Risk profiles in the productive sectors of craft firms, small and medium enterprises and public shops:

ceramic sanitaryware

(Istat code number: 26.22)

RESEARCH REPORT

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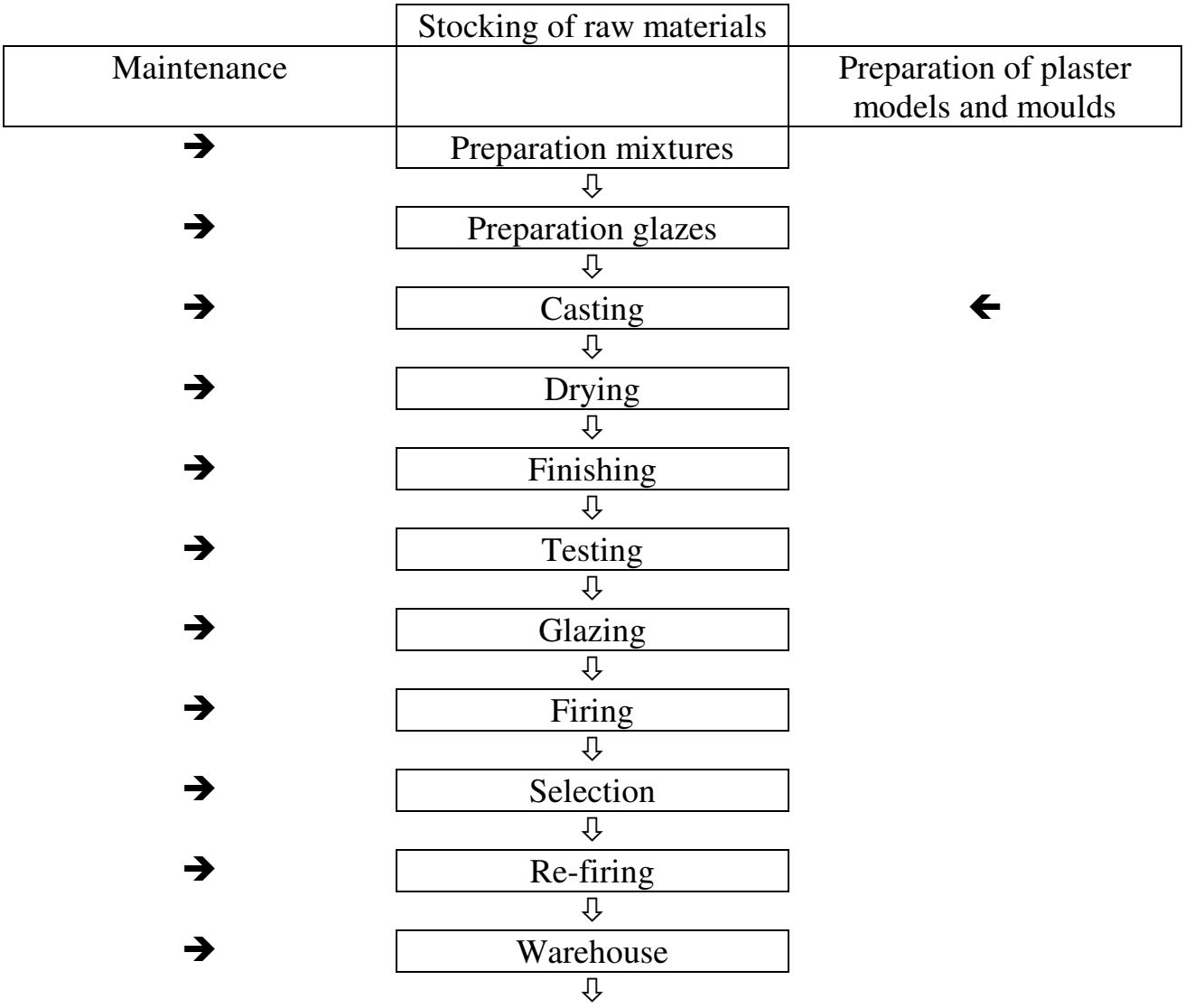
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I.S.P.E.S.L. **PROJECT *SI.PRE*.** **REGIONS**

NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**STORING OF RAW MATERIALS**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**DUST-NOISE-MICROCLIMATE-POSTURE**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**3**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**PREPARATION MIXTURES**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**DUST-NOISE- POSTURE- MECHANICAL RISKS - ELECTRICAL RISKS**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**17**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**PREPARATION GLAZES**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**DUST-NOISE- POSTURE- MECHANICAL RISKS - ELECTRICAL RISKS**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**17**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**PREPARATION PLASTER MOULDS**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**POSTURE- MECHANICAL RISKS - ELECTRICAL RISKS**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**102**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**CASTING**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**DUST - POSTURE - MECHANICAL RISKS -**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**472**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
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5. RISK CODE: (office use only)	
6. NO. WORKERS:	**35**

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1. SECTOR:	**CERAMIC SANITARYWARE**
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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**TESTING**
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6. NO. WORKERS:	**107**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
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6. NO. WORKERS:	**130**

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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**FIRING**
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5. RISK CODE: (office use only)	
6. NO. WORKERS:	**127**

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I.S.P.E.S.L. **PROJECT *SI.PRE*.** **REGIONS**

NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**SELECTION**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**MICROCLIMATE- POSTURE**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**39**

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I.S.P.E.S.L. **PROJECT *SI.PRE*.** **REGIONS**

NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**RE-FIRING**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**DUST-NOISE-MICROCLIMATE- LIGHTING-POSTURE- MECHANICAL RISKS-ELECTRICAL RISKS**
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6. NO. WORKERS:	**32**

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I.S.P.E.S.L. **PROJECT *SI.PRE*.** **REGIONS**

NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**WAREHOUSING**
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NATIONAL DATABASE OF SECTORAL RISK PROFILES

1. SECTOR:	**CERAMIC SANITARYWARE**
2. MANUFACTURING PHASE:	**MAINTENANCE**
3. INAIL CODE:	**7341**
4. RISK FACTOR:	**DUST-NOISE-MICROCLIMATE-VAPOURS-LIGHTING-POSTURE- ELECTRICAL RISKS-MECHANICAL RISKS**
5. RISK CODE: (office use only)	
6. NO. WORKERS:	**97**

Warehouse

Once the production cycle is complete, the product is packaged and made ready for shipment.

Manufacturing phase

In this area workers choose pieces, dividing them into the categories: colour, quality and series, and package them on wooden benches using polyethylene stretch wrapping. Top-quality pieces are packed in cardboard boxes.
Another type of packaging used to bind materials is that of thermoshrinking film, which is heated using a gas flame.
Noise levels in the warehouse unit are usually low despite high values for the palletisation flame (up to 90dB$_A$). Palletisation times are extremely short and background noise is practically inexistent (65-70dB$_A$), since the warehouse is usually set apart from production units and is very large, with few persons working therein.
Some firms possess grinding machines to rectify some types of wash basins.

Machinery and equipment

A small amount of machinery is present in the warehouse since most operations are concerned with the handling, selection and packaging of pieces, these operations being of a predominantly manual nature.
Warehouse machinery thus consists of:

◊ Trolleys for handling pieces and forklift trucks;

◊ Flames to heat stretch materials used for packaging.

Forklift trucks work practically throughout the working day. They are thus subjected to considerable mechanical stress and wear and tear. The turnover of machinery is thus rapid, meaning that machines remain state-of-the-art in terms of both production and regulatory aspects.
The latest grinding machines are endowed with EC labelling and are soundproofed, generating low noise levels.

Risk factors

Warehouse

1.	Possibility of contusions-distortions to hands and feet from falling pieces
2.	Collision with forklift trucks (shunters) and transpallets
3.	Presence of compressed inflammable gas / inflammable materials
4.	Manual handling of loads
5.	Risk of noise due to use of grinding machines

1) Possibility of contusions-distortions to hands and feet from falling pieces

When handling sanitaryware in the selection and packaging stages, workers may drop materials, crushing or injuring their feet.
For this reason workers should wear safety shoes specially designed to protect lower limbs from this danger.

2) Collision with forklift trucks (shunters) and transpallets
Specific risks are those connected with the handling of sanitaryware using forklift trucks.
The presence of a large number of sanitary pieces in storage units means that movement is not always simple, with the risk of colliding with pieces of machinery or with protection elements.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.

3) Presence of compressed inflammable gas / inflammable materials
As far as gas is concerned, such presence is limited to a low-capacity methane supply needed to power the pneumatic gun, or to a small LPG cylinder.
Easy-to-use flame-trap valves and manual disconnecting devices have been installed.
Upon the completion of work, the flexible tube is gathered and wound onto a specially constructed support.
This tube should be replaced at the first sign of damage, and in any case every five years.
With reference to inflammable materials (box board), the presence of cardboard adjacent to the palletisation zone is kept to a minimum, and there are notices banning the use of free flames and smoking inside specified areas.
Naked flames for palletisation operations are used in a suitably aerated area, equipped with a nearby fire extinguisher, by staff trained for this purpose.
Workers must wear suitable fireproof clothing, a face mask and gloves. Shoes should also be fireproof and easy to remove.
Palletisation operations are performed at a distance from other pallets, and the plastic cap should be of the type not propagating dioxin for heating.
Workers wear ear protection to defend themselves from the noise generated by the speed of emission of the flame.

4) Manual handling of loads
It should be considered that fired material has lost a further 20% in weight compared with the raw material as a result of firing operations, and is thus lighter and easier to handle, being more compact, unlike the raw material, which literally breaks up if it is moved at high speed and subjected to bumps.
Loads are however handled manually using transpallets, which are pushed by workers.

5) Grinding machines and wheels
The presence of abrasive grinding wheels and grinding machines in the unit pushes up noise levels to 82-83 $dB_{A.}$ The noise risk is mainly due to the rotation of the diamond grinding wheel on the piece.

Likely damage
Refer to the separate chapter on likely damage.

Intervention

With regard to the risk of injury to feet caused by dropped objects, it has been deemed necessary to make workers wear safety shoes endowed with a reinforced metal toe.
To minimise the danger of collisions with moving machinery, dangerous protuberances have been made more visible by being painted a striped yellow-green colour, while, where possible, runways for moving machines have been designed to leave room of at least 0.70m for persons to pass (although this space is no longer compulsory).
These runways are well demarcated by continuous yellow lines on the floor, which must always be kept in an efficient state.
Vehicles have also been fitted with a flashing light and siren for reversing.
To overcome the problem of noise caused by palletisation operations, experiments have been carried out with low-noise heating pistols, or pistols fitted with a system for conveying combustion gases, made in such a way as to prevent the formation of vortexes and thus reduce the noise generated by the machine.
To limit damage caused by noise, workers have been supplied with ear plugs and headphones. The use of this equipment is compulsory.
The results of the above experiments have unfortunately been disappointing, since the use of these pistols required the use of stretch film of reduced thickness that did not afford sufficient protection to palletised material that was then stored in outside yards exposed to climatic elements.
Grinding machines have been removed from all other manufacturing areas so as to reduce the noise level of the entire unit, and have been fitted with soundproof covers in order to reduce and in some cases practically eliminate its contribution to the generation of noise.

Outsourcing

None of the ordinary operations performed during this phase are contracted out to other companies.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase of production does not generate any sort of external risk, with the exception of possible packing operations using thermoshrinking materials.
Such operations generate atmospheric emissions, requiring suitable filtration before emission.
Waste products produced include broken pieces to be thrown away, which are put in a special bin and sent by a third-party firm to be crushed and produce chamotte; broken or useless packaging or cardboard, which are stored in a metal bin and sent to an authorised waste disposal site.
Harmful or toxic waste is not produced.

PREPARATION OF MIXTURES

The mixture used to manufacture sanitaryware articles is made using raw materials such as clays, kaolin, quartz, feldspar and chamotte for preparing fire-clay mixtures.
The preparation of the vitreous-china mixture does not differ greatly from that of fire-clay, apart from the different proportions of raw materials used (materials being the same) and the fact that chamotte (made up of fired pieces that are broken and ground) is added for fire-clay.
The usual composition of a vitreous-china mixture is as follows:

Ball-clays	20-28 %
Kaolins	25-35 %
Quartz	23-31 %
Feldspar	15-23 %
Soda	0.5-1%
Cobalt sulphate	0.5-1%

MANUFACTURING PHASE
The preparation of mixtures entails the following main phases:
Dispensing of raw materials
Dissolving of clays and kaolins (1st phase) inside the mixers or turbine mixers
Sifting and deferrisation of the fraction obtained
Mixing of the clayey suspension with quartz and feldspar (2nd phase), again inside the mixers or turbine mixers
Maturing of barbotine inside slow propeller-mixers.
The quartz and feldspar are removed from the silos using augers in sealed tubing, leading firstly to an automatic weighing machine and then, via other screw and worm conveyors, directly to the propeller-mixers or turbine mixers.
The materials stored in paper bags are poured out manually onto the conveyors' loading points or into the mouths of mixers.
Conveyor belts or power shovels are used to take clays and kaolins from concrete boxes to the mixers.
The obtained mixture is sifted using vibrating sieves, deferrised using electric or permanent magnets and sent to a second mixer, where the other raw materials are added. After further sifting and deferrisation operations, the mixture is sent to storage tanks fitted with slow propeller mixers to prevent heavier elements from precipitating.
The vitreous-china or fire-clay mixture is then stored in wells equipped with slow mixers until it needs to be sent via pumps to the central casting tubes to serve single machines or manual casters.

MACHINERY AND EQUIPMENT
Dispensing of Kaolins and clays:
These materials are dispensed using a power shovel or shunter endowed with loading bucket. Materials are usually dispensed in terms of volume, except when there are weighing systems, when dispensing is effected by weight.
Once dispensing operations are complete, raw materials are placed in rapid maritime-propeller mixers, consisting of cylindrical containers having a truck-tapered base, inside which an impeller ending in a maritime propeller proceeds to dissolve the product in the water.
To obtain even faster dissolving, some plants possess turbine mixers, that is to say mixers endowed with a special impeller permitting a better and faster mixing of the product with the water.
Storage of Quartz and Feldspar:
These are stored in steel silos, materials being loaded by means of compression, fitted with a filter capable of allowing air to flow outside, or in "big-bags", that is to say large dust-tight sacks.
From the storage silos materials are transported to weighing scales via auger extractors.
Raw materials are then weighed for dispensing purposes in order to be certain about what goes into the mixers.
There are also deferrisation filters and sieves that enable the mixture to be deferrised and form a smooth granulometry.

RISK FACTORS

1.	Possible inhaling of dust dispersed in the air containing crystalline silica during the loading and movement of raw materials
2.	Possibility of collisions owing to presence of forklift truck in the unit
3.	Possibility of falls from work stations suspended above stirrers and mixers
4.	Possible contact with belts transporting raw materials
5.	Possibility of collisions with obstacles placed on runways and work stations
6.	Exposure to impulsive and continuous noise from motors and conveyor belts in the unit
7.	Possible unevenness of floor owing to pits and holes
8.	Possible danger of physical damage caused by moving parts (rotating parts, moving belts)

9.	Possibility of falls owing to presence of clay mixes rendered slippery by presence of water
10.	Load handling-related problems
11.	Electrical risks

1.Possible inhaling of dust dispersed in the air containing crystalline silica
Powders are produced chiefly during the mixer or turbine mixer loading phases.
A centralised dust extraction system is thus in place, endowed with outlet hoods having speeds sufficient to prevent dust from being dispersed in the air and a direction of air movement that tends to take dust away from the worker (air suction hoods located above are to be avoided).
The collection speed on the front of the hoods ranges from 2 to 3.5 m/sec.
The same goes for weighing systems, which are fitted with a closed upper structure whose wall is marked off by rubber strips if they are loaded by scrapers or closed-lid trolleys, into which the material is placed directly from the silos.
All loading areas have been equipped with dust extraction points to prevent dust produced during the unloading of clay onto the scales, using devices equipped with buckets, from being dispersed into the air.
The entire dust extraction system flows into a suction filter endowed with a suitably permeable hose or cartridge filtering device.
This must ensure that the air sucked in deposits most of the transported dust before leaving the filter.
In addition to this plant engineering measure, there are procedures to be observed such as the use of individual protection devices (masks, respirators, etc.) with a degree of filtration appropriate to the powders involved (FFP2) during the main dust-producing phases.
The level of dust in the unit ranges from 0.81 to 1.49 mg/m^3 for breathable dust and from 0.07 to 0.47 mg/m^3 for dust containing free crystalline silica.

2**. Possibility of collisions owing to presence of forklift truck in mixing unit**
Specific risks are concerned with the possibility of being hit by internal vehicles (transpallets or shunters) moving in work areas.

3.**Possibility of falls from work stations suspended above stirrers and mixers**
Checks on the quality / properties of liquid barbotine are carried out from work stations that are sometimes raised above the unit's work floor.
Accident prevention protective devices are accordingly in place along the perimeter of these raised areas.

4.**Possible contact with belts transporting raw materials**
Specific risks relate to possible collisions with moving parts, such as belts transporting raw materials.

5.**Possibility of collisions with obstacles placed on runways and work stations**
Specific risks relate to the presence of protuberances and obstacles placed on runways and in work areas.
Owing to the large number of machines, it is not always easy to move down runways, with the consequent danger of colliding with pieces of machinery or protective parts.

6. **Exposure to impulsive and continuous noise**
Noise levels for the unit are generally high, especially during operations involving vibratory sieves, mixers, turbine mixers and pneumatic pumps.
The Lep,d of the mixture preparation unit ranges from 79 to 83 dB_A.

7. **Possible unevenness of floor owing to pits and holes and consequent danger of falls**
A hole is usually prepared in the mixture room to facilitate the loading of mixing wells and to satisfy the need to make the material transportation pumps work from below.
It is thus quite common to have quite deep wells (seldom exceeding 4 metres).

8. **Possible danger of physical damage caused by moving parts (rotating parts, moving belts)**
As there are a considerable number of machines whose moving parts consist of motors and gear motors, transmitting movement to rotating axes via belts, there is the danger of physical damage owing to accidental contact with these parts.

9. **Possibility of falls owing to slippery floors**
With water used almost continuously in manufacturing processes and cleaning operations, floors are often wet.
If cleaning operations are not effective, mixtures of water and raw materials can become extremely slippery, posing a serious threat to workers.

10.**Load handling-related problems**

Some load-handling operations (involving bins, raw material sacks, etc.) are performed manually.
Such operations may put a strain on workers' backbones, leading to a flexion and/or torsion of the bust.

11.High electric voltage - danger of electric shock
All machines are powered by electricity. The presence of water and humid conditions requires the rigorous application of electrical technical standards in order to avoid damage to persons and things.
All necessary measures have been adopted to cover against risks deriving from the use of electric energy, ensuring the safety of workers and integrity of machinery, namely:
*protection from direct contact: adoption of highly sensitive differential switches and earthing;
*protection from indirect contact: adoption of suitably insulated materials and covering, opening of instrument board only possible using special tool or upon interruption of supplies (cutter block);
*general protection: magneto-thermal switch, suitable wire sections to avoid overheating, instrument boards located in such a way as to avoid being damaged, cleaning of inside of instrument board, ensuring that no foreign bodies enter;
*preventive maintenance: regular tightening of screws to avoid overheating or malfunctioning, substitution of mechanically or electrically worn pieces;
* non-combustible cables of a suitable voltage class.
The coverings of electric switchboards should be insulated to a degree appropriate to the installation environment (minimum IP44, in view of the presence of water and dust in the unit).
These should be kept clean and free of obstacles; they should only be opened using a special tool or must be endowed with a switch having cutter block.
All structures must be directly earthed, and power lines should be derived from highly sensitive differential switches designed to protect workers from direct contacts.
Untrained and unauthorised staff should also be prevented from modifying the safety devices or circuitry of instrument boards.

LIKELY DAMAGE
Refer to separate chapter on likely damage.

INTERVENTION
Actions aimed at reducing risks deriving from the inhalation of silicosis-producing dust include:
Dust extraction devices located at emission points with hoods having a collection speed ranging from 2 to 3.5 m/sec;
Filtering device adequate for the dust being treated, having an efficiency of at least 85% for dust exceeding 1 micron in size;
Use of individual devices to protect respiratory tracts, having a degree of filtration of at least FFP2;
To minimise the danger of collisions with moving machinery, where possible, runways for vehicles have been designed to leave room of at least 0.70m for persons to pass (although this space is no longer compulsory).
These runways are well demarcated by continuous yellow lines on the floor.
All vehicles have also been fitted with a flashing light and siren for reversing.
Workers driving these vehicles must work with the utmost caution, avoiding sudden manoeuvres that could cause damage to persons and things.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.
Notices are also displayed warning about the presence of moving vehicles.
To avoid falls from raised work areas standard railings are fitted (100cm in height, a strip halfway down and foot-stop 15cm from ground level) where necessary.
To minimise the risk of contact with belts transporting raw materials, any dangerous protuberances have been rendered more visible.
To minimise the danger of contacts owing to the presence of obstacles on runways, dangerous protuberances have been rendered more visible by the addition of yellow-black stripes.
These runways are well demarcated by continuous yellow lines on the floor and must always be kept in an efficient state.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.
Noise levels in the unit are kept in check in the following ways:
- for vibratory sieves: correct maintenance (scheduled substitution) of damping seals of sieves (which harden as they age, transmitting vibrations not required for their functioning);
- for mixers: close the doors of the openings required for their loading;

- for pumps: the use of suitable silencers or rubber tubing placed on the air outlet tube, terminating in non-airtight plastic tanks. This has brought about a significant drop in the noise produced, this being particularly harmful and bothersome as it is impulsive;
- in periods in which the above equipment is working, workers have orders to wear personal protection devices (headphones, ear plugs, etc.) appropriate to the degree of noise generated.

The correct maintenance of machinery and timely repair of any defects also helps to avoid the gradual increase in noise levels owing to the deterioration of bearings or other rotating parts.
To reduce the level of risk relating to the presence of holes in the mixture preparation room, the zones in question have been bordered off with standard metal railings (with smooth banisters, separation bar and foot-stop).
Access to the area is via a staircase having antislip steps, accidental access to which is prevented by a chain fixed with spring catches.
Hole bases are built with a slight inclination towards a drain for possible liquid spills and to facilitate cleaning operations.
Care has also been taken with the lighting of staircases and underground passages, be they uncovered or below the floor.
Passages consist of grates or antislip sheets, which tend to become dirty and wet, and include entrance stairs, accidental access to which is prevented by a chain fixed with spring catches.
To avoid risks deriving from moving parts, all belts and chains have been covered with protective finger-proof sumps and compartmented moving parts.
The same goes for suction-fans which, if they are within reach, are fitted with protective meshes around moving parts.
To minimise the risk of falls in the unit, floors are cleaned thoroughly on a daily basis, and special care is taken to minimise floor unevenness owing to the accumulation of dirt and of possible snags.
Workers have also been equipped with antislip, safety shoes.
To limit load handling-related problems, heavy loads, particularly loads in excess of 30 kg, are to be lifted gradually and with the aid of another person or special equipment. Staff are also supplied with information on the correct movement and handling of loads and on possible damage deriving from incorrect performance.

OUTSOURCING
None of the ordinary operations performed during this phase are contracted out to other companies

REFERENT LEGISLATION
Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- All other laws in place in our State on the subject of occupational health and safety.

EXTERNAL RISK
This phase generates atmospheric emissions, especially during material dispensing operations, Before flowing outside the plant, the fluid stream is conveyed through a suitable installation fitted with a dry filter.
The water used for cleaning operations in the unit is transported to the water treatment plant where, together with other water coming from the entire plant, it undergoes a deflocculation process in compliance with the parameters of “Merli" law 319/76. Once this treatment is complete, some firms in the district send the product to a disposal plant.
More and more firms however are re-utilising recycled water. Once it is treated, it is returned to a preferential network of industrial water for supplementary uses (cleaning, removal systems, etc.). This system makes it possible to reduce the amounts of water taken directly from underground sources, minimising the cost of reagents and, if recycling is 100%, firms can avoid the journey to a disposal plant.
Waste produced consists chiefly of leftover mixture, which is temporarily stored in suitable bins and subsequently re-used.

Preparation of glazes

In the ceramics industry glazes are based on water without solvents. They are suspensions of clay and oxides reduced to a given granulometry by means of grinding using drum-ball mills.
The breakdown in weight of glazes used for sanitaryware is as follows, remembering that water makes up around 40% of the total:

Potassium Feldspar	15 %
Soda Feldspar	15 %
Dolomite	5 %
Kaolin	13 %
Barium Carbonate	6 %
Calcium Carbonate	6 %
Quartz	30 %
Zirconium Silicate	10 %

Manufacturing phase

Work begins by loading the clay, oxides and other materials in the ball mills.
The sacks of materials are placed on top of the non-operative mill. Materials are loaded into the mill through a trap door using a funnel.
When the material has been loaded, the door is closed and the mill is set in motion for as long as needed for grinding purposes.
The mix is put into grinding drums to obtain a special granulometry with a low residue.
Once milling is complete, the glaze is removed using a special tap fitted on the drum. It is then deferrised using an electro-magnet, after which the largest pieces are removed using a vibratory sieve.
After all these cleaning operations the glaze is stored in a plastic vat ready to supply, using compressed air pumps, the aerographs used to glaze pieces.
Noise levels are quite high during the grinding process (sometimes over 90 dB_A). The mill rotating operation is thus performed in evening and night-time periods when workers are not present.

Machinery and equipment

◊ Grinding mills

Grinding mills consist of steel cylinders having a ceramic material coating on the inside (silica or porcelain or alubit brick).
The grinding parts inside the machine are cylindrical spheres of the same material as the inside coating.
Mills are powered by gear motors coupled to cylinders via a V-type belt.
Mills are protected by means of barriers having gates fitted with a safety stroke end that blocks rotation when the gates are opened.

◊ Deferrisation and sieving system

The deferrisation system consists of deferrisation filters that work using permanent magnets that help capture the ferrous particles that might be present in the glaze.
Gravity causes the glaze to flow through the filters and move towards a vibratory sieve having a stainless steel mesh, which keeps granulometry under control.
The machines used in this unit are quite old since, with grinding drums being coated on the inside, the internal part is periodically replaced or restored, and firms in the district have proceeded to bring existing facilities up to current standards through the compartmenting of their installations.

New, EC labelled machines are used in new installations, and constitute a low percentage of the total (around 5%).

Risk factors

1	***Possible inhalation of dust containing a high percentage of silica***
2	***Possibility of collisions owing to presence of shunter in glazing room***
3	***Possibility of falls from work areas located above mills***
4	***Possibility of collisions with obstacles placed on runways and in work areas***
5	***Possible exposure to relatively high impulsive and continuous noise***
6	***Possible unevenness of floor (holes for wells, etc.) and consequent danger of falls***
7	***Possibility of physical damage from moving parts (rotating parts, belts, etc.)***
8	***Possible falls owing to slippery floor***
9	***Load handling-related problems***
10	***High electric voltage - danger of electric shock***

1.Possible inhalation of dust containing a high percentage of silica

Dust is produced chiefly during drum-loading phases.
The sacks of raw materials are loaded onto a mezzanine floor above the drums using a forklift truck.
The contents of the sacks are poured from the pallet using funnels into the rotating drums.
A centralised air suction system is thus in place, endowed with outlet hoods having speeds sufficient to prevent dust from being dispersed in the air and a direction of air movement that tends to take dust away from the worker (air suction hoods located above are to be avoided).
The speed on the front of the hoods ranges from 2 to 3.5 m/sec.
The entire suction system flows into a suction filter endowed with a suitably permeable hose or cartridge filtering device.
This must ensure that the air sucked in deposits most of the transported dust before leaving the filter.
In addition to this plant engineering measure, there are procedures to be observed such as the use of individual protection devices (masks, respirators, etc.) with a degree of filtration appropriate to the dust involved (FFP2) during the main dust-producing phases.
The level of dust in the unit ranges from 0.81 to 1.49 mg/m^3 for breathable dust and from 0.07 to 0.47 mg/m^3 for dust containing free crystalline silica.
A product (zirconium silicate) is used in the glaze that contains traces of uranium and torium that emit radioactivity.
The level of dust is kept low however by the suction systems rendered necessary by the presence of free crystalline silica.

2.Possibility of collisions owing to presence of shunter in glazing room

Specific risks are concerned with the possibility of being hit by internal vehicles (transpallets or shunters) moving in work areas.
To minimise this danger, where possible, runways for vehicles have been designed to leave room of at least 0.70 m for persons to pass (although this space is no longer compulsory).

These runways are well demarcated by continuous yellow lines on the floor, which must always be kept in an efficient state.
All vehicles have also been fitted with a flashing light and siren for reversing.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.

3. Possibility of falls from work areas located above mills

The elements of which glazes are made up are loaded from work areas that are raised above the unit's ground level.

4.Possibility of collisions with obstacles placed on runways and in work areas

Specific risks relate to the presence of protuberances and obstacles placed on runways and in work areas.
Owing to the large number of machines, it is not always easy to move down runways, with the consequent danger of colliding with pieces of machinery or protective parts.
To minimise this danger, dangerous protuberances have been rendered more visible by the addition of yellow-black stripes.
These runways are well demarcated by continuous yellow lines on the floor and must be kept in a permanent state of efficiency.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.

5. Possible exposure to relatively high impulsive and continuous noise

Noise levels for the unit are generally high, especially during operations involving drums, vibratory sieves and pneumatic pumps.
Workers' mean exposure to noise in the glaze preparation unit varies between 72 and 81 dB_A.
A recently constructed factory has recorded the lowest noise levels thanks to extensive available space and a sufficient number of mills that can work when staff are not present. The highest levels have been recorded at a firm where the unit is not adequately separated from other units and where the number of mills is inadequate.

6. Possible unevenness of floor (holes for pits, etc.) and danger of falls

A hole is usually dug in the glaze preparation unit for the loading of underground grinding drums.
It is thus quite common to have quite deep shafts (seldom exceeding 4 metres). To avoid connected risks, the zones in question have been bordered off with standard metal railings (with smooth banisters, separation bar and foot-stop).
Access to the area is via a staircase having antislip steps, accidental access to which is prevented by a chain fixed with spring catches.
Hole bases are built with a slight inclination towards a sort of drain for possible liquid spills and to facilitate cleaning operations.
Care has also been taken with the lighting of staircases and underground passages, be they uncovered or below the floor.
Passages consist of grates or antislip sheets, which tend to become dirty and wet, and include entrance stairs, accidental access to which is prevented by a chain fixed with spring catches.

7. ***Possibility of physical damage from moving parts (rotating parts, belts, etc.)***

As there are a considerable number of machines whose moving parts consist of motors and gear motors, transmitting movement to rotating axes via belts, there is the danger of physical damage owing to accidental contact with these parts.

To avoid risks deriving from moving parts, all belts and chains have been covered with protective finger-proof sumps.

The same goes for the fans of suction systems which, if they are within reach, are fitted with protective meshes around moving parts.

Another source of danger are the rotating drums, whose area is marked off by robust metal structures that can only be removed using special tools. Openable parts are fitted with standard cutter blocks (positive opening or safety stroke end with key that cannot be tampered with).

Another danger is represented by drum loading and unloading phases, when the worker moves close to the moving part; this must be still and blocked (using brakes or mechanical blocks of varying types).

It is also good practice to ensure that one side of the drum is in contact with a side wall and that the drum rotates in the direction of the wall to minimise the risk of rolling should a hub or base give way.

8. Possible falls owing to slippery floor

With water used almost continuously in manufacturing processes and cleaning operations, floors are often wet.

If cleaning operations are not effective, mixtures of water and raw materials can become extremely slippery, posing a serious threat to workers.

9.Load handling-related problems

Some load-handling operations (involving bins, raw material sacks, etc.) are performed manually or using trolleys or transpallets.

Such operations may put a strain on workers' backbones, leading to a flexion and/or torsion of the bust.

10.High electric voltage - danger of electric shock

All machines are powered by electricity. All necessary measures have been adopted to ensure the safety of workers, namely:

*protection from direct contact: adoption of highly sensitive differential switches and earthing;

*protection from indirect contact: adoption of suitably insulated materials and covering, opening of instrument board only possible using special tool or upon interruption of supplies (cutter block);

*general protection: magneto-thermal switch, suitable wire sections to avoid overheating, instrument boards located to avoid being damaged, cleaning of inside of instrument board, ensuring that no foreign bodies are introduced;

*preventive maintenance: regular tightening of screws to avoid overheating or malfunctioning, substitution of mechanically or electrically worn pieces;

* non-combustible cables of a suitable voltage class.

The coverings of electric switchboards should be insulated to a degree appropriate to the installation environment (minimum IP44, in view of the presence of water and dust in the unit).

These should be kept clean and free of obstacles; they should only be opened using a special tool or must be endowed with a switch having cutter block.

All structures must be directly earthed, and power lines should be derived from highly sensitive differential switches designed to protect workers from direct contacts.
Untrained and unauthorised staff should also be prevented from modifying the safety devices or circuitry of instrument boards.

Likely damage

Refer to separate chapter on likely damage.

Intervention

With regard to the danger of the inhalation of dust during pouring operations, mobile air suction devices have been installed at loading points to collect dust produced during mill-loading operations.
The fluid stream, containing the dust collected from air suction points, flows into a filter situated outside the plant, together with the fan used for relative suction operations.
The suctions hoods are connected to the fixed transportation system using flexible tubes, adding to the mobility of the hoods and enabling the worker to improve their position.
Hoods are placed opposite the worker so as to avoid the Aerosol effect.
Zirconium silicate is supplied in small quantities, sufficient to meet the needs of a few days. This material is stored in a safe place and kept under surveillance.
As regards the risk of collisions with vehicles, structural measures have been adopted for the building, with the creation of runways, notices warning of obstacles and structural alterations to machines, with the addition of flashing lights and reverse warning sirens.
Measures have also been taken to provide staff with training and information about load-handling practices.
To avoid falls from raised work areas, accident prevention protection has been installed along the sides of these areas, consisting of standard railings (100cm in height, a strip halfway down and foot-stop 15cm from ground level).
Efforts have been made to reduce noise levels in the following ways:
- grinding drums are located in positions separate from working areas. Workers are present only for strictly necessary operations, i.e. loading and unloading.
- for vibratory sieves: correct maintenance (scheduled substitution) of damping seals of sieves (which harden as they age, transmitting vibrations not required for their functioning);
- for pumps: the use of suitable silencers for parts where compressed air is unloaded. This has brought about a significant drop in the noise produced, this being particularly harmful and bothersome as it is impulsive;
- in periods in which the above equipment is working, workers have orders to wear individual protection devices (headphones, ear plugs, etc.) appropriate to the degree of noise generated;
- the correct maintenance of machinery and timely repair of any defects also helps to avoid the gradual increase in noise levels owing to the deterioration of bearings or other moving parts.

Drums are compartmented using gates endowed with a safety stroke end to prevent the mill from rotating if the gates are opened. The drum hub has also been endowed with a brake to keep the drum still during loading phases.
To minimise the risk of falling in the mixture preparation unit, floors are cleaned thoroughly on a daily basis, and special care is taken to minimise floor unevenness owing to the accumulation of dirt and possible snags.
Workers have also been equipped with antislip, safety shoes.

To limit load handling-related problems, heavy loads, particularly loads in excess of 30 kg, are to be lifted gradually and with the aid of another person or special equipment. Staff are also supplied with accurate and specific information.
This unit has adopted the use of low voltage-powered electric commands because of the considerable presence of water.

Outsourcing

None of the ordinary operations performed during this phase are contracted out to other companies.

Reference legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- Law 319/77 and all Community directives pertaining to the disposal of wastewater produced by manufacturing cycles
- the framework law on noise pollution (Law 447/1995) for noise emissions generated outside the plant
- UNIEN 294 for the protection of workers in relation to contacts with moving parts and UNIEN60204/1 concerning electric installations on board machines
- all other laws in place in our State on the subject of occupational health and safety

External risks

This phase generates atmospheric emissions, especially during material dispensing operations. Before flowing outside the plant, the fluid stream is conveyed through a suitable installation fitted with a dry filter.
The level of dust flowing out of the filters to outside the plant ranges from 5 to 10 mg/m^3.
Any water used in cleaning systems is transported to the water treatment plant where, together with other water coming from the entire plant, it undergoes a deflocculation process in compliance with the parameters of “Merli" law 319/76. Once this treatment is complete, some firms in the district send the product to a disposal plant.
More and more firms however are re-utilising recycled water. Once it is treated, it is returned to a preferential network of industrial water for supplementary uses (for cleaning systems, etc.). This system makes it possible to reduce the amounts of water taken directly from underground sources, minimising the cost of reagents and, if recycling is 100%, firms can avoid the journey to the disposal plant.
The waste produced consists chiefly of empty sacks that contained glaze ingredients. These sacks are stored in a metal bin before they are sent to an authorised waste disposal site.

Modelling, Preparation of Plaster Moulds, Casting of Dies

This unit is concerned with the study of the forms of pieces to be produced and the construction of prototypes, in plaster or resin, of pieces that will then enter production.
The same unit deals with the material execution of dies needed for all the factory's casting machines.
The plaster needed to meet the unit's requirements is stored in a steel silo outside the plant and extracted using a rotating mixing screw.

Manufacturing phase

The die preparation unit is currently the most artisanal part of the entire sanitaryware-producing factory.
This unit creates plaster models which, with appropriate counter-deformations, will go to reproduce the piece in the desired form, taking into account the process that the piece will undergo during the firing phase.
The starting point is a block of plaster that is cast inside a standard mould (WC, bidet, basin, etc.)
This block is cast inside a die and is left to dry for about one day.
On the following day the block is worked manually by the worker using flat trowels, sharpened scrapers and sand paper, to bestow upon the piece a smooth and honed look, practically the finished piece.
Compressed air is used to remove residue material.
Once complete, the original is ready to be used as a model for the preparation of the resin mould.
Preparations for the resin mould begin with the preparation of a form-work inside which the mould itself will be cast using a mixture of resins.
Carbon steel reinforcing rods are sometimes placed in the form-work, and are set by welding.
The plaster mould is fixed to the form using clamps, then the resin is cast and left to dry for at least one day.
When the original plaster mould has been removed from the resin mould, the plaster moulds to be used for industrial production are cast.
The industrial production of moulds is effected by casting the dissolved plaster with water inside the previously prepared resin moulds.
The mould is filled using a bucket that empties the container in which the plaster was dissolved in water.
Once the water-plaster mix has reached the right consistency inside the mould, it is removed using compressed air.
Once detached, the mould is set, being allowed to dry on top of pilework, placed thereon using electrical transpallets or shunters.

Dissolving and casting of plaster

The plaster is stored inside steel silos, where it is loaded from the supply tank using a compressor located on the tank. This operation is performed by the firm supplying the plant with raw materials.
On the top of the silo is a counterweight safety valve and a filter to reduce the release of dust during silo loading operations caused by the tank's compressor.
Depending on production needs, plaster is taken from the silo using auger extractors connected to the base of the silo. From here the plaster is transported to the loading point of the container, inside which the plaster will be mixed with water.
At this point plaster dust is released into the air.
Once the desired quantities of plaster and water are loaded into the container, the plaster is dissolved using a maritime-propeller mixer rotating at a speed of between 100 and 500 r.p.m.

Once dissolved, the plaster is taken on a trolley to the casting point and placed inside the resin mould for casting.
When casting operations are complete, the containers are cleaned using a plastic or wooden mallet to remove any plaster stuck to the container.
Risks:
Possibility of inhaling dust produced during unloading of the plaster from the silo using the auger extractor
Electrical risks due to working with electric switchboard
Mechanical risks due to working in vicinity of maritime-propeller mixer rotating at high speed
Risks due to handling of loads on top of trolleys
Risks due to handling of sacks full of plaster and water
Methods to avoid risks:
The plaster unloading point from the silo to the end of the conveyor belt is equipped with a suitable suction device to keep the level of breathable plaster dust below the limit specified by the manufacturer in its safety handbook.
Controls are low-voltage and the electrical installations conform to standards for humid-zone installations (IP44).
The maritime-propeller mixers are fitted with devices to prevent rotation until the propellers have reached the down position.
Workers are taught how to make correct use of transpallets and to adopt the 30 kg/person criterion when handling loads.

Dissolving and casting of resins
Resins usually consist of two elements, that is they are made of two products brought together to provoke the catalytic reactions needed to produce the desired properties for these products.
The dissolving phase begins with the dispensing of raw materials in the container used for dissolving. Other products are often mixed in with the resins to enhance the qualities of hardness, robustness, etc.
Having dispensed the products to be dissolved, dissolving begins, using a mixer with a rotating propeller set at an orthogonal angle to the ground.
Once the mix has reached the desired characteristics, it is cast in the form-work in which the original plaster cast is housed. The cast mould is then placed inside a box endowed with a system of ventilation to allow vapours leaving the container to disappear by the next day.
Risks:
Possibility of inhaling vapours produced by solvents or resins
Electrical risks due to working with electric switchboard
Mechanical risks due to use of mixers.
Methods to avoid risks:
Resins are prepared and cast in a suitably equipped room endowed with an air suction device for changing the room's air during such operations, so as to maintain a low concentration of volatile elements of resins.
Ventilation systems are capable of changing the room's air 2 to 5 times an hour.
This room has a single wing door with an emergency slide-handle.
The resin preparation room is equipped with a dry powder extinguisher located in a zone within easy reach of workers.
The above operations are performed by a worker endowed with a respirator having activated charcoal filters that can keep breathable values below the limits recommended by the suppliers of raw materials in their safety handbooks.
The electric installation in the resin preparation room should have a degree of protection at least up to IP44, with non-combustible wires and flame insulating joints in wall crossings.

The mixer for dissolving resins is low-voltage and is endowed with an insulation transformer.

Storage of plaster moulds
Prepared plaster moulds are set and stored on top of shelves consisting of metal pilework using electrical lifting devices; they are brought down via the same means.
Risks:
Handling of loads with the aid of mechanical devices
Possibility of workers colliding with other moulds present on shelves.
Methods to avoid risks:
Runways should be adequately marked and serviced;
Workers using mechanical devices should receive appropriate training about their job;
The deposit zone should be off limits to unauthorised personnel.

Machinery and equipment

Speedy mixers for mixing the plaster with water and resins
Steel silos, fitted with filters on top, for the storage of ventilated plaster
Welding machines for making iron rod reinforcements
The machines present in this unit appear to be quite old, since the technological level required is quite low, almost all work being artisanal in nature.

Risk factors

Preparation of Moulds / Dies

1.	Possibility of mechanical traumas caused by cutting instruments for the modelling of plaster moulds
2.	Possibility of inhaling debris and dust produced by modelling and the blowing of plaster models, as well as welding fumes and plaster dust
3.	Handling of loads
4.	Possibility of loads falling on workers' feet
5.	Risks connected with the circulation of unit vehicles (shunters, transpallets, etc.)
6.	Noise due to compressed air devices used to detach moulds and to blowing of debris during phases
7.	Risks tied up with the possible inhaling of epoxy resins during catalysis

1.Possibility of mechanical traumas caused by cutting instruments for the modelling of plaster moulds

The use of manual equipment (with blades and sharpened edges) to execute and finish the model may cause physical damage (cuts, pricks, abrasions, etc.)

2.Possibility of inhaling debris and dust produced by modelling and the blowing of plaster models, as well as welding fumes and plaster dust

Dust are produced chiefly when plaster is used.
In special areas (weighing, mixing, etc.), air suction systems are in place, endowed on the outside with a filter having a degree of filtration suitable for the material being removed.
This ensures that prior to leaving the filter, the air sucked up has deposited most of the transported dust.
This means that it is important to carry out the scheduled maintenance of all suction and removal systems. This job should be performed with great care, these systems having a high concentration of dust.

3. Handling of loads

Some handling operations are performed manually.
Such operations may put a strain on workers' backbones, leading to a flexion and/or torsion of the bust.

4.Possibility of loads falling on workers' feet

When moving portions of dies and models, workers may drop materials and crush or injure their feet.

5. Risks connected with the circulation of unit vehicles (shunters, transpallets, etc.)

The specific risks pertain to the possibility of being hit by internal vehicles (e.g. transpallets or shunters) moving inside buildings.

6.Noise due to compressed air devices used to detach moulds and to blow debris during phases

Noise levels in this units are generally not high, with the exception of the phase for the removal of moulds and blowing of debris, during which compressed air is used. As this work is practically totally artisanal in nature, few pieces are produced by each worker (4-5 pieces a day per worker).
In a large factory (producing about 1,000 sanitaryware items a day), 5 workers are employed in the modelling unit.
When the above machines are in use, workers have orders to wear individual protection devices (headphones, ear plugs, etc.) appropriate to the degree of noise generated.
The correct maintenance of machinery and timely repair of any defects also helps to avoid the gradual increase in noise levels owing to the deterioration of bearings or other moving parts.

7.Risks tied up with the use of epoxy resins

Specific risks are those connected with the possibility of breathing in epoxy resins during the catalysis phase.

Likely damage

Refer to the separate chapter on likely damage.

Intervention

Workers should wear gloves to protect their hands and have been notified of the risks connected with the activity performed.
Suction systems, located at points where plaster is used, are capable of "self-cleaning", minimising the need for extraordinary human intervention.
In addition to this plant engineering measure, there are procedures to be observed such as the use of individual protection devices (masks, respirators, etc.) with a degree of filtration appropriate to the dust involved.
Prevention action includes the company's instructions for performing such operations with the utmost care and gradually (e.g. avoid sudden unloading of materials, etc.), warning workers not to adopt free blowing during cleaning operations in non-aspirated zones, as this could scatter dust and extend the area of risk.
To limit load handling-related problems, heavy loads, particularly loads in excess of 30 kg, are to be lifted gradually and with the aid of another person or special equipment.

To avoid injuries caused by objects falling on feet, safety shoes specially designed to protect lower limbs from this danger should be worn.
To minimise the danger of collisions with moving machinery, where possible, runways for moving machines have been designed to leave room of at least 0.70m for persons to pass.
These runways are well demarcated by continuous yellow lines on the floor, which must always be kept in an efficient state.
Vehicles have also been fitted with a flashing light and siren for reversing.
Workers driving these vehicles must work with the utmost caution, avoiding sudden manoeuvres that could cause damage to persons and things.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.
Notices are also displayed warning about the presence of moving vehicles.
For the welding area a mobile suction cap fitted with a filter suitable for welding fumes is used.
Workers are supplied with suitable face masks to keep down the level of plaster dust breathed in and with safety shoes fitted with reinforced toes.
Runways inside the unit must be well marked and correctly maintained. Workers in charge of transport vehicles in the unit are trained and informed about the use of vehicles.
When plaster pieces are removed from the resin moulds, workers must wear ear plugs or headphones regardless of the noise level reached in the room.
With regard to the risk of inhaling epoxy resins, these resins are prepared inside a box endowed with a suction device, and workers are supplied with respirators having activated charcoal filters to make air breathable.

Outsourcing

None of the ordinary operations performed during this phase are contracted out to other companies.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety

External risk

This phase generates atmospheric emissions especially during material dispensing operations. Before flowing outside the plant, the fluid current is conveyed through a suitable system fitted with a dry hose or braided filter capable of "self-cleaning" by means of a blast of compressed air.
Waste produced is made up chiefly of plaster residues, which are temporarily stored in special bins before being sent to waste disposal sites.

Casting

Sanitary articles are moulded through barbotine casting using porous plaster moulds. Water is slowly absorbed, solidifying the mixture which forms a thin layer around the wall of the mould. This layer gradually thickens.
This process continues over time but gradually slows down because of the lengthening of the time needed for the water to cross the thickness of the layer already formed and because of the degree of saturation of the capillaries.

Manufacturing phase

Moulding by casting of both fire-clay and vitreous-china articles may be carried out manually or mechanically.
The distinction between manual and mechanised casting is concerned solely with the different way of moving moulds, which in the former case is performed by the caster and in the latter case with the aid of the machine used.
In the case of mechanical casting, machines that allow the automatic closure of plaster moulds, within which barbotine is poured using pumps, are used.
Having opened the moulds by means of automatic pattern-draw machines, of varying size and shape depending on the production item, workers remove pieces from the moulds and place them on appropriate trolleys, where they are left to dry for a longer period of time.
When the mixture reaches a certain raw resistance, the article can be moved either manually or mechanically.
Once casting is complete, the plaster moulds are quite humid. To reduce the high percentage of humidity a system of channels is used to feed heat in proximity to the dies. The grid is placed below the dies themselves, and heat can be fed through the use of hot air directly over the dies or through tubes containing hot air fuelled by hot air generators.
After having heated the portions making up the dies, the hot air, being saturated with humidity, is expelled.
The die drying operation is performed without the presence of personnel in the plant.

Equipment and machinery

Equipment required for manual and mechanised casting consists of:

- ◊ barbotine distribution equipment, in the form of tubing allowing the supply of the mixture in liquid form from storage tanks to the inside of plaster moulds;
- ◊ manual casting areas, consisting of wooden frames on which the die portions are laid. Once they are fitted, assembled and tightened, these portions constitute the basis for the casting of sanitary articles.
- ◊ semiautomatic and automatic mechanised casting frames, basically consisting of casting frames where dies are moved along tracks or using other systems, relieving the caster of fatigue;
- ◊ mechanised casting frames endowed with a drawing lever; in addition to the functions of automatic casting frames, these reduce effort required for the drawing of pieces from dies and for their placement on storage tables.

Mechanised casting equipment makes it possible to perform the same activities performed via manual casting, with the advantage of ensuring, through the use of standardised procedures, the saving of considerable time and space, product uniformity and reductions in manufacturing time.

It is also important to note that the spread of this type of plant engineering has brought about a considerable improvement in working conditions.
Semiautomatic casting frames are endowed with casting equipment with which all moulds can be cast at the same time. Other operations, i.e. the closing and opening of dies, removal and handling of pieces, are performed manually.
Automatic casting frames permit a greater number of operations, that can be performed automatically using drawing levers (for the removal of pieces and their subsequent handling) and equipment to make functional holes.
The stock of machinery is generally quite old owing to the relatively low need to upgrade the technological level of equipment, especially for manual work stations and for the earlier type of semiautomatic casting frames. In recent years however these work stations have been modernised, with the introduction of more complex and productive lines that are gradually replacing older equipment, even though some products are still being manufactured manually owing to their complexity.
The latest machines in production obviously have the EC label and conform to the European directive, including machinery produced by local craft firms within the district.

Risk factors

Manual casting

1.	Possible inhalation of dust of varying nature, in particular dust containing silica materials
2.	Risks due to handling of pieces
3.	Risks due to possible traumas arising from pieces falling from caster's hands
4.	Risks due to handling of tools required for making functional holes on pieces.
5.	Risks due to possible slips owing to the leak of barbotine from casting tubes
6.	Risk of back-lumbar tears due to the movement performed when removing pieces moulded inside the dies
7.	Microclimate

Automatic casting
In addition to the risks of manual casting operations there are also:

8.	The risk of being trapped between the two halves of the die
9.	Electrical risks due to working with electric switchboard

1. Possible inhalation of dust containing silica;
A possible source of dust is that of mixture falling onto the ground during casting operations and forming dust after being walked on.
This situation does not occur frequently, and is the result of the poor maintenance of circuits or of the poor coupling of dies and usually their excessive wear and tear.
Another source of dust inhalation is that of the use of talcum on dies during casting preparation operations for that shift or for the following day.
Talcum is applied using a sponge. The sponge is saturated with talcum and applied on the plaster die. Any excess talcum is then removed, again using a sponge.

In almost all casting units in firms located in the district, cast pieces are finished. The very nature of this operation creates a considerable quantity of dust inside the unit (the finishing phase will however be considered as a separate phase from the present one).

2. Risks due to handling of pieces
Some load handling operations (of dies, crude sanitaryware, etc.) are performed manually.
Such operations may be very dangerous because of the unnatural posture required.
Dies consist of a large number of elements (depending on the complexity of the mould cast) that are assembled using clamps to form the airtight cavity needed for casting.

3. Risks due to possible traumas through pieces falling from caster's hands
Because of the weight of pieces, dies and portions of dies, there is the danger of pieces falling onto the lower limbs of workers.

4. Risks due to handling of tools required for making functional holes on pieces
The use of hand tools (blades, knives, etc.) for making functional holes on pieces may cause injuries.

5. Risks due to possible slips owing to the leak of barbotine from casting tubes
The almost continuous use of water in the process and for washing means that the floor is often wet.
If cleaning is ineffective, the water and mixture left on the ground can be very hazardous for workers.

6. Risks of back / lumbar tears
Regardless of the weight of articles and dies, the handling of pieces and dies in a position distant from the barycentre represents a danger because of the unnatural posture required of the worker.
In addition to risks of a general nature for casters, there are also dangers deriving from the operations of automatic machinery.

7. Microclimate
The humidity produced by the drying of plaster dies and of cast pieces goes into the atmosphere, making microclimatic conditions quite heavy, with workers working in short sleeves and shorts.

8. The risk of being trapped between the two halves of the die
As closure operations are performed automatically by the machine, there is the danger of the machine worker or other personnel getting trapped between the parts making up the dies.
Because of this risk, machine controls are operated manually, or the work station is constantly monitored during work activity.

9. Electrical risks due to working with an electric switchboard
All casting machines (except manual frames) are powered by electric energy, so dangers tied up with the use of this energy source are present for workers.

Likely damage

Refer to the separate chapter on likely damage.

Intervention

To prevent the spread of dust owing to walking on mixture that has fallen on the ground, mixture should be removed when it is still moist to prevent the formation of dust when it dries.
During the application of talcum, lasting around 30 minutes throughout the process cycle, workers must wear filtering face masks with a degree of filtration of at least FFP2.
Floors and application zones are cleaned using a washing-drying machine, and a dry-cleaner, not a mop, for areas that are harder to get at.
Extraordinary cleaning operations should regularly be performed for machinery and structures using mobile vacuum cleaners.
Special care has been taken inside casting rooms with the installation of air changing systems designed to dilute the presence of pollutants in the unit.
The number of changes of air adopted by firms in the Civita Castellana district varies from 2 to 5.
This number clearly depends on the number of staff performing casting operations in the unit.
The more air changes, the lower the level of environmental dust.
To limit difficulties concerning the manual handling of loads during casting operations, a procedure has been adopted to gradually lift heavy loads, with the help of another person or special equipment, especially loads in excess of 30 kg.
Manual operations for the opening of dies are moreover performed in pairs. Dies are overturned and inclined for drawing purposes by “rolling” the dies onto the specially designed wooden storage tables.
With regard to the risk of using cutting instruments for making necessary holes and cuts on pieces, efforts have been made to supply information on the possible consequences deriving from the misuse of these tools.
To minimise the risk of injuries deriving from the impact of falling pieces on workers' lower limbs, workers have been provided with antislip safety shoes.
To minimise the risk of slipping on liquid mixtures on the ground, floors are cleaned thoroughly every day, and special care is taken to keep the floor as smooth as possible by preventing the accumulation of dirt and anything else that may cause workers to trip up.
Workers have been supplied with antislip, safety shoes.
To minimise risks deriving from the manual handling of loads, workers have been given direct training on the correct procedures for handling loads.
All necessary measures have been adopted to cover against risks deriving from the use of electric energy, ensuring the safety of workers and integrity of machinery, namely:
*protection from direct contact: adoption of highly sensitive differential switches and earthing;
*protection from indirect contact: adoption of suitably insulated materials and covering, opening of instrument board only possible using special tool or upon interruption of supplies (cutter block);
*general protection: magneto-thermal switch, suitable wire sections to avoid overheating, instrument boards located to avoid being damaged, cleaning of inside of instrument board, ensuring that no foreign items are introduced;
* preventive maintenance: regular tightening of screws to avoid overheating or malfunctioning, substitution of mechanically or electrically worn pieces;
* non-combustible cables of a suitable voltage class.
The coverings of electric switchboards should be insulated to a degree appropriate to the installation environment (minimum IP44, in view of the presence of water and dust in the unit).
These should be kept clean and free of obstacles; they should only be opened using a special tool or must be endowed with a switch having cutter block.
All structures must be directly earthed, and power lines should be derived from highly sensitive differential switches designed to protect workers from direct contacts.
Untrained and unauthorised staff should also be prevented from modifying the safety devices or circuitry of instrument boards.

Outsourcing

Cleaning operations in the casting and finishing unit are usually contracted out to outside firms performing this service (this is the case for at least 90% of firms in the district).
In these cases it is very important for the firm's management to evaluate the suitability of the firm designated to perform this task.
One of the first checks to be performed in this context is an appraisal of requirements through the Certificate of Registration with the Chamber of Commerce. The owner of the cleaning firm is also asked to sign a declaration acknowledging the obligations set forth in law 626/94 and law 277/91 as regards relations with his employees.
Management should also liaise with the other company in respect of a mutual understanding of the risks involved in the activity being discharged.
The third-party firm must also conform to the provision of using not mops but dry cleaners for the removal of powdery materials and of using the washing-drying machine.
Workers of the outsourcing firm must also wear individual protective devices to protect respiratory tracts, with a degree of filtration at least up to FFP2.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Legislative Decree 626/94 and subsequent amendments for the handling of supply contracts /outsourcing
- Presidential Decree 203/88 governing the discharge of emissions into the atmosphere
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates atmospheric emissions especially during the dust removal and finishing phases. During these operations a suction system takes air into the external environment after appropriate filtering.
The waste produced consists mainly of the residual mixture, which is provisionally stored in special bins and subsequently re-used.

Drying
This phase entails the elimination of water contained in the interstices of the moulded piece.

Manufacturing phase
This phase is not really a manufacturing phase, since pieces to be dried are stored in periodic drying machines or left to dry in the open air or on suspended tray conveyor chains. The operations in this phase therefore consist of the handling of pieces or of trolleys holding pieces.

Machinery and equipment
The purpose of drying machines in to bring sanitaryware articles up to the level of humidity required to perform subsequent testing and glazing operations, or to bring the piece to a residual humidity of below 1%, bringing down the weight of the piece in terms of water by 30%.
In the Civita Castellana district these machines are spreading to many firms since they permit rapid drying times and a reduction in space occupied.
This indeed is a transition phase: drying methods used to consist of placing sanitaryware on trolleys or suspended tray conveyors adjacent to the kiln, but these are now going out of use, especially since during this phase humidity is generated in units that is harmful for staff and for ongoing manufacturing processes.
Drying machines consist of chambers in which pieces are dried with a strong vorticity of air treatment.
The length of drying cycles varies from 12 hours to 2 days. With these processes, the humidity content drops close to zero at a maximum temperature of 100°C.
Drying machines use flows of hot air that strike pieces indirectly and alternating cycles of heat in and saturated air out.
As regards possible sources of noise from the drying machine, the machine is turned on in the afternoon/evening when staff are not present.

Risk factors
1.	Risks deriving from pushing of storage trolleys for loading/unloading to/from drying machine.

Hazards relating to this task are basically concerned with the handling/pushing of trolleys, since when the drying machine is loaded the machine begins the drying cycle, which concludes at the end of the set time.
We believe that this task was a solution to the problem of drying pieces using fans that dispersed dust throughout the workplace and contributed to unhealthy working conditions.
Possible damage may be caused to workers' feet by contact with trolley wheels.

Likely damage
Refer to the separate chapter on likely damage.

Intervention
Workers have been endowed with safety shoes fitted with reinforced toes in order to minimise and reduce feet injuries.

Outsourcing
None of the ordinary operations in this phase are contracted out to other firms.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates emissions into the atmosphere, since the air flowing out drags up material particles.
We consider however that the extent of these emissions is quite modest, since in the absence of filtering devices dust levels range from 0.5 to 0.9 mg/m^3.

Finishing

Casting workers are also responsible for the finishing of pieces. This entails the removal of barbotine burrs generated by the union of dies.

Manufacturing phase

The worker takes the piece that is to be finished, places it on a light lathe and proceeds with the finishing operation, using metal scrapers and plastic abrasive sponges.
When this operation is complete, the worker deposits the piece on specially prepared trolleys.
The finishing operation entails the removal, using metal scrapers and abrasive sponges, of the barbotine burrs present on the piece caused by the union of dies.
At the conclusion of the removal phase, the worker overturns the piece to empty the dust produced into the basin of the lathe, and re-places it on the storage table before moving on to the next piece.

Machinery and equipment

This operation is performed in an area having a finishing lathe and, below the revolving finishing lathe, a metal sheet funnel for collecting powder produced during the phase and transporting it inside a container situated below the cone.
Also below the lathe is a wire-mesh sheet, below which there are metal sheet collection boxes for the removal of powder and cleaning of the work area.
The wire mesh below the finishing lathes also serves to prevent finishing shavings from being trodden on, and the smaller fractions from returning to the air.

Risk factors

1.	Possibility of inhaling dust of various sorts, in particular dust containing silica materials
2.	Risks deriving from handling of pieces
3.	Risk of injury owing to pieces falling from caster's hands
4.	Risks deriving from continuous use of wet sponge

1. Possibility of inhaling dust of various sorts, in particular dust containing silica materials
The level of dust in the finishing phase ranges from 0.942 to 1.138 mg/m^3 for breathable dust and from 0.06 to 0.08 mg/m^3 for dust containing free crystalline silica.
The amount of dust produced chiefly in the phase of finishing pieces cast on the previous day is limited by the type of lathes used.
In addition to this plant engineering measure, procedural measures are in place, such as the use of individual protection devices (face masks, respirators, etc.) having a degree of filtration suitable for circulating dust, during the main dust-producing phases.
Another measure adopted to reduce dust during finishing operations is that of covering pieces stored on drying tables to prevent pieces from drying too much, so that in the finishing phase they are still quite moist.
Another possible source of dust is the mixture that, falling onto the floor, is walked on and dispersed.

2. Risks deriving from handling of pieces
Raw sanitary articles are handled manually: the worker takes the piece that is to be finished, places it on the lathe and, once the finishing process is complete, re-places it on top of a trolley having castor wheels.

This movement may put considerable stress on workers' backbones, leading to the flexion and torsion of the bust as the load is lifted outside the worker's barycentre.

3. Risk of injury owing to pieces falling from worker's hands
Workers handle pieces that can cause injury if they are dropped onto lower limbs.

4. Risks deriving from continuous use of wet sponge
At the conclusion of finishing operations, the worker performs the sponging phase, making the piece smooth by rubbing it with a suitably wringed wet sponge.

Likely damage

Refer to the separate chapter on likely damage.

Intervention

To limit the production of dust during finishing operations, the following measures have been adopted:
When casting operations are complete, pieces are covered with plastic bags (which tend not to accumulate dust) to minimise the lost of moistness so that pieces are not over-dry during the finishing phase;
Light lathes with basins are used, below which a wire mesh is placed with removable sheet metal drawers to facilitate cleaning.
Finishing lathes are now endowed with a suction system for dust produced during finishing operations. This system consists of suction hoods, on the front of which the air speed ranges from 2 to 3 m/sec, capable of sucking in powders and transporting them to a dust removal system located outside the factory.
This system has the advantage of keeping the area in a state of depression and of minimising the amount of dust produced near the worker. It also increases the number of times air is changed in the work area, while at the same time diminishing the pollutant.
In addition to this system, a small number of firms have recently adopted a dust extraction system (of a vacuum cleaner type, with cleaned flows transported outside) to be used inside the piece itself, so that the piece, not being overturned, does not create a cloud of dust as a result of this operation. The suction system in question makes it easy to clean the work area effectively and quickly.
The combination of these solutions have gone to halve global dust levels during manufacturing phases. The non-overturning of the piece has also meant that dust does not collect on the worker's clothes.
In addition to all the above procedures and technical devices, workers must also wear individual protective devices to protect respiratory tracts, namely face masks with a degree of filtration at least up to FFP2, and a powder-repelling covering (apron) to protect the worker's clothes.
To limit difficulties concerning the manual handling of loads during casting operations, a procedure has been adopted to gradually lift heavy loads, with the help of another person or special equipment, especially loads in excess of 30 kg. Workers have also been informed about risks deriving from incorrect movements when handling loads.
We should stress that the solution of vacuum-cleaning powders inside the pieces means that the latter do not need to be overturned, leading to a reduction in the number of times pieces need to be lifted.
To minimise the risk of pieces dropping onto lower limbs, workers have been supplied with safety shoes endowed with reinforced toes.

Outsourcing

Cleaning operations in the casting and finishing unit are usually contracted out to outside firms performing this service (this is the case for at least 90% of firms in the district).
In these cases it is very important for the firm's management to evaluate the suitability of the firm designated to perform this task.
One of the first checks to be performed in this context is an appraisal of requirements through the Certificate of Registration with the Chamber of Commerce. The owner of the cleaning firm is also asked to sign a declaration acknowledging the obligations set forth in law 626/94 and law 277/91 in relations with his employees.
Management should also liaise with the other company in respect of a mutual understanding of the risks involved in the activity being discharged.
The third-party firm must also conform to the provision of using not mops but dry-cleaning machines for the removal of powdery materials and of using the washing-drying machine.
Workers of the outsourcing firm must also wear individual protective devices to protect respiratory tracts with a degree of filtration at least up to FFP2.

Referent legislation

Law provisions referred to in this phase are:

- Decree Law 277/91 on the subject of noise and dust
- Legislative Decree 626/94 and subsequent amendments for the handling of supply contracts /outsourcing
- Presidential Decree 203/88 governing the discharge of emissions into the atmosphere
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates atmospheric emissions during finishing operations, where local air suction systems are in place. Before flowing outside the plant, the fluid stream is conveyed through a suitable installation fitted with a dry cartridge filter, which is self-cleaning thanks to blasts of compressed air.
Dust levels in air going from these filters to outside the factory range from 6 to 8 mg/m^3.

Testing
Testing is carried out on pieces once they are dried and prior to glazing.

Manufacturing phase
Once they are dried, pieces move on to the testing phase. In this phase they are further finished and inspected carefully to verify the presence of evident defects jeopardising the integrity of the piece.
The worker takes the piece from the storage trolley, places it on a lathe turned manually, inspects in minutely, brushing on jet oil, verifying whether there are cracks or splits just below the surface. When this inspection is complete, he further finishes the piece and removes any dust that would have an adverse effect on the subsequent glazing phase. Using a wet sponge, he smoothes the piece, covering possible depressions or rough patches.
Once this sequence of operations is complete he removes the piece from the turning lathe and returns it to a storage trolley.
All the above operations are performed in compartmented booths fitted with dust extraction devices.

Machinery and equipment
All the above operations are carried out inside a cabin equipped with a dust extraction device located in front of the worker.
These booths are of two types: a dry type, fitted with suction and effluent removal devices, located outside the plant; or cabins endowed with a film filter and suction-fan located above the cabin.
The positioning outside of ventilators and dust removal systems inevitably has a significant impact on background noise produced in the unit.
Dust collection speeds usually adopted in the production sector range from 0.7 m/s to 1.4 m/s.
The greater the speed, the more dust is captured, of course, but when certain levels are exceeded there are problems for the wellbeing of staff (excessive air currents)
For the removal of resulting dust, air guns are used for blowing, but because of the high flow required, serious noise-related problems occur (noise in excess of 100 dBA).
Dust levels measured in this phase range from 0.88 to 1.174 mg/m^3 for breathable dust, while dust containing free crystalline silica ranges from 0.092 to 0.127 mg/m^3.
These guns have been silenced using air flow silencers that optimise flow by reducing vortexes and thus lowering acoustic power (to levels below 85 dBA).
Outside the cabins below the worker's feet there are screen panels so that dust produced by testing operations are not walked upon and returned to the air by the worker's feet.
Systems are now being drawn up for the suction of dust instead of its being blown, a solution which, results being equal, would work with lower collection speeds, reducing the energy consumption of removal systems, and would relieve workers of the task of overturning the piece in order to remove the more evident powdery part.
With reference to the age of machines, we can state that 50% of machines are 10-15 years old, while the other half are quite new, thanks in part to the implementation of Community Directive 89/392 on the safety of machines. New machines thus have the EC label.

Risk factors

1.	Noise generated by air guns for blowing operations
2.	Formation of dust during the blowing of pieces and use of wet sponge
3.	Possibility of pieces falling onto workers' feet owing to inefficient/incorrect grasp
4.	Manual handling of loads, with loading/unloading of trolleys and lathes
5.	Use of jet oil

Noise hazard
This unit is usually very noisy owing to the use of air guns for the blowing of pieces and the presence of suction-fans in the production unit.
During blowing operations noise may exceed 100 dB_A.
The noise generated by the suction-fan goes into the surrounding area, where a number of booths are often concentrated. There is therefore the problem of overlapping noise, which is not in itself a problem but creates quite a relevant background noise.
Background noise for fans installed in production units usually ranges from 78 to 80 dB_A.

Possible inhalation of dust
The formation of dust during blowing operations in booths is kept under control using a suction system whose speed is such that it prevents dust from dispersing into the atmosphere and creates a flow of air tending to take dust away from the worker. In this operation the concentration of breathable free crystalline silica ranges from 0.13 to 0.60 mg/m^3
In addition to this plant engineering measure, procedural measures are in place, such as the use of individual protection devices, namely face masks having a degree of filtration at least up to Paragraphs, suitable for circulating dust (usually containing silica particles) during the main dust-producing phases, and working clothes that repel dust.
Prevention measures are completed by the company procedure of performing such operations with the utmost care.
The use of a wet sponge to complete the piece entails the risk of arthritis of the hands.

Crushing of lower limbs
When handling sanitaryware during the testing phase the worker may suffer injuries if materials fall onto parts of the body, especially the lower limbs.
It is therefore felt that workers should wear safety shoes specially designed to prevent feet from being crushed.
Workers must always be suitably informed as to the inherent risks of the working task being performed and the correct safety procedures adopted and to be adopted.

Manual handling of pieces
The handling of pieces owing to loading/unloading to and from trolleys and the preparation of pieces in booths means that the worker has to lift and transport pieces weighing between 15 and 20 kg. Around 150 pieces are tested on average during one shift.

Manual handling of pieces
The use of jet oil, which is a mixture of hydrocarbons, brings about the risk of inhalation. For this reason the operation is performed inside the booth endowed with suction devices at the back to prevent workers from breathing in these vapours.

Likely damage
Refer to the separate chapter on likely damage.

Intervention
Noise-related risk can be mitigated in the following ways:
- use of silencers placed at the air outlet. This measure has led to a significant reduction in noise which, being impulsive, is particularly harmful and bothersome;
- when these devices are working, workers also have orders to wear individual protection devices (headphones, ear plugs, etc.) suitable for the noise levels measured.

The correct maintenance of machinery furthermore prevents the slow build-up of noise owing to the wear and tear of bearings or other moving parts.
Units also display warning signs recalling the mandatory use of individual protection devices such as ear plugs/headphones, since for such operations the Lep_d exceeds 85 dB_A.
With regard to risks deriving from dust, recent studies have been looking at localised suction systems using tubing that can exploit the Venturi effect. With these systems, dust is no longer completely blown from the piece, but is first sucked up using this device.
This solution has already led to a reduction in dust levels even for units having low front collection speed levels. We may state that dust levels have been halved.
The main solutions currently adopted however remain the use of individual means of protection such as face masks with a filter offering a degree of protection of at least FFP2.
To reduce the risk of materials falling onto workers' feet, safety shoes with reinforced tips are worn.
As regards the problem of load handling, action has been taken to inform workers as to the correct posture to adopt during handling operations and the damage that can be caused by performing work using incorrect procedures.
To limit problems caused by the manual handling of loads, workers are advised to lift heavy loads gradually and with the aid of a person or special equipment, especially loads in excess of 30 kg.
Loads exceeding 30 kg are fire-clay pieces which, by virtue of their nature, shape and weight, should be lifted in pairs. Workers have also been specially trained as to the correct handling of loads and the damage caused by such operations performed incorrectly.

Outsourcing

None of the routine operations of this phase are contracted out to third parties.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates effluents, especially emissions into the atmosphere, since the fluid stream produced mixed with particulate is conveyed outside.
Before flowing out, dust is of course conveyed through an appropriate dust extraction system.
The efficiency of older plants, namely those endowed with film filters, was not very satisfactory, although they ensured a quantity of outgoing dust of less than 30 mg/m^3, since water is quite an ineffective way of removing dust.
The new dry extraction systems are usually endowed with a pneumatic self-cleaning system (practically no maintenance required, the filter remaining close to nominal conditions), achieving values of lower than 5 mg/m^3.
Dust settling inside dry extraction devices is re-utilised in the production cycle once it is returned to the mixture preparation unit. If the plant does not possess a mixture preparation unit, this dust is delivered to authorised firms, which transport them as re-usable materials to plants dealing solely in the preparation of mixtures on behalf of third parties.

Water present in wet extraction systems is transported to the factory's treatment plant where, together with other water coming from the entire plant, it undergoes a deflocculation process in compliance with the parameters of “Merli" law 319/76. Once this treatment is complete, some firms in the district send the product to a disposal plant.
More and more firms however are re-utilising recycled water. Once it is treated, it is returned to a preferential network of industrial water for supplementary uses (for cleaning, removal systems, etc.). This system makes it possible to reduce the amounts of water taken directly from underground sources, minimising the cost of reagents and, if recycling is 100%, firms can avoid the journey to a disposal plant.
The sludge produced by treatment processes is temporarily stored in special bins. It is then transported by authorised firms to companies that re-use it as a raw material (cement works, tile makers, etc.).

Spraying

In this phase the dried product is sprayed with a water-based glaze using spray air guns.

Manufacturing phase

In the glazing unit coatings are applied to sanitaryware to obtain predetermined technical and aesthetic characteristics.
This process is performed according to the type of plant being used:

- manually, inside a booth;
- automatically, on an assembly line.

Manufacturing phases are as follows:

- taking of piece from storage trolley and positioning in booth, or on the robot's conveyor belt
- glazing of piece using aerograph controlled manually or using pre-programmed robot, inside a booth fitted with air suction device
- removal of the piece from the booth or robot belt and its replacement on a storage trolley endowed with castors.

Machinery and equipment

- Booths with manual aerographs are endowed with spray guns that draw glaze (using a pump) from a container located at the side of the booth.

The piece is glazed inside the booth on a revolving lathe.
The booth limits overspray of the sprayed glaze to a pressure of around 4 - 6 bar.
Glaze dust is removed via a fan located above the booth. Using this suction device, glaze dust is eliminated through a system of film filters and additional mechanical filtering.
Manual glazing booths using air guns can be of two types:

- with incorporated suction device and film filter for dust extraction
- with centralised suction device and external wet extraction system

- Robot-based systems are made up of a chain of stations at which different operations are performed.

Automated machinery monitored at the entrance and exit are cut off from the outside with elements that make it impossible for workers to make contact with moving parts.
Sanitaryware articles placed on suspended tray conveyors move along a chain of stations consisting of: entry / loading; spraying using cup gun; manual spraying areas for the glazing of zones hard to get at; cleaning of tray conveyors; drying.
There are a number of automated glazing systems. The most common are roundabout multi-position systems, accumulation systems and carousel systems.
The roundabout system permits automated glazing in a limited space and entails a lower investment than other solutions.
In each position of the machine a specific job is performed: loading of piece, automated glazing, removal of piece, cleaning of base.
The accumulation system is an evolution of the previous system, to which has been added:

- a feed belt
- an automatic loader, taking the piece from the feed belt and automatically positioning it on the load bay of the machine
- an automatic unloader, performing the opposite operation
- an unloading belt that receives and accumulates glazed pieces for their subsequent removal.

The carousel system consists of a merry-go-round machine resting on the ground, on which lathes have been positioned.

The unit also contains fog nozzle lances for the high-pressure spraying of water to fully clean the unit at the end of the shift.
A fog nozzle lance is also used in the unit for the cleaning and removal of residue glaze.
Manual glazing booths have a dust collection speed on the variable front ranging from 0.6 to 1.4 m/sec.
Greater speeds than these would produce better dust collection but would also cause microclimatic problems for exposed workers.

Risk factors

Manual and Automatic Spraying

Manual Spraying

1.	Noise generated by glaze-spraying guns and fog nozzle lance
2.	Formation of dust during spraying owing to the nebulisation of fractions making up the glaze
3.	Possibility of pieces falling onto workers' feet owing to mishandling
4.	Manual handling of loads

The same risks exist for automatic spraying, with the addition of the following risk:

5.	Handling of suspended tray conveyors or beds for the transporting of pieces to the spraying zone

*** Possible exposure to relatively high impulsive and continuous noise**
Noise levels for the unit are generally high, owing to the use of spray guns in the booths and to the presence of suction-fans in the booth itself.
Workers' exposure to noise in the manual glazing unit varies between 85 and 90 dB_A, while that of workers in the automatic spraying zone ranges from 78 to 85 dB_A.
This difference is due to the fact that manual booth workers must always be present, while on the automated line the action of workers is limited to the loading and unloading of tray conveyors, and glazing operations are performed by robot arms inside heat insulated compartments.
Booths are quite noisy, since the noise generated by the dust extraction fan, if it is inside the factory, is released into an area where a certain number of booths are often situated. There is thus the problem of the multiplication of such noise, generating background noise that can be bothersome.

Possible inhalation of dust
The creation of dust during spraying in the booth is kept under control using a dust extraction system working at speeds (0.6-1.4m/sec) designed to prevent generated dust from spreading to other areas, with the movement of air directed away from the worker.
Dust levels in the unit range from 0.86 to 1.24 mg/m^3 for breathable dust, and from 0.1 to 0.15 mg/m^3 for dust containing free crystalline silica.
Notices have been put up in the unit about the compulsory use of individual protection devices.

Danger of crushed lower limbs
When sanitaryware is moved during the glazing phase, workers' feet may be crushed and injured if materials are dropped.

Manual handling risks

The movement of pieces, including the loading/unloading of trolleys and the preparation of pieces in booths, means that workers have to lift and transport pieces, which weigh from 15 to 20kg. Around 100 pieces are usually glazed in a single shift.

Movement of suspended tray conveyors or beds to transport pieces to spraying area
The movement of sanitaryware using suspended tray conveyors or beds must be performed very carefully.
When crossing zones below which persons might be moving with machinery, the tray conveyors should be suitably protected.
All robotised systems are also endowed with efficient emergency devices.

Likely damage

Refer to the separate chapter on likely damage.

Intervention

Efforts to reduce noise levels in the spraying unit have been made as follows:
- by placing dust extraction and cleaning systems outside the factory in order to reduce background noise.
- to glaze pieces lowering the pressure of guns; this has led to poor results in terms of quality.

In addition to this, when the above devices are operating, workers are required to wear individual protection devices (headphones, ear plugs, etc.) suitable for the noise levels measured.
The correct maintenance of machinery furthermore prevents the slow build-up of noise owing to the wear and tear of bearings or other moving parts, all anomalies being reported to the respective manager in a timely manner.
To reduce risks for workers during glazing operations, the following actions have been taken:
In the booth dust is sucked up using a fan situated above the booth; dust is removed using a combined filtration system made up of a first phase of film filters and a second mechanical phase using fabric filters.
This ensures that before leaving the filter, the air sucked up has deposited as much of the transported dust as possible.
In addition to this plant engineering measure, there are procedures to be observed such as the use of individual protection devices (masks, respirators, etc.) offering a degree of filtration of at least FFP2, appropriate to the dust circulating.
Prevention action includes the company's instructions for performing such operations with the utmost care.
To avoid injury to workers owing to objects falling onto feet, specially designed safety shoes should be worn to protect lower limbs from this danger.
For load-handling problems, workers have been supplied with information about the correct posture to be adopted when handling loads and about possible injuries that may be caused by adopting incorrect procedures.
To limit load handling-related problems, heavy loads, particularly loads in excess of 30 kg, are to be lifted gradually and with the aid of another person or special equipment.
Loads exceeding 30 kg are fire-clay pieces which, by virtue of their nature, shape and weight, should be lifted in pairs. Workers have also been specially trained as to the correct handling of loads and the damage caused by such operations performed incorrectly.

Outsourcing

None of the routine operations during this phase are contracted out to third parties.

Referent legislation

Law provisions referred to in this phase are:

- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- Presidential Decree 203/88 governing the discharge of emissions into the atmosphere
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates emissions into the atmosphere during the spraying of sanitaryware. Before flowing outside the plant, the fluid stream is conveyed through a suitable installation fitted with a wet filter (for low-temperature wet-flow dust, wet filters, venturi scrubbers or combined filters are usually adopted).

The degree of efficiency of filters naturally depends on construction characteristics.

In the district of Civita Castellana filters have dust levels ranging from 4-5 mg/Nm^3 to 30 mg/Nm^3.

Any water used in cleaning systems is transported to the water treatment plant where, together with other water coming from the entire plant, it undergoes a deflocculation process in compliance with the parameters of “Merli" law 319/76. Once this treatment is complete, some firms in the district send the product to a disposal plant.

More and more firms however are re-utilising recycled water. Once it is treated, it is returned to a preferential network of industrial water for supplementary uses (for cleaning systems, etc.). This system makes it possible to reduce the amounts of water taken directly from underground sources, minimising the cost of reagents and, if recycling is 100%, firms can avoid its journey to a disposal plant.

The waste produced consists chiefly of leftover glazes that are re-used in the cycle after having been ground down in rotary ball mills.

Firing

The firing phase is between the glazing phase and the phase centring on the selection of fired pieces in the warehouse.
When the piece leaves the kiln, it has reached its chemical-physical equilibrium and its maximum mechanical resistance.
The re-firing phase is for pieces not fully meeting the quality tests at the selection unit but that have slight defects that can be rectified with small repairs.
The two phases are basically identical, firing taking place with the same kilns, predominantly periodic kilns in the re-firing phase.

Manufacturing phase

Once they are glazed, pieces are stored on trolleys endowed with castor wheels, from which kiln workers take the mix of pieces of differing shapes and sizes required to optimise the kiln's trolley loads.
In the firing unit sanitaryware articles are thermoprocessed in systems generally powered using gaseous fuel.
Before being loaded in the kilns, pieces are blown with air guns inside booths fitted with dust extraction devices.
The booths for the blowing of pieces are basically similar to those used in the piece-testing phase.
When they are to be fired, pieces are manually placed by workers on the shelves of metal trolleys coated with a refractory material.
The firing phase serves to heat sanitary articles to bring the product up to the temperature at which chemical-physical transformations take place in order to obtain a product having pre-determined characteristics.
When firing is complete, the pieces removed from the kiln are stored on a suspended tray conveyor or on trolleys to be transported to the warehouse.

Machinery and equipment

There are two main categories of kiln for the firing of ceramic material: continuous and periodic kilns.
In the continuous, or tunnel, kiln, the trolleys move through the kiln from the loading point to the unloading point. Different sections of the kiln are set to different temperatures. When each trolley leaves the kiln, another is introduced, so that the cycle is continuous.
With periodic kilns trolleys are all introduced at the same time into the firing chamber. When all trolleys are loaded, the doors are closed and the firing cycle commences.
The maximum firing temperature for sanitary articles is around 1270°C. The fuel mostly used to power this machinery is methane gas, although a few firms use LPG.
Kilns consist of a metallic or brickwork external structure and an internal structure made of a refractory material and/or ceramic fibre.
The kiln trolleys are also metallic, coated with a refractory or ceramic fibre material.
There are also rails for moving the trolleys, hydraulic systems for moving the trolleys inside the kiln and transfer tables for changing rail lines.
The level of dust in this unit is rather low, with values ranging from 0.434 to 0.646 mg/m^3 for breathable dust, and from 0.032 to 0.048 mg/m^3 for free crystalline silica dust.

Risk factors

1.	Movement of trolleys and transfer tables
2.	Noise generated by kiln fans and blowing operations
3.	Possibility of uneven floors and consequent risk of falls

4.	Presence of hot or burning objects
5.	Presence of ceramic fibre
6.	Microclimate
7.	Presence of high electric voltage
8.	Manual handling of loads

1- Movement of trolleys and transfer tables

When moving trolleys and transfer tables, workers may suffer injuries owing impact with materials or the crushing of feet.

There is also the danger of injury due to incorrect posture when pushing or moving trolleys and transfer tables.

2- Possible exposure to relatively loud continuous, impulsive noises;

The unit is generally quite noisy owing to the presence of electric fans and gas tubing in which the fluid flows quite quickly.

Unit noise is mainly due to:

- noise generated during the firing phase for those kilns that have fans located inside the factory;
- noise generated by the blowing of pieces using air guns before they are placed in the kiln, and possibly generated by the presence of fans in the dust removal booth in the same unit.

The noise level of units where kilns are located is around 82 dB_A for continuous kilns and 78 dB_A for periodic kilns if fans are located outside the factory. The figure rises to 85 dB_A if fans are located in the vicinity of the kiln.

A distinction needs to be made between the two types of machinery: continuous kiln workers are always present near the machinery, while for periodic kiln workers the lighting of the kiln and the commencement of firing operations coincide with the termination of their shift.

Kiln workers are exposed to noise levels averaging between 82 and 85 dB_A.

3 -Possibility of uneven floors (e.g. holes for inspection, etc.) and the risk of falls

In tunnel type kilns a number of ground holes are required to inspect trolleys and the kiln itself from below.

Access to these holes is via a staircase endowed with banisters and chains fixed with spring catches in order to prevent accidental falls.

For both types of kiln (continuous and periodic) housing structures are set in the floor for propulsion lines, transfer tables and rails.

4 - Presence of hot or burning objects

In the case of continuous kilns, maintenance must be performed while the machinery is operational, therefore workers come into contact with very hot objects during these operations.

As far as possible, installations should be built or modified to allow convenient and rapid intervention.

To minimise difficulties in this area, preventive maintenance procedures are in place, carried out when the plant is normally not operational with a view to preventing the need for repairs while the plant is working at hot temperatures.

5 - Use of ceramic fibre as heat insulator

Ceramic fibre is one of the most commonly used heat insulators at high temperatures (up to 1600°C). In recent times it has mainly been used for the construction of kilns and kiln trolleys.

The fibre is usually used for the heat insulating walls of kilns or trolleys. Under normal working conditions it is not dispersed into the atmosphere, and its dispersion is always minimal.

The production of dust is greatest when these walls are being prepared and, especially, when they are removed.
Above the temperature of 900°C ceramic fibre is turned into cristobalite, a particular form of free crystalline silica.

6 - Microclimate
The unit where kilns are installed inside a plant producing ceramic articles is by nature very hot owing to the presence of considerable installed thermal power (2,000,000-10,000,000 kCal/h).
Wall insulation, not being total, allows a certain amount of heat energy to escape, through conduction, from inside, where temperatures are close to 1270°C.
The heat energy dispersed into the atmosphere tends to raise the air temperature and create poor situations for the physical wellbeing of workers.
The problem of the microclimate near kilns tends to be greater in summer months owing to the high temperatures recorded outside.

7 - Presence of high electric voltage
A considerable number of machines are installed in the kiln area, especially fans, that are powered by electric energy.

8 - Manual handling of loads
Sanitary articles are loaded and unloaded manually from the trolleys, which are coated in a refractory material. Pieces are also lifted manually with a side rotation of the trunk, a movement which may damage workers' backbone.

Likely damage
Refer to the separate chapter on likely damage.

Intervention
As regards the moving of trolleys and transfer tables, most firms in the district perform this task automatically in order to avoid load-handling risks. Workers also wear safety shoes with reinforced toes.
One of the most successful prevention actions performed in the firing and re-firing unit has been that of moving kiln fans from the plant to a soundproof hut in order to reduce background noise in the unit and thus reduce individual exposure levels.
The correct maintenance of machinery furthermore prevents the slow build-up of noise owing to the wear and tear of bearings or other moving parts.
Furthermore, the air guns used to blow pieces prior to firing have been fitted with silencers designed to minimise the noise emitted directly by the guns.
To avoid dangers related to the presence of ground holes, the zones in question have been bordered off with metal railings endowed with standard banisters, to prevent unauthorised and thus uninformed staff from entering. These zones have also been endowed with good lighting.
Propulsion lines have also been protected from the entry of personnel. Entry can only be at the loading point and is authorised for unit workers, technicians and maintenance workers only.
In the proximity of kilns or hot equipment which, for technical reasons cannot be turned off (e.g. continuous kilns, etc.), workers must take all reasonable precautions to protect themselves from heat.
More specifically, workers must use non-plastic, heat insulating gloves to protect their hands. For very high temperatures they should wear high-temperature insulating suits (in aluminised kevlar, avoiding asbestos-based clothing especially if it is in a poor state), together with suitable headwear, gloves and footwear.

Actions must be performed for brief periods. Longer types of intervention must be split up into several phases to prevent workers from feeling ill owing to excessive exposure to heat (producing a collapse, etc.). Actions must also be performed in the presence of at least one other person.
During the installation and removal of insulating walls made from ceramic fibre, suction devices should be located below so as to maintain a vacuum situation and ensure the change of air.
During installation operations workers should wear goggles, face masks and fabric clothing (not throw-away fabrics) to prevent fibres from penetrating the skin. During wall removal operations, special breathing apparatus must be worn.
These operations should be performed by specialist personnel or by third-party specialist firms which, by virtue of their specialist knowledge and precision can ensure the wellbeing of maintenance workers and of workers inside the plant.
To deal with the microclimate problem, air-change systems have been installed to ventilate the work setting and improve the conditions of physical wellbeing.
These environmental ventilation systems have been created to move large volumes of air at low speeds so as not to create difficult heat-related situations.
All measures designed to protect the wellbeing of workers and the integrity of machinery powered by electric energy have been set in place, namely:
*protection from direct contact: adoption of highly sensitive differential switches and earthing;
*protection from indirect contact: adoption of suitably insulated materials and covering, opening of instrument board only possible using special tool or upon interruption of supplies (cutter block);
*general protection: magneto-thermal switch, suitable wire sections to avoid overheating, instrument boards located to avoid being damaged, cleaning of inside of instrument board, ensuring that no foreign objects are introduced;
*routine/preventive maintenance: regular tightening of screws to avoid overheating or malfunctioning, substitution of mechanically or electrically worn pieces;
* non-combustible cables of a suitable voltage class.
The coverings of electric switchboards should be insulated to a degree appropriate to the installation environment (minimum IP44, in view of the presence of water and dust in the unit).
These should be kept clean and free of obstacles; they should only be opened using a special tool or must be endowed with a switch having cutter block.
All structures must be regularly checked for the suitability and connection of earthing systems, and power lines should be derived from highly sensitive differential switches designed to protect workers from direct contacts.
Untrained and unauthorised staff should also be prevented from modifying the safety devices or circuitry of instrument boards.
To limit problems caused by the manual handling of loads, workers are advised to lift heavy loads gradually and with the aid of a person or special equipment, especially loads in excess of 30 kg.
Loads exceeding 30 kg are fire-clay pieces which, by virtue of their nature, shape and weight, should be lifted in pairs. Workers have also been specially trained as to the correct handling of loads and the damage caused by such operations performed incorrectly.

Outsourcing

Operations entailing the assembly and disassembly of kilns are always entrusted to the respective kiln manufacturers.
Nowadays, as ceramic fibre is considered a cancerous material, maintenance operations involving ceramic fibre insulating layers are contracted out to third-party specialist firms.

Referent legislation

Law provisions referred to in this phase are:

- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- Presidential Decree 203/88 and subsequent amendments governing the discharge of emissions into the atmosphere
- The suggestions and recommendations of the ECFIA as regards the use of ceramic fibre
- CEI standard 64/4 governing installations in places most at risk in respect of fires and explosions for the design and execution of electrical installations
- the framework law on noise pollution (Law 447/1995) for noise emissions generated outside the plant
- activities carried out in the present phase are all activities controlled by Firefighting forces, being most at risk in respect of fires; reference should be made to all national legislation and to best practice norms governing the matter.
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates emissions into the atmosphere, especially:

- during operations to remove dust from sanitary articles, before flowing outside the fluid stream is conveyed through a system endowed with a dry filter (cartridge or hose filter), the concentration of the effluent is around 5 - 8 mg/m^3
- during firing phases; these emissions mainly consist of a high-temperature fluid stream having the following characteristics:

Flow rate	1800 Nm^3/h
Particles	0.150 mg/Nm^3
No_x	41 mg/Nm^3
SiO^2	0.053
Pb-Mg-Al-Fe-Ca-Ti-K-Th	Traces

One should bear in mind however that every kiln is designed according to the express wishes of the customer, consequently the flow rate and composition of effluents are extremely variable, the above table giving purely indicative values.

Selection

When it leaves the kiln, the piece is checked and sent to the warehouse or to the re-firing unit, according to the defect discovered.
Any defects are rectified before the piece is sent to the re-firing unit.

Manufacturing phase

In this area workers select pieces, dividing them into the categories: colour, quality and series and package them on wooden benches using polyethylene stretch wrapping. Top-quality pieces are packed in cardboard boxes.
Some pieces are sent for re-firing, depending on the type of defect.
Another type of packaging used to bind materials is that of thermoshrinking film, which is heated using a gas flame.
Noise levels in the warehouse unit are usually low despite high values for the palletisation flame (up to 90dB$_A$). Palletisation times are extremely short and background noise is practically inexistent (65-70dB$_A$), since the warehouse is usually set apart from production units and is very large, with few persons working therein.
There is an increase in noise levels in the event of defect repairs before faulty pieces are sent back for re-firing.

Machinery and equipment

A small amount of machinery is present in the warehouse since most operations are concerned with the handling, selection and packaging of pieces, these operations being of a predominantly manual nature.
Warehouse machinery thus consists of:

◊ Trolleys for handling pieces and forklift trucks;
◊ Flames to heat stretch materials used for packaging.

Forklift trucks work practically throughout the working day. They are thus subjected to considerable mechanical stress and wear and tear. The turnover of machinery is thus rapid, meaning that machines remain state-of-the-art in terms of both production and regulatory aspects.
There are also pneumatic guns for rectifying defects.

Risk factors

Selection and Warehouse

1.	Possibility of contusions-distortions to hands and feet from falling pieces
2.	Collision with forklift trucks (shunters) and transpallets
3.	Presence of compressed inflammable gas / inflammable materials
4.	Manual handling of loads
5.	Use of pneumatic percussion peens

1) Possibility of contusions-distortions to hands and feet from falling pieces

When handling sanitaryware in the selection and packaging stages, workers may drop materials, crushing or injuring their feet.

For this reason workers should wear safety shoes specially designed to protect lower limbs from this danger.

2) Collision with forklift trucks (shunters) and transpallets
Specific risks are those connected with the handling of sanitaryware using forklift trucks.
The presence of a large number of sanitary pieces in storage units means that movement is not always simple, with the risk of colliding with pieces of machinery or with protection elements.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.

3) Presence of compressed inflammable gas / inflammable materials
As far as gas is concerned, this presence is limited to a low-capacity methane supply needed to power the pneumatic gun, or to a small LPG cylinder.
Easy-to-use flame-trap valves and manual disconnecting devices have been installed.
Upon the completion of work, the flexible tube is gathered and wound onto a specially constructed support.
This tube should be replaced at the first sign of damage, and in any case every five years.
With reference to inflammable materials (box board), the presence of cardboard adjacent to the palletisation zone is kept to a minimum, and there are notices banning the use of naked flames and smoking inside specified areas.
Naked flames for palletisation operations are used in a suitably aerated area, equipped with a nearby fire extinguisher, by staff trained for this purpose.
Workers must wear suitable fireproof clothing, a face mask and gloves. Shoes should also be fireproof and easy to remove.
Palletisation operations are performed at a distance from other pallets, and the plastic cap should be of the type not propagating dioxin for heating.
Workers must wear ear protection to defend themselves from the noise generated by the speed of emission of the flame.

4) Manual handling of loads
It should be considered that fired material has lost a further 20% in weight compared with the raw material as a result of firing operations, and is thus lighter and easier to handle, being more compact, unlike the raw material, which literally breaks up if it is moved at high speed and subjected to bumps.
Loads are however handled manually using transpallets, which are pushed by workers.

5) Use of pneumatic percussion peens
In the finishing phase pneumatic percussion peens are used. These generate considerable noise when coming into contact with the fired piece.
Noise levels can peak at 100 dB_A, and up to 95 dB_A when the device is silenced, although its use is limited in terms of time, and the Lep,d reaches approximately 85 dB_A.

Likely damage

Refer to the separate chapter on likely damage.

Intervention

With regard to the risk of injury to feet caused by dropped objects, it has been deemed necessary to make workers wear safety shoes endowed with a reinforced metal toe.
To minimise the danger of collisions with moving machinery, dangerous protuberances have been made more visible by being painted a striped yellow-green colour, while, where possible, runways for moving machines have been designed to leave room of at least 0.70m for persons to pass (although this space is no longer compulsory).
These runways are well demarcated by continuous yellow lines on the floor, which must always be kept in an efficient state.
Vehicles have also been fitted with a flashing light and siren for reversing.
To overcome the problem of noise caused by palletisation operations, experiments have been carried out with low-noise heating pistols, or pistols fitted with a system for conveying combustion gases, made in such a way as to prevent the formation of vortexes and thus reduce the noise generated by the machine.
To limit damage caused by noise, workers have been supplied with ear plugs and headphones. The use of this equipment is compulsory.
The results of the above experiments have unfortunately been disappointing, since the use of these pistols required the use of stretch film of reduced thickness that did not afford sufficient protection to palletised material that was then stored in outside yards exposed to climatic elements.
Touch-up areas have been separated from other areas inside the warehouse, and considerable benefits have accrued thanks to the adoption of silenced devices when compressed air exits pistols.

Outsourcing

None of the ordinary operations performed during this phase are contracted out to other companies.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase of production does not generate any sort of external risk, with the exception of possible packaging operations using thermoshrinking materials.
Such operations generate atmospheric emissions, requiring suitable filtration before emission.
Waste products produced include broken pieces to be thrown away, which are put in a special bin and sent by a third-party firm to be crushed and produce chamotte; broken or useless packaging or cardboard, which is stored in a metal bin and sent to an authorised waste disposal site.
Harmful or toxic waste is not produced.

Re-firing

The re-firing phase comes after the preliminary selection of fired pieces in the warehouse, where pieces with slight defects are rectified and sent for re-firing.
Once it leaves the kiln the piece has reached its chemical-physical equilibrium and its maximum mechanical resistance.
The re-firing phase involves those pieces that do not fully come up to qualitative standards, but have defects that are so slight that they can be hidden with a minor repair.
The two phases are basically the same, with the same kilns being used, practically always periodic kilns for the re-firing phase.

Manufacturing phase

Pieces are stored on trolleys equipped with castor wheels, from which kiln workers take the mix of pieces of differing shapes and sizes needed to optimise the kiln's trolley loads.
In the firing unit sanitary articles are thermoprocessed in systems generally powered using gaseous fuel.
Before being loaded in the kilns, pieces are blown with air guns inside booths fitted with dust extraction devices.
The booths for the blowing of pieces are basically similar to those used in the piece-testing phase.
When they are to be fired, pieces are manually placed by workers on the shelves of metal trolleys coated with a refractory material.
The firing phase serves to heat sanitary articles to bring the product up to the temperature at which chemical-physical transformations take place in order to obtain a product having pre-determined characteristics.
When firing is complete, the pieces removed from the kiln are stored on a suspended tray conveyor or on trolleys to be transported to the warehouse.

Machinery and equipment

There are two main categories of kiln for the firing of ceramic material: continuous and periodic kilns.
In the continuous, or tunnel, kiln, the trolleys move through the kiln from the loading point to the unloading point. Different sections of the kiln are set to different temperatures. When each trolley leaves the kiln, another is introduced, so that the cycle is continuous.
With periodic kilns trolleys are all introduced at the same time into the firing chamber. When all trolleys are loaded, the doors are closed and the firing cycle commences.
The maximum firing temperature for sanitary articles is around 1270°C. The fuel mostly used to power this machinery is methane gas, although a few firms use LPG.
Kilns consist of a metallic or brickwork external structure and an internal structure made of a refractory material and/or ceramic fibre.
The kiln trolleys are also metallic, coated with a refractory or ceramic fibre material.
There are also rails for moving the trolleys, hydraulic systems for moving the trolleys inside the kiln and transfer tables for changing rail lines.
The level of dust in this unit is rather low, with values ranging from 0.434 to 0.646 mg/m^3 for breathable dust, and from 0.032 to 0.048 mg/m^3 for free crystalline silica dust.

Risk factors

1.	Movement of trolleys and transfer tables
2.	Noise generated by kiln fans and blowing operations
3.	Possibility of uneven floors and the risk of falling
4.	Presence of hot or burning objects

5.	Presence of ceramic fibre
6.	Microclimate
7.	Presence of high electric voltage
8.	Manual handling of loads

Movement of trolleys and transfer tables

When moving trolleys and transfer tables, workers may suffer injuries owing impact with materials or the crushing of feet.

There is also the danger of injury due to incorrect posture when pushing or moving trolleys and transfer tables.

2- Possible exposure to relatively loud continuous, impulsive and loud noises;

The unit is generally quite noisy owing to the presence of electric fans and gas tubing in which the fluid flows quite quickly.

Unit noise is mainly due to:

- noise generated during the firing phase in those kilns that have fans located inside the factory;
- noise generated by the blowing of pieces using air guns before they are placed in the kiln, and possibly generated by the presence of fans in the dust removal booth in the same unit.

The noise level of units where kilns are located is around 82 dB_A for continuous kilns and 78 dB_A for periodic kilns if fans are located outside the factory. The figure rises to 85 dB_A if fans are located near the kiln.

A distinction needs to be made between the two types of machinery: continuous kiln workers are always present near the machinery, while for periodic kiln workers the lighting of the kiln and the commencement of firing operations coincide with the termination of their shift.

Kiln workers are exposed to noise levels averaging between 82 and 85 dB_A.

3 - Possibility of uneven floors and consequent risk of falls

In tunnel type kilns a number of ground holes are required to inspect trolleys and the kiln itself from below.

Access to these holes is via a staircase endowed with banisters and chains fixed with spring catches in order to prevent accidental falls.

For both types of kiln (continuous and periodic) housing structures are set in the floor for propulsion lines, transfer tables and rails.

4 - Presence of hot or burning objects

In the case of continuous kilns maintenance must be performed while the machinery is operational, therefore workers come into contact with very hot objects during these operations.

As far as possible, installations should be built or modified to allow convenient and rapid intervention.

To minimise difficulties in this area, preventive maintenance procedures are in place, carried out when the plant is normally not operational with a view to preventing the need for repairs while the plant is working at hot temperatures.

5 - Use of ceramic fibre as heat insulator

Ceramic fibre is one of the most commonly used heat insulators at high temperatures (up to 1600°C). In recent times it has mainly been used for the construction of kilns and kiln trolleys.

The fibre is usually used for the heat insulating walls of kilns or trolleys. Under normal working conditions it is not dispersed into the atmosphere, and its dispersion is always minimal.

The production of dust is greatest when these walls are being prepared and, especially, when they are removed.

Above the temperature of 900°C ceramic fibre is turned into cristobalite, a particular form of free crystalline silica.

6 - Microclimate
The unit where kilns are installed inside a plant producing ceramic articles is by nature very hot owing to the presence of considerable installed thermal power (2,000,000-10,000,000 kCal/h).
Wall insulation, not being total, allows a certain amount of heat energy to escape, through conduction, from inside, where temperatures are close to 1270°C.
The heat energy dispersed into the atmosphere tends to raise the air temperature and create poor situations for the physical wellbeing of workers.
The problem of the microclimate near kilns tends to be greater in summer months owing to the high temperatures recorded outside.

7 - Presence of high electric voltage - danger of electric shocks
A considerable number of machines are installed in the kiln area, especially fans, that are powered by electric energy.

8 - Manual handling of loads

Sanitary articles are loaded and unloaded manually from the trolleys, which are coated in a refractory material. Pieces are also lifted with a side rotation of the bust, a movement which may damage workers' backbones.

Likely damage
Refer to the separate chapter on likely damage.

Intervention
As regards the moving of trolleys and transfer tables, most firms in the district perform this task automatically in order to avoid load-moving risks. Workers also wear safety shoes with reinforced toes.
One of the most successful prevention actions performed in the firing and re-firing unit has been that of moving kiln fans from the plant to a soundproof hut in order to reduce background noise in the unit and thus reduce the individual exposure levels.
The correct maintenance of machinery furthermore prevents the slow build-up of noise owing to the wear and tear of bearings or other moving parts.
Furthermore, the air guns used to blow pieces prior to firing have been fitted with silencers designed to minimise the noise emitted directly by the guns.
To avoid dangers related to the presence of ground holes, the zones in question have been bordered off with metal railings endowed with standard banisters, to prevent unauthorised and thus uninformed staff from entering. These zones have also been endowed with good lighting.
Propulsion lines have also been protected from the entry of personnel. Entry can only be at the loading point and is authorised for unit workers, technicians and maintenance workers only.
In the proximity of kilns or hot equipment which, for technical reasons cannot be turned off (e.g. continuous kilns, etc.), workers must take all reasonable precautions to protect themselves from heat.
More specifically, workers must use non-plastic, heat insulating gloves to protect their hands. For very high temperatures they should wear high-temperature insulating suits (in aluminised kevlar, avoiding asbestos-based clothing especially if it is in a poor state), together with suitable headwear, gloves and footwear.

Actions must be performed for brief periods. Longer types of intervention must be split up into several phases to prevent workers from feeling ill owing to excessive exposure to heat (producing a collapse, etc.). Actions must also be performed in the presence of at least one other person.
During the installation and removal of insulating walls made from ceramic fibre, suction devices should be located below so as to maintain a vacuum situation and ensure the change of air.
During installation operations workers should wear goggles, face masks and fabric clothing (not throw-away fabrics) to prevent fibres from penetrating the skin. During wall removal operations, special breathing apparatus must be worn.
These operations should be performed by specialist personnel or by third-party specialist firms which, by virtue of their specialist knowledge and precision can ensure the wellbeing of maintenance workers and of workers inside the plant.
To deal with the microclimate problem, air-change systems have been installed to ventilate the work setting and improve the conditions of physical wellbeing.
These environmental ventilation systems have been created to move large volumes of air at low speeds so as not to create difficult heat-related situations.
All measures designed to protect the wellbeing of workers and the integrity of machinery powered by electric energy have been set in place, namely:
*protection from direct contact: adoption of highly sensitive differential switches and earthing;
*protection from indirect contact: adoption of suitably insulated materials and covering, opening of instrument board only possible using special tool or upon interruption of supplies (cutter block);
*general protection: magneto-thermal switch, suitable wire sections to avoid overheating, instrument boards located to avoid being damaged, cleaning of inside of instrument board, ensuring that no foreign objects are introduced;
*routine/preventive maintenance: regular tightening of screws to avoid overheating or malfunctioning, substitution of mechanically or electrically worn pieces;
* non-combustible cables of a suitable voltage class.
The coverings of electric switchboards should be insulated to a degree appropriate to the installation environment (minimum IP44, in view of the presence of water and dust in the unit).
These should be kept clean and free of obstacles; they should only be opened using a special tool or must be endowed with a switch having cutter block.
All structures must be regularly checked for the suitability and connection of earthing systems, and power lines should be derived from highly sensitive differential switches designed to protect workers from direct contacts.
Untrained and unauthorised staff should also be prevented from modifying the safety devices or circuitry of instrument boards.
To limit problems caused by the manual handling of loads, workers are advised to lift heavy loads gradually and with the aid of a person or special equipment, especially loads in excess of 30 kg.
Loads exceeding 30 kg are fire-clay pieces which, by virtue of their nature, shape and weight, should be lifted in pairs. Workers have also been specially trained as to the correct handling of loads and the damage caused by such operations performed incorrectly.

Outsourcing

Operations entailing the assembly and disassembly of kilns are always entrusted to the respective kiln manufacturers.
Nowadays, as ceramic fibre is considered a cancerous material, maintenance operations involving ceramic fibre insulating layers are contracted out to third-party specialist firms.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust

- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- Presidential Decree 203/88 and subsequent amendments governing the discharge of emissions into the atmosphere
- the suggestions and recommendations of the ECFIA as regards the use of ceramic fibre
- CEI standard 64/4 governing installations in places most at risk in respect of fires and explosions for the design and execution of electrical installations
- the framework law on noise pollution (Law 447/1995) for noise emissions generated outside the plant
- activities carried out in the present phase are all activities controlled by Firefighting forces, being most at risk in respect of fires; reference should be made to all national legislation and to best practice norms governing the matter.
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase generates emissions into the atmosphere, especially:

- during operations to remove powder from sanitary articles, before flowing outside the fluid stream is conveyed through a system endowed with a dry filter (cartridges or hose filter), the concentration of the effluent is around 5 - 8 mg/m^3
- during firing phases; these emissions mainly consist of a high-temperature fluid stream having the following characteristics:

Flow rate	1800 Nm^3/h
Particles	0.150 mg/Nm^3
No_x	41 mg/Nm^3
SiO^2	0.053
Pb-Mg-Al-Fe-Ca-Ti-K-Th	Traces

One should bear in mind however that every kiln is designed according to the express wishes of the customer, consequently the flow rate and composition of effluents are extremely variable, the above table giving purely indicative values.

Warehouse

Once the production cycle is complete, the product is packaged and made ready for shipment.

Manufacturing phase

In this area workers choose pieces, dividing them into the categories: colour, quality and series, and package them on wooden benches using polyethylene stretch wrapping. Top-quality pieces are packed in cardboard boxes.
Another type of packaging used to bind materials is that of thermoshrinking film, which is heated using a gas flame.
Noise levels in the warehouse unit are usually low despite high values for the palletisation flame (up to 90dB$_A$). Palletisation times are extremely short and background noise is practically inexistent (65-70dB$_A$), since the warehouse is usually set apart from production units and is very large, with few persons working therein.
Some firms possess grinding machines to rectify some types of wash basins.

Machinery and equipment

A small amount of machinery is present in the warehouse since most operations are concerned with the handling, selection and packaging of pieces, these operations being of a predominantly manual nature.
Warehouse machinery thus consists of:

◊ Trolleys for handling pieces and forklift trucks;

◊ Flames to heat stretch materials used for packaging.

Forklift trucks work practically throughout the working day. They are thus subjected to considerable mechanical stress and wear and tear. The turnover of machinery is thus rapid, meaning that machines remain state-of-the-art in terms of both production and regulatory aspects.
The latest grinding machines are endowed with EC labelling and are soundproofed, generating low noise levels.

Risk factors

Warehouse

1.	Possibility of contusions-distortions to hands and feet from falling pieces
2.	Collision with forklift trucks (shunters) and transpallets
3.	Presence of compressed inflammable gas / inflammable materials
4.	Manual handling of loads
5.	Risk of noise due to use of grinding machines

1) Possibility of contusions-distortions to hands and feet from falling pieces

When handling sanitaryware in the selection and packaging stages, workers may drop materials, crushing or injuring their feet.
For this reason workers should wear safety shoes specially designed to protect lower limbs from this danger.

2) Collision with forklift trucks (shunters) and transpallets
Specific risks are those connected with the handling of sanitaryware using forklift trucks.
The presence of a large number of sanitary pieces in storage units means that movement is not always simple, with the risk of colliding with pieces of machinery or with protection elements.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.

3) Presence of compressed inflammable gas / inflammable materials
As far as gas is concerned, such presence is limited to a low-capacity methane supply needed to power the pneumatic gun, or to a small LPG cylinder.
Easy-to-use flame-trap valves and manual disconnecting devices have been installed.
Upon the completion of work, the flexible tube is gathered and wound onto a specially constructed support.
This tube should be replaced at the first sign of damage, and in any case every five years.
With reference to inflammable materials (box board), the presence of cardboard adjacent to the palletisation zone is kept to a minimum, and there are notices banning the use of free flames and smoking inside specified areas.
Naked flames for palletisation operations are used in a suitably aerated area, equipped with a nearby fire extinguisher, by staff trained for this purpose.
Workers must wear suitable fireproof clothing, a face mask and gloves. Shoes should also be fireproof and easy to remove.
Palletisation operations are performed at a distance from other pallets, and the plastic cap should be of the type not propagating dioxin for heating.
Workers wear ear protection to defend themselves from the noise generated by the speed of emission of the flame.

4) Manual handling of loads
It should be considered that fired material has lost a further 20% in weight compared with the raw material as a result of firing operations, and is thus lighter and easier to handle, being more compact, unlike the raw material, which literally breaks up if it is moved at high speed and subjected to bumps.
Loads are however handled manually using transpallets, which are pushed by workers.

5) Grinding machines and wheels
The presence of abrasive grinding wheels and grinding machines in the unit pushes up noise levels to 82-83 $dB_{A.}$ The noise risk is mainly due to the rotation of the diamond grinding wheel on the piece.

Likely damage
Refer to the separate chapter on likely damage.

Intervention

With regard to the risk of injury to feet caused by dropped objects, it has been deemed necessary to make workers wear safety shoes endowed with a reinforced metal toe.
To minimise the danger of collisions with moving machinery, dangerous protuberances have been made more visible by being painted a striped yellow-green colour, while, where possible, runways for moving machines have been designed to leave room of at least 0.70m for persons to pass (although this space is no longer compulsory).
These runways are well demarcated by continuous yellow lines on the floor, which must always be kept in an efficient state.
Vehicles have also been fitted with a flashing light and siren for reversing.
To overcome the problem of noise caused by palletisation operations, experiments have been carried out with low-noise heating pistols, or pistols fitted with a system for conveying combustion gases, made in such a way as to prevent the formation of vortexes and thus reduce the noise generated by the machine.
To limit damage caused by noise, workers have been supplied with ear plugs and headphones. The use of this equipment is compulsory.
The results of the above experiments have unfortunately been disappointing, since the use of these pistols required the use of stretch film of reduced thickness that did not afford sufficient protection to palletised material that was then stored in outside yards exposed to climatic elements.
Grinding machines have been removed from all other manufacturing areas so as to reduce the noise level of the entire unit, and have been fitted with soundproof covers in order to reduce and in some cases practically eliminate its contribution to the generation of noise.

Outsourcing

None of the ordinary operations performed during this phase are contracted out to other companies.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- all other laws in place in our State on the subject of occupational health and safety.

External risk

This phase of production does not generate any sort of external risk, with the exception of possible packing operations using thermoshrinking materials.
Such operations generate atmospheric emissions, requiring suitable filtration before emission.
Waste products produced include broken pieces to be thrown away, which are put in a special bin and sent by a third-party firm to be crushed and produce chamotte; broken or useless packaging or cardboard, which are stored in a metal bin and sent to an authorised waste disposal site.
Harmful or toxic waste is not produced.

Maintenance

This unit performs minor electrical and mechanical repairs and routine maintenance operations required for the running of the factory.
Workers go to the workshop chiefly to collect materials needed for repairs or to prepare pieces to be placed/replaced. The lion's share of the work is performed in the factory adjacent to the machines or installations that need repairing.
Specialist third-party companies are contacted for specific extraordinary maintenance operations.

Manufacturing phase

The factory's “mechanic”, or maintenance manager, deals with the routine maintenance of the factory's machinery and installations and liaisons with external firms for the installation or repair of new machinery.
A small workshop is normally present in the plant for minor repairs. Larger repairs are normally carried out by outside specialist firms (plumbers, mechanics, electricians, installers of special installations, etc.).
Owing to the nature of his job, the maintenance manager is exposed to all factory risks.

Machinery and equipment

The general services department comprises all those services that are fundamental for the correct technological running of the firm but cannot be included in a specific department. The supervising unit responsible for the correct functioning thereof is the workshop.
This department contains mechanical and/or electrical maintenance workers.
To perform their job correctly, they must have a perfect knowledge of the firm's technological cycles and of the machinery used therein.
Department instrumentation is that needed for preventive maintenance and to restore machinery after malfunctions.
The following machinery is usually present:

◊ Lathe with or without "copying" device;
◊ Cylinders and blowpipes;
◊ Vertical drilling machine;
◊ Electrode or wire welding machine(s);
◊ Grinding wheels, grinding machines
◊ Saws, cutting-off machines.
◊ Other portable tools.

Outside the workshop unit there are other sorts of machinery, such as:

◊ Compressors;
◊ Heat generators (exchange of smoke/air);
◊ Heat generators (exchange of smoke/water);
◊ Methane decompression cabin;
◊ Electrical energy transformation cabin;
◊ Electric generating set;
◊ Air conditioning sets.

Risk factors

In light of the above, it may be deduced that as mechanics are exposed to every type of company risk great care has been taken in informing them correctly about dangers and relative procedures to

be observed. Mechanics have also been given appropriate equipment and individual protection devices for the operations to be performed.
These workers are also kept informed of any new machinery or procedures.

1.	Possible danger of physical damage from moving parts (rotating parts, belts, etc.)
2.	Possible collision with protruding surfaces or machines in movement (forklift trucks, etc.)
3.	Possibility of slippery floor and consequent falls
4.	Handling of loads in excess of 30 kg
5.	Possible exposure to impulsive and continuous relatively high-level noise
6.	Presence of compressed gases
7.	Presence of inflammable and/or compressed gases
8.	Presence of high voltages;
9.	Presence of hot bodies or liquids that could cause burns
10.	Possible inhalation/intake of dust having a high silica content;

Possible danger of physical damage from moving parts (rotating parts, belts, etc.) or electric shock

In the workshop:
Machines that could generate mechanical risks from entanglement or collision are drills, lathes, grinding wheels and other machines with rotating/revolving parts.
To limit such dangers, lathes are fitted with a transparent screen that can be removed when the machine is not working. This protects the worker from impact with the rotating piece and from the release of shavings that could cause burns or physical damage of some sort in view of the speeds involved.
Workers in this department also know they must wear clothes having elastic or zipped sleeves to avoid the danger of hanging parts that may get tangled up in moving equipment.
Workers have also been told to wear protective goggles when working with rotating grinding wheels, whose state must be examined by sight before every working session.
Furthermore, gloves to prevent cuts must be worn when handling sharp or slippery pieces, while “non plastic” gloves must be worn when handling very hot pieces.
Every precaution is taken when using the blowpipe, excluding the use of grease on seals, with the insertion of flame-trap valves in tubes, the substitution of tubes that are damaged in any way and the expedient of keeping cylinders open only for the time needed to perform the job.
Moving vacuum caps endowed with activated charcoal filters are capable of sucking up fumes produced by welding operations.
In order to prevent machines from coming on automatically when power supplies return after a breakdown, they have been fitted with a switch-off device when the power goes down.
Outside:
As many machines have moving parts consisting of motors and gear motors, which transmit movement to rotating axes via belts, there is the danger of physical damage owing to accidental contact with these parts.
To prevent this from happening, all belts and chains have been covered with a protective casing.
The same goes for fans which, if within reach, are fitted with protective meshes, making it impossible for fingers to make contact with moving parts.
Mechanics are aware that they must turn off power supplies before working on moving parts. If repair workers are not clearly visible (work performed crouching down or behind machines), a notice warning that the machine is being repaired must be placed on the machine's control panel, and all possible measures must be taken to prevent the machine from being accidentally switched on (e.g. removal of general fuses, etc.).

Another source of danger are rotating drums, whose area is marked off by robust metal structures that can only be removed using special tools. Openable parts are fitted with standard cutter blocks (positive opening or safety stroke end with key that cannot be tampered with).
The same goes for drums with reference to measures to be taken prior to their maintenance.
As regards the danger of electric shock, electric installations must be continually serviced in a workmanlike fashion by suitably qualified technicians. The internal mechanic has the job of restoring protective devices that may go off to an active status, replacing burnt fuses with others of the same type, power and speed of interruption.
Electric switchboards must all be tightly sealed and fitted with a door-block switch or with a door that can only be opened using a key or special tool.
Control circuits are made from BTS (24Vac) and push-button panels are airtight (IP44) and easy to use and identify.
The department's main electricity supplies are taken from a highly-sensitive magneto-thermal differential switch.
All switchboards are endowed with wiring diagrams and numbered wiring for easy and safe routine and extraordinary maintenance.
The lighting system is also IP44, consisting of suitably powerful lights clearly showing up potential dangers.
Self-powered emergency lights are present in a number sufficient to ensure that the area can be vacated without creating dangers for workers.
Special care has been taken with the earthing and equipotential system throughout the plant, especially for incoming and outgoing tubing that could convey dangerous potential to earth.
Specific notices are displayed to warn about tampering with safety devices, lubricating or cleaning parts in movement, opening electric switchboards (except for qualified staff) and about general electrical dangers.

Possible collision with protruding surfaces or machines in movement (forklift trucks, etc.)

In the workshop:
An impending danger are the metal beams that have been cut or are to be cut. These must immediately be cut using the saw and placed vertically or horizontally on suitable racks.
Outside:
The presence of a considerable number of machines means that movement is not always simple, and there is the danger of colliding with pieces of machinery or with protective elements. Another danger is that of being hit by internal transport vehicles (such as transpallets or forklift trucks) moving inside areas while maintenance work is being performed.
To minimise this danger, dangerous protuberances have been made more visible by being painted a striped yellow-green colour, while, where possible, runways for moving machines have been designed to leave room of at least 0.70m for persons to pass.
These runways are well demarcated by continuous yellow lines on the floor, which must always be kept in an efficient state.
Vehicles have also been fitted with a flashing light and siren for reversing.
Workers driving these vehicles must work with the utmost caution, avoiding sudden manoeuvres that could cause damage to persons and things.
The level of illumination should be suitably distributed to avoid significant differences between semi-dark and over-light zones and frequent sources of glare.
Runways should be left uncluttered and clean to ensure that machine operators do not have to negotiate unexpected obstacles and that there is suitable friction between the machine and the floor.
Notices are also displayed warning about the presence of moving vehicles.

Possibility of slippery floor and consequent falls

In the workshop:

Solid or liquid lubricants and cutting liquids (for lathes and drills) are used. These can come into contact with the floor and constitute a serious danger to workers and anyone having to enter the workshop. Orders have thus been given to take great care over maintaining the efficiency of pump caps for cutting liquids and immediately cleaning up the spillage of lubricants, using absorbing substances such as sawdust, kaolin or suitable cloths.

This absorbing material must then be disposed of in appropriate containers according to their level of danger.

Outside

With water used almost continuously in manufacturing processes and cleaning operations, the factory's floors (especially in glazing and mixture areas) are often wet. If cleaning operations are not effective, the blend of water/mixture can become extremely slippery, posing a serious threat to workers.

To minimise such risks, floors are cleaned thoroughly on a daily basis, and special care is taken to minimise floor unevenness owing to the accumulation of dirt and possible snags.

Workers have also been equipped with antislip shoes.

Handling of loads in excess of 30 kg

In the workshop it is often necessary to lift loads exceeding 30 kg (motors to be repaired, pulleys, etc.), in which cases the help of other workers or suitable hoisting apparatus (small cranes, fork lift, etc.) should be sought.

All hoisting apparatus is endowed with safety devices (for hydraulic equipment piloted stop valves, for electrical equipment anti-reverse brakes, etc.). Machines operators must use them correctly and not exceed the test capacity.

If pieces need slinging, approved cloth slings for that class of load or chains of a suitable mesh are used.

The worker must verify the integrity of hoisting apparatus, of hooks, and of the correct equilibrium/stability of the load to be hoisted.

Outside:

The same as for the workshop.

Possible exposure to impulsive and continuous relatively high-level noise

In the workshop:

The department is generally noisy, especially when saws, lathes and drills are operating.

The degree of exposure of a maintenance manager entails a $Lep,_w$ ranging from 82 to 85 dB_A, but some machines have quite a high Leq:

Lathe	85 dB_A
Sanding machine	100 dB_A
Welding machine	82 dB_A
Cutting-off machine	102 dB_A

Exposure to the noise generated by these machines is relatively low however in terms of time.

When the above machines are in use, workers have orders to wear personal protection devices (headphones, ear plugs, etc.) appropriate to the degree of noise generated.

The correct maintenance of machinery and timely repair of any defects also helps to avoid the gradual increase in noise levels owing to the deterioration of bearings or other rotating parts.

Blow guns are silenced or fitted with silencers.

Displayed in the area are notices warning about the obligatory use of individual protection devices.

Presence of compressed gases

Compressor room:

Preventive maintenance of compressors, in particular calibration and safety parts, is essential in avoiding what may become serious problems (e.g. excess pressure of valves, breakdowns, alarms).

All maintenance operations are carried out after having emptied the machine of residual air and cut off power supplies.

A visual examination is undertaken to ascertain the absence of cracks in tubing and tanks and the integrity and sealing of tubing.

Any welding of pressurised tanks and tampering and recalibration of safety parts are to be avoided at all costs.

The mechanic must also inspect the work of external maintenance workers (plumbers, etc.), their use of safety equipment and full compliance with relative standards. He must notify the management of any intervention which he believes to be non-compliant or to go against given instructions.

Presence of inflammable and/or explosive gases

The factory possesses a pressurised fuel (methane) distribution network, containing final decompression units, filters and controls.

This network must be inspected on a regular basis to verify its integrity and the absence of leaks.

This inspection should be performed with soapy water or, preferably, with a leak detector device, with the absolute exclusion of naked flames or similar devices.

As this network derives from a system kept under greater pressure using a decompression cabin, it is necessary to check that all equipment is working correctly in that cabin, with no leaks or unusual noises. The decompression chamber should be kept clean and free of obstacles so that liquid leaks can be verified at sight.

In the presence of antifreeze heating devices (decompression being practically adiabatic), these devices must be working perfectly and must not be a possible cause of explosions or fires.

The flameproof or AD-FT electric system must be tested for the correct tightness of fuse boxes and couplings.

Extraordinary maintenance must be entrusted to qualified third-party firms that issue suitable certification as regards the type of intervention performed and the complete restoration of original safety levels.

Inside the factory gas leak detectors must be checked at least twice a month to ensure their correct functioning. The sensor head must be replaced as soon as there is a significant loss in sensitivity.

Electro-valves used for gas supplies must be checked, in particular for the absence of leaks and the integrity of the operating coils.

The mechanic must also inspect the work of external maintenance workers (plumbers, etc.), their use of safety equipment and full compliance with relative standards. He must notify the management of any intervention which he believes to be non-compliant or to go against given instructions.

The ramps of the blown-air burners must be modified in full compliance with existing UNI-CIG standards.

The mechanic shall ensure the testing of valve seals, the redundancy of the system upon closure, the impossibility of tampering with control switches on a continuous basis and the interruption of gas supplies after 3 seconds should there be no flame.

Should repairs to piping be required, the system must be emptied and cleaned, first with an inert gas, usually nitrogen, and with air to avert dangers arising from the use of flames or sparks (such as those generated by blowpipes or sanding machines).

Presence of high voltages

If there is no person qualified among the factory staff to do the job, all maintenance operations in the electric transformer cabin must be carried out by authorised firms. The intervention of internal staff not specifically designated for this job is absolutely forbidden.
The only operations that can be performed by internal services are the cleaning of areas and restoration of protective devices to an active status, only when the external service is unavailable.
In such cases it is necessary to follow to the letter the following procedure:
Opening of automatic low-voltage switches and of the switches of the transformer's fixed re-phasing condensators;
Wait for the latter to be discharged with the appropriate resistances (if this does not happen there is medium voltage on the primary unit of the transformer, even though this is cut off from the mains);
Use of gloves and insulating footboard;
Opening of medium voltage on-load disconnecting switches;
Visual examination of opening (when possible)
Closure of grounding knives;
Visual examination of closure (when possible);
Access to fuses - inspection and substitution;
Closure of protective parts;
Opening of grounding knives;
Use of gloves and insulating footboard;
Closure of medium voltage disconnecting switch;
Visual examination of absence of arcs or anomalies;
Closure of low voltage switches.
If the re-opening is automatic, avoid further actions and wait for the intervention of qualified external technicians.

Presence of hot bodies or liquids that could cause burns

Factory maintenance may involve intervention for kilns or hot equipment. When for technical reasons it is impossible to switch them off (e.g. continuous kiln, etc.) the worker must take every reasonable precaution to defend himself from heat.
In particular, he must wear non-plastic heat-resistant gloves to protect hands, fabric clothing totally covering the body, excluding short-sleeved shirts and similar clothes.
For very high temperatures high-temperature resistant suits must be worn, made out of aluminised kevlar (avoid suits containing asbestos, especially if they are old), complete with suitable headwear and gloves.
Intervention must be performed over brief periods. If more time is needed, intervention should be staggered over several phases to prevent workers from suffering excess exposure to heat (e.g. collapse, etc.)
Whenever possible, installations must be designed or modified to ensure convenient and speedy intervention.
Preventive maintenance procedures should always be performed when the plant is normally non-operational to avoid breakdowns during high temperatures.

Possible inhalation/intake of dust having a high silica content

All dust extraction and filtering systems require ordinary and extraordinary maintenance. Wherever intervention is carried out, moreover, the presence of dust is likely.

This makes it necessary to carry out routine maintenance of all dust extraction and cleaning equipment. This activity should be performed with the utmost care, these installations containing a high concentration of dust.

It is difficult to establish maintenance workers' degree of exposure to dust. During all maintenance operations on installations likely to contain dust, maintenance workers must however wear special clothing to protect respiratory tracts, i.e. filtering face masks having a degree of filtration of at least FFP2.

In addition to this plant engineering measure, there are procedures to be observed such as the use of individual protection devices (masks, respirators, etc.) with a degree of filtration appropriate to the dust involved.

Prevention action includes the company's instructions for performing such operations with the utmost care and gradually (e.g. avoid sudden unloading of materials, etc.), warning workers not to carry out free blowing during cleaning operations in non-aspirated zones, as this could scatter dust and extend the area of risk.

Once operations are complete, the room/area should be adequately aerated before workers can remove individual protection devices.

Displayed in factory areas are notices warning about the obligatory use of individual protection devices.

Likely damage

Refer to the separate chapter on likely damage.

Intervention

Briefly, intervention to limit damage accruing from rotating or moving parts includes: Screens over lathes or drills; Sumps on rotating parts; Minimum voltage switches in the workshop; Explosion-proof valves on welding cylinders; Meshes on fans; Careful scheduled maintenance; Highly-sensitive general differential; Switchboards and lighting having IP44 minimum protection; Adoption of BTS for controls; Grounding and equipotential equipment; Warning notices.

Briefly, intervention to limit risks owing to moving vehicles: Placing of long beams to mark off work areas; yellow-black stripes where necessary; Demarcation of runways; Flashing lights and sirens on vehicles; Runways free of obstacles and clean; Warning notices.

Briefly, to minimise the risk of falls owing to slippery conditions, the following actions are adopted: Maintenance of cutting liquid pumps; Cleaning of spilled lubricants; General cleaning; Antislip shoes.

To minimise risks relating to the lifting of loads: Lifting in pairs or using suitable devices if loads exceed 30 kg; Checking integrity of hoisting apparatus; Checking capacity of hoisting apparatus; Checking stability of load.

To reduce effects caused by noise: Scheduled maintenance of all machinery; Silencers for compressed air devices; Care taken over operations without generating unnecessary noise; Use of individual protection devices; Warning notices.

To reduce risks deriving from compressed gases, the following measures are adopted: Repair work when the plant is empty and non-operational; Visual examination of installations; Checking the work of external plant engineers.

To eradicate risks deriving from the internal use of inflammable gases: Repair work when the plant is empty and non-operational; Visual examination of installations; Checking the work of external

plant engineers; Checking the integrity of protection devices; Checking for possible leaks; Checking AD-FT installations.
To reduce risks deriving from the use of electric energy: Use of individual protective insulation devices; Procedures observed to the letter; Avoid re-attempting to perform actions; Call qualified external service.
To reduce risks deriving from possible contact with hot, burn-provoking materials, the following procedures and measures must be adopted: Use of suitable means of protection; Brief, specific actions; Optimisation of installations and procedures; Preference for preventive maintenance.
Actions to reduce risks deriving from exposure to dust: Use of suitable means of individual protection; Care taken in performing operations; Avoid the use of compressed air in open air; Warning notices.

Outsourcing

Routine and extraordinary maintenance of an electrical or plumbing nature are contracted out to third-party firms.
These operations must be carried out by qualified firms endowed with suitable technical and professional competence and able to issue certification regarding the conformity of work effected.
The above must be carried out in compliance with legislation on tender contracts pursuant to Legislative Decree 626/94 and subsequent amendments.

Referent legislation

Law provisions referred to in this phase are:
- Decree Law 277/91 on the subject of noise and dust
- Recommendations made by the ACGIH (American Conference of Governmental Industrial Hygienists) in respect of the TLV-TWA of free crystalline silica
- Community Directive 89/392 implemented through Presidential Decree 459/97 regulating safety and the use of machinery
- Law 46/90 on the safety of technical installations and specific CEI and UNI standards for single topics
- Laws on methane gas and LPG transportation networks.
- all other laws in place in our State on the subject of occupational health and safety

External risk

This phase generates atmospheric emissions especially during welding and similar operations. Before flowing outside the plant, the fluid stream is conveyed through a suitable system fitted with a charcoal activated dry filter.
Waste produced is made up chiefly of residues from maintenance operations (expendable materials, replaced parts, etc.) which must be collected and disposed of by authorised firms at authorised waste disposal sites.