description of protective measures implemented to eliminate identified hazards or to reduce risks and, when appropriate, the indication of the residual risks associated with the machinery, (Risk Assessment).

- standards and technical specifications used, detailing Essential Health and Safety Requirements covered by such standards,

- technical reports giving the results of the tests carried out either by the manufacturer or a body chosen by the responsible person,
Technical File Should Consist of

Sequence Number 7  Sort Number 4  High [75]
Section: 4  4.0 General Requirements
Question: 1  Is all electrical equipment suitable for its intended use and does it conform to relevant EN/IEC Standards? (Standard – EN 60204 4.2)

Hazard Description
Electric shock due to confusion as a result of the machine being fitted with more than one supply disconnecting device which are not clearly identified with their function.
Each individual panel having a main feed to an isolator should be clearly labelled as to where they are fed from.

Control Measures
Clearly identify each supply disconnection device with its function.
EN60204-1 clause 5.4

Notes

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Introduced 23 March 2011
Completed By
Completed Date
Implemented

Sequence Number 8 Sort Number 35
Section: 4  4.0 General Requirements
Question: 1  Is all electrical equipment suitable for its intended use and does it conform to relevant EN/IEC Standards? (Standard – EN 60204 4.2)

Hazard Description
Electric shock due to confusion as a result of there being inadequate identification of electrical conductors.

Control Measures
Ensure all cables and termination points are clearly identified by colour, markings or both such markings are transferred to the drawings, in accordance with BS EN 60204-1:2006+A1:2009, Clause 13.1 & 13.2

Notes

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Introduced 23 March 2011
Completed By
Completed Date
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Comments:
There appears to be a mixture of using cable sheath numbering and others where numbering has been manually tagged. Ensure the coding is correctly transferred to electrical drawings.

Printed on: 29 March 2011
Powered by M-Com Software from Laidler Associates
| www.laidler.eu | +44 (0)131 227 7777 | mail@laidler.eu | 9-2f-64
Technical File Should Consist of

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**EN13849 - Safety of Machinery 1:2008 - Safety Related Parts of Control Systems**

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**Project**

- **Job Number:** 29950
- **Name:** Pipe Handling System

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**Company:** Acme
- **Contact:**
- **Address:**
- **Telephone:**

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**Machine Details**

- **Serial Number:** 01
- **Type:** Pipe Handling System
- **Model:** 123456
- **Manufacturer:** Acme
- **Power Supply:** Nominal 3+ N + PE 400V, 50Hz.
- **Location:** Line 2
- **Building:** Manufacturing base 1
- **Area:** Production

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**Date Assessed:** 27/01/2011

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**EN13849 Assessment**

**Title:** Test 4

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**Severity:** 1
**Frequency:** 1
**Probability:** 1

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**Notes:**
Technical File Should Consist of

• a copy of the instructions for the machinery,

• where appropriate, the EC declaration of incorporation for included partly completed machinery and the relevant assembly instructions for such machinery,

• where appropriate, copies of the EC declaration of conformity of machinery or other products incorporated into the machinery,
Technical File Should Consist of

- a copy of the EC declaration of conformity;
- for series manufacture, the internal measures that will be implemented to ensure that the machinery remains in conformity with the provisions of the Directive. (Quality System).
Changes to Declaration of Conformity

• Name and address of the person who is authorised to compile the Technical File, who must be established in the European Community.
• Where appropriate a statement confirming declaration of conformity with other applicable directives.
• The place and date of the declaration.
• Must be typewritten or handwritten in capital letters.

It is illegal to affix the CE mark to a machine unless it complies with all applicable Directives.
Step 3
Declaration of Conformity or Incorporation.
This has to accompany the machine.
The Declaration of Incorporation is used with a machine which is specifically designed to be incorporated into a complex assembly and not capable of independent work.
Implementing the Work Equipment Directive
89/655/EEC.

Provision and Use of Work Equipment Regulations 1998

APPLIES TO ALL WORK EQUIPMENT NOW REGARDLESS OF AGE INCLUDING CE MARKED EQUIPMENT.
• Made under the Health & Safety at Work Act 1974.
• Only applies where the HSWA applies.
• Does not require a CE mark, Technical File or Declaration of Conformity.

• Mobile work equipment.
• Lifting equipment.
• The inspection of work equipment.

APPLIES TO ALL WORK EQUIPMENT, REGARDLESS OF AGE INCLUDING CE MARKED EQUIPMENT
If You Don’t Comply

• It could result in prosecution and penalties, on conviction, of a fine of up to
  a) On summary conviction £20,000 fine and or 3 Months in prison.
  b) On conviction on indictment unlimited fine and or two years imprisonment
  c) Many more prosecutions under PUWER than other Regulations
Part I  Introduction.
Part II  General. Regs 1 to 24
Part III Mobile Work Equipment. Regs 25 to 30
Part IV Power Presses. Regs 31 to 35
Part V  Miscellaneous. Regs 36 to 39

Regulations 1 to 9 with the exception of regulation 6 are to do with Policies and Procedures and look at Policies and Procedures, Maintenance, Operating Information, Training, Health and Safety Policies, etc.
• Where the safety of work equipment depends on installation it must be inspected

(a) After installation and before being put into service for the first time or

(b) After assembly at a new site or in a new location.

• Work Equipment exposed to conditions causing deterioration liable to result in a dangerous situation must be inspected
(a) At suitable intervals, and
(b) Each time circumstances liable to jeopardise the safety have occurred.

- The results of any inspection made under this regulation must be recorded.
- These records must be kept until the next inspection is recorded.
Regulation 6 - Inspection
The persons who determine the nature of the inspections required and who carry out the inspections are competent to do so.

The competent person deciding the nature of the inspection should have the necessary knowledge and experience to decide what the inspection should include, how and when it should be carried out.

The competent person carrying out the inspection should have the necessary knowledge and experience to know what to look at, what to look for, how and who to report to.

Covers things like Testing of Light Guards and Scanners etc.
Regulation 10 – Community Requirements

- Requires that an Employer must ensure that any equipment that is subject to European Directives complies with all applicable Essential Health and Safety Requirements of the Directives that apply to it.
• Regulation 11 – Access to Dangerous Parts of Machinery
• Regulation 12 – Specified Hazards, Fire, Heat etc
• Regulation 13 – High/Low Temperatures
• Regulation 14 – Start Controls
• Regulation 15 – Stop Controls
• Regulation 16 – E Stop Controls
Regulations 11-24

- Regulation 17 – Operating Controls
- Regulation 18 – Control Systems
- Regulation 19 – Isolation of Energy
- Regulation 20 – Stability
- Regulation 21 – Lighting
- Regulation 22 – Maintenance
- Regulation 23 – Markings
- Regulation 24 – Warnings
Regulations 25 - 39

- Regulation 25 - 30 – Mobile Work Equipment
- Other Regulations on Power Presses etc
- Revocation of Other Regulations
Machinery Safety Lifecycle – from design to disposal
Risk Assessment

- Carried out across all phases of the lifecycle of the machine
  - Design
  - Prototype
  - Installation
  - Operations
  - Process
  - Maintenance
• The first EHSR 1.1.2 asks us to carry out a risk assessment.
• First we must identify all the hazards, that is any thing that has the potential to cause harm.
• Then we must assess the risk, that is the likelihood of a person or persons coming into contact with the hazard and how much damage it would cause.
Identify the hazard

• Example;
• A manipulating robot is a hazard.
• A moving conveyor is a hazard.
• A pallet wrapper is a hazard.

Because they have the potential to do harm!
Assess the Risk

- That is the likelihood of a person or persons coming into contact with the hazard and how much damage it would cause.
Control Measures

- Design the hazard out.
- Remove the need for man machine interface.
- Design in safeguards.
- Reduce the possibility of occurrence.
- Reduce the degree of harm.
- Warn and inform (but only if you can achieve adequate safety).
Now we have decided on the control measures we must ensure that they will comply with the EHSR’s.

To do this we can use EuroNorm (EN Standards)
The EHSR’s are mandatory the EN Standards are not however:

“Machinery manufactured in conformity with specified published European Harmonised standards will be presumed to comply with Essential Health and Safety Requirements covered by those standards”
BS EN ISO 12100:2010
Safety of machinery
Basic principles for design.
Risk Assessment and risk reduction

BS EN 60204 - 1
Electrical Equipment

BS EN 13849-1
Safety-related parts of control systems.

BS EN ISO 13850
Emergency Stop

SPECIFIC PROTECTIVE DEVICE STANDARDS
2 Hand Controls
Light Curtains
Safety Switches etc

TYPE C STANDARDS for Machines
Examples of “B” Type Standards

• BS EN 953  Relates to the selection and manufacturing of Guards.
• BS EN 349 Relates to minimum gaps to prevent Crushing of the whole body
• BS EN ISO 13857 Relates to the positioning of guards to protect the upper limbs and the lower limbs.
Examples of C Type Standards

BS EN 415 Series “Safety of Packaging Machines” in 9 parts part 4 applies to Palletisers and De-Palletisers.

BS EN 10218 “Industrial Robots Recommendations for Safety”.

BS EN 12417 “Safety of Machine tools Machining Centres”.
### BS EN ISO 13857

#### Table 2 — Reaching over protective structures — High risk

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*Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.*

*Protective structures lower than 1 400 mm should not be used without additional safety measures.*

*For hazard zones above 2 700 mm, refer to 4.2.1.*
Enclosing Fixed Guard
Section: 11 Section 11: Dangerous Parts of Machinery
Question: 1 Is access to dangerous parts of the machinery protected?

### Hazard Description
Injury due to reaching into the machine from the infeed / outfeed due to inadequate tunnel guarding.

### Control Measures
Install suitable tunnel guarding to prevent personnel reaching hazardous parts of the machine at infeed / outfeed areas of the machine.

Fixed guard should be used where access is infrequent and the guards should be secured with fixings which require special tools to remove, when the fixings are removed the guard should not be able to remain in place.

Where frequent access is required (e.g. more than once per shift), moveable guards should be used which are fitted with positive acting interlocks. The interlocks must be fail safe safety devices and installed in accordance with the EN13849 risk assessment, refer to the attached report.

Tunnel guarding should be a minimum of 850mm long to prevent reaching into the danger zone. Care should also be taken when fitting tunnel guards that access is not possible from underneath the infeed or outfeed.

See EN953, EN13857 for further information

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**Notes**

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**Introduced** 01 May 2012

**Completed By**

**Completed Date**

**Implemented**
**Sequence Number:** 18  
**Sort Number:** 40  
**Low (7.5)**

**Section:** 1  
**Question:** Is the machine electrically safe?

**Hazard Description:**  
Electric shock hazard due to direct contact with live conductors. There are conductors that do not travel from fixed termination to fixed termination.

**Control Measures:**  
Ensure all conductors travel from terminal to terminal without joints or splices. EN60204-1:2006, clause 13.12

*Chocolate block and in-line crimp connectors are inadequate.*

**Notes:**

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**Introduced**  
01 May 2012  
**Completed By**  
**Completed Date**  
**Implemented**
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<td>Can safe maintenance be carried out on the machine?</td>
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### Hazard Description

Electric shock due to direct contact with hazardous live parts within the electrical enclosure.

* Main incoming neutral connection
* PSU terminals

### Control Measures

Ensure that live parts are located inside enclosures that provide protection against direct contact of at least IP2X.

EN60204-1:2006, clause 6.2.2

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<th>Completed By</th>
<th>Completed Date</th>
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<td>28 March 2012</td>
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ISO EN13849-1&2

Is a replacement for EN 954-1 can be used for any energy source.
ISO EN13849-1&2

- Introduces Performance levels (probability of a dangerous failure per hour) a,b,c,d,e.

- Based on the Safety Related Parts of the control system (SRP/CS).

- Data to be obtained from manufacturer Mean Time To (dangerous) Failure MTTD.
Four stage approach:

- Perform a risk assessment
- For the identified risks, allocate the safety measure (Performance Level (PL))
- Devise a system architecture that is suitable for the Performance Level
- Validate the design to check that it meets the requirements of the initial risk assessment
EN 13849-1
(Risikograph)

Performance level

Low risk

PL_r

a

b

c

d

e

High risk

Start

F1

F2

S1

S2

F1

F2

F1

F2

F1

F2

F1

F2

F1

F2

S = Severity of injury
S1: Slight (normally reversible) injury
S2: Serious (normally irreversible) injury or death

F = Frequency and/or exposure to the hazard
F1: Seldom to quite often and/or the exposure time is short
F2: Frequent to continuous and/or the exposure time is short

P = Possibility of avoiding hazard or limiting harm
P1: Possible under special conditions
P2: Scarce or possible