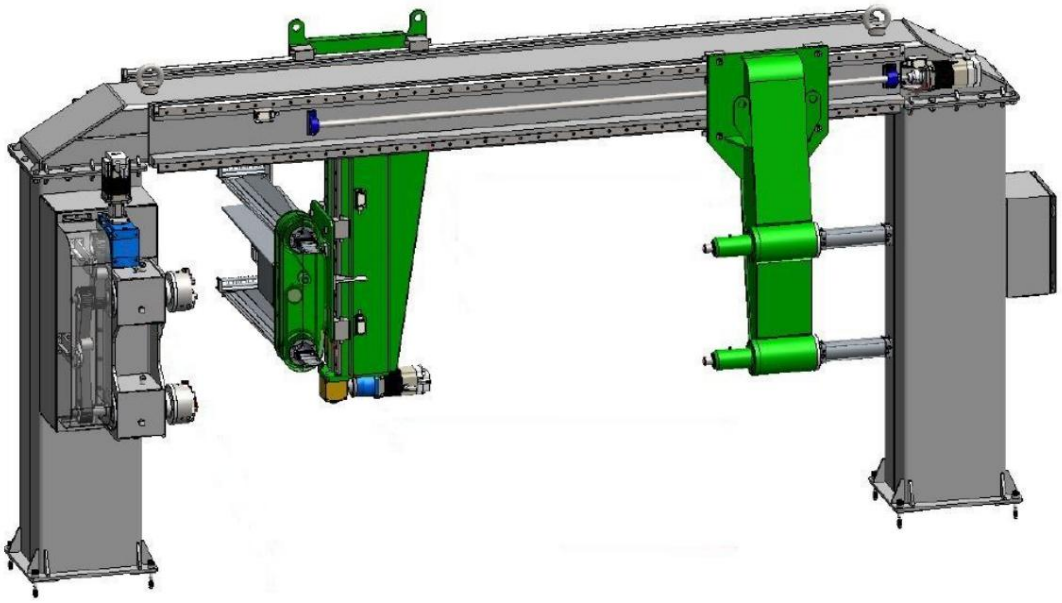
Installation, use and maintenance manual

FILAMENT WINDING MACHINE
FW-6AX-2SP



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CE DECLARATION OF CONFORMITY

FOR DESIGN/CONSTRUCTION OF CE MACHINES
IN ACCORDANCE WITH ANNEX II A OF DIRECTIVE 2006/42/EC

THE COMPANY	**VEM S.p.A. – FILAMENT WINDING TECHNOLOGY**
BASED IN	**Via Malignani, 23 – 33058** **S. Giorgio di Nogaro (UD) - ITALY**

DECLARE THAT

THE CAR	**Filament Winding Machine** **FW-6AX-2SP**
HAVING THE FOLLOWING FUNCTION	**Production of manufactured articles** **in composite material by discontinuous filament winding**
SERIAL NUMBER AND YEAR	**001 of 2008**

IT IS DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH THE ESSENTIAL REQUIREMENTS OF SAFETY AND HEALTH PROTECTION OF
MACHINERY DIRECTIVE 2006/42/EC - ANNEX THE

Therefore, pursuant to Annex V of the Machinery Directive 2006/42/EC we declare:

- The marking of the symbol CE is affixed to the supply;
- The technical file is available at the manufacturer's premises.

THE FOLLOWING HARMONIZED STANDARDS WERE USED FOR THE PROPER IMPLEMENTATION OF ESSENTIAL HEALTH AND SAFETY REQUIREMENTS OF ANNEX I:

- Compliance Electrical according to: EN 60204-1;
- UNI EN 12100 - Safety of machinery - General design principles - Evaluation risk management and risk reduction;
- Low Voltage Directive 2006/95/CE;
- Electromagnetic Compatibility Directive 2004/108/CE;
- UNI EN ISO 4414 - Pneumatics - General rules and safety requirements for systems and their components.

S. GEORGE OF NOGARO, 22/02/2008

THE MANUFACTURER
(STAMP AND SIGNATURE)

1. General information

The following activities are highlighted:

- Before installing, using and/or maintaining the machine, yes recommends that you read this manual for installation, use and maintenance;
- This manual is to be considered to all intents and purposes as an integral part of the machine, therefore this manual is aimed at the operator and the personnel who have the responsibility for the correct use of the machine for safety purposes;
- The installation, use and maintenance manual must be kept in its entirety life cycle of the machine accompanying it, so that it is the same available for any consultation;
- Pass this manual on to any other user or subsequent owner of the machine;
- Use the manual in such a way as not to damage all or part of the content, by storing it in areas protected from humidity and heat, and not by peeling, tearing or rewriting parts of the manual for any reason.

In order to ensure the safety of the operator, the safety of operation and a long life of the machine must be observed in the instructions of the manual, together with the safety and accident prevention regulations according to the legislation in force.

This installation, use and maintenance manual refers to the machine **Filament Winding cod. FW-6AX-2SP,** which was conceived, designed and built to be used in the configuration and in the conditions indicated in the attached technical drawings, for the construction of unidentified axisymmetric hollow components in a single standard, up a portal structure with wagons on horizontal guides hanging from the upper beam of the frame main, with the possibility of movement according to 6 main axes, using different materials during the process. Based on the need and technical characteristics of the product

finished required, metallic and non-metallic molds are used which, in some cases, after the processing phase on the machine, they are removed by means of a special one equipment; in case the used mold becomes part of the finished product, it is not removed at the end of the work cycle. The maximum dimensions of the components that can be made on the machine are:

- Diameter (or maximum transversal dimension): 450 mm;
- Length: 3000mm.

The size of the maximum diameter depends on whether or not you use the two spindles provided on the machine; the maximum transverse dimension or diameter is 450 mm valid if both spindles are used, and if only one is used the maximum diameter increases. The maximum capacity per spindle is 150 kg, to be considered with particular attention especially in the use of the machine in single configuration spindle.

The frequency of use of the machine is not established a priori, which depends on the piece and of the requested quantity can be configured to work on consecutive shifts, or in discontinuous mode for a single work cycle alternating with continuous work periods. The maximum number of operators is 2. The maximum pressure of the compressed air of the factory in which it operates is 10 bar, with a minimum flow rate suited to the specific requests.

Below is a table with the main types of materials used for the production of products using the 6-axis double spindle Filament Winding machine:

Main materials that can be used	
FIBRE	
Glass fiber	Spools of filaments
Carbon fiber	Spools of filaments
Aramid fiber	Spools of filaments
RESINS	
polyester resins	
Vinylester resins	
Epoxy resins	
CATALYST	
Peroxides	Used with polyester and vinylester resins
Cobalt salts	Used with polyester and vinylester resins
Amines	Mostly used with epoxies

The Filament Winding machine, as can be seen from the previous table, works with various types of substances, defined in the technical characteristics and analyzed accordingly to the safety data sheets by the end user of the machine, which he then carries out also their own risk assessments based on the substances actually used. Opposite of these choices could generate, for example, dangers of explosion, due to formation of explosive mixtures in the presence of gases, vapors or combustible dust of some unstable and highly reactive substances or explosive material, or risks to health and safety that derive, or may derive, from the effects of chemical agents present on the site of work or as a result of any work activity belonging to the work cycle of the machine involving the presence of chemical agents.

The documentation supplied with the machine contains the technical data sheets and the safety data sheets of all consumables used during processing, for consultation by specialized operators in charge of programming, configuration and start-up of the Filament Winding machine.

During the processing of the products, small quantities of waste are produced mainly in the following forms:

- Drops of resin at the points of contact between the impregnated fibers and the organs machine mechanics;
- Resin dripping on the component being processed;

- Limited waste of dry or impregnated fibers due to initial attack or problems during processing.

Special waste, collected in suitably positioned tanks, must be disposed of as special waste according to the regulations in force in the relevant country.

The indications given in this installation, use and maintenance manual yes integrate with the technical information and directly applied safety requirements on the machine, and with the safety standards in force in the country where the machine comes from installed.

2. Identification of the manufacturer

	come spa
	Via Malignani, 23 – 33058 S. GIORGIO DI NOGARO (UD) - ITALY
	Tel. +39 0431 622180 - Fax +39 0431 622186
	Email: vem@vem.eu

3. Product Identification - Technical Specifications

Description	**Filament Winding machine 6 axes double spindle**
Code	**FW-6AX-2SP**
Badge number	**FW6AX2SP001**
Version	**0**
Revision	**0**
Drawing number	**AV.400.01.000** **AV.400.02.000** **AV.400.03.000** **AV.400.04.000** **AV.400.05.000**
Range diameter	**0-450 mm**
Maximum weight per spindle	**150 kg**
Maximum spindle rotation speed	**90 rpm**
Maximum torque delivered to the spindle	**300 Nm**
Max pressure pneumatic pistons	**10 bar**
Maximum longitudinal axis translation speed (Y)	**1 m/s**
Useful travel of the longitudinal axis (Y)	**3000 mm**
Maximum transversal axis translation speed (X)	**0,6 m/s**
Useful travel of the cross axis (X)	**500 mm**
Maximum rotation speed of the fiber holder tool (B)	**120 rpm**
Useful travel of the vertical axis (Z)	**382 mm**
Maximum speed of vertical axis (Z)	**3 m/min**
Tailstock axis travel (Z11)	**2960 mm**
Tailstock axis maximum speed (Z11)	**30 m/min**
Maximum jog speed	**2 m/min**
Maximum rotation speed in jog	**50 rpm**
Year of construction	**2008**

3.1 Preliminary Information

The **Filament Winding machine** covered by this document was made, based on a project by VEM technicians, by external companies, which on the basis of their own skills have developed the main components of the machine, i.e. mechanical structure, framework electrical, pneumatic system and wiring on the machine; such outside firms have supplied to following delivery, regular declarations of conformity according to the Machinery Directive 2006/42/EC, Electromagnetic Compatibility Directive, Low Voltage Directive and others applicable directives and regulations, summarized in the declaration of conformity of this manual, for the correct construction, installation and configuration, drawings technical and dimensional surveys.

The technical drawings of interest to the user are attached to this document produced by VEM. The machine in question has been subjected to calculations and considerations in the light of the dimensions and technical characteristics set in the design phase, according to the construction precision and minimum geometric tolerances peculiar to these applications. In case of bumps or sliding contacts that could wear or damage the machine, the same goes reviewed and re-evaluated by technicians and qualified and specialized personnel; in order to avoid such situations, the machine must be used with caution, installed in non-aggressive environments, as well as handled with caution and without impacts or inappropriate movements that could damage it harm in any way; at the end of the handling procedures the machine goes fixed to the industrial floor and checked in all its sub-components. For ratings on the structural strength of the assembly in question, have been taken into consideration masses involved, geometries and positions of the centers of gravity of the parts moved and of the machine. Please refer to the structural calculation report and to view the technical file for more information on these considerations. All elements of the pneumatic circuit a supplied with the machine have been sized in relation to the loads to which they come subjected, to the operating pressures and to the operating logic, designed to facilitate them the use by the operator; all the wiring diagrams are attached tires of the systems installed on the machine.

3.2 CE marking

The Filament Winding machine covered by this installation and use manual and maintenance complies with the health and safety requirements of the Directive Machines 2006/42/EC, and therefore pursuant to Presidential Decree No. 17/10 the marking can be affixed CE, bearing information relating to the description of the machine, code, serial number serial number, capacity per spindle, diameter range, max spindle rotation speed, torque maximum delivered to the spindle, year of construction. Below is an image with i data indicated on the adhesive plate, applied directly to the structure of the machine by gluing on galvanized sheet metal th. 15/10 and consequent riveting on the structure of support.

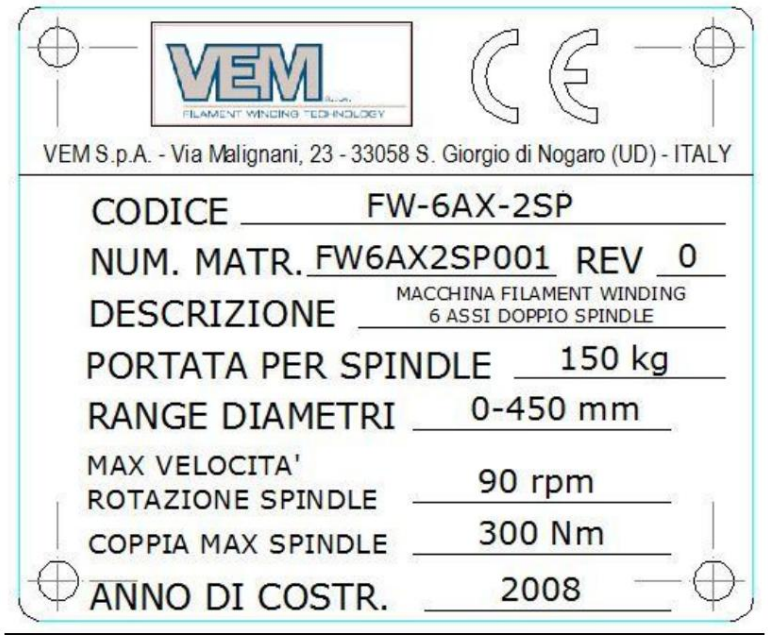


Figure 1 - Detail of the CE plate

4. Description of the machine

The Filament Winding machine has a gantry configuration with carriages on guides horizontal hanging from the upper beam of the main frame, and is equipped with 6 main axes, corresponding to 6 possible movements managed by motors:

- Main spindle rotation (C);
- Longitudinal translation parallel to the spindle axis of the holder tool fiber (Y);
- Transversal translation perpendicular to the spindle axis of the holder tool fiber (X);
- Vertical translation perpendicular to the spindle axis of the holder tool fiber (Z);
- Rotation of the fiber holder tool (B);
- Translation of the tailstock (Z11).

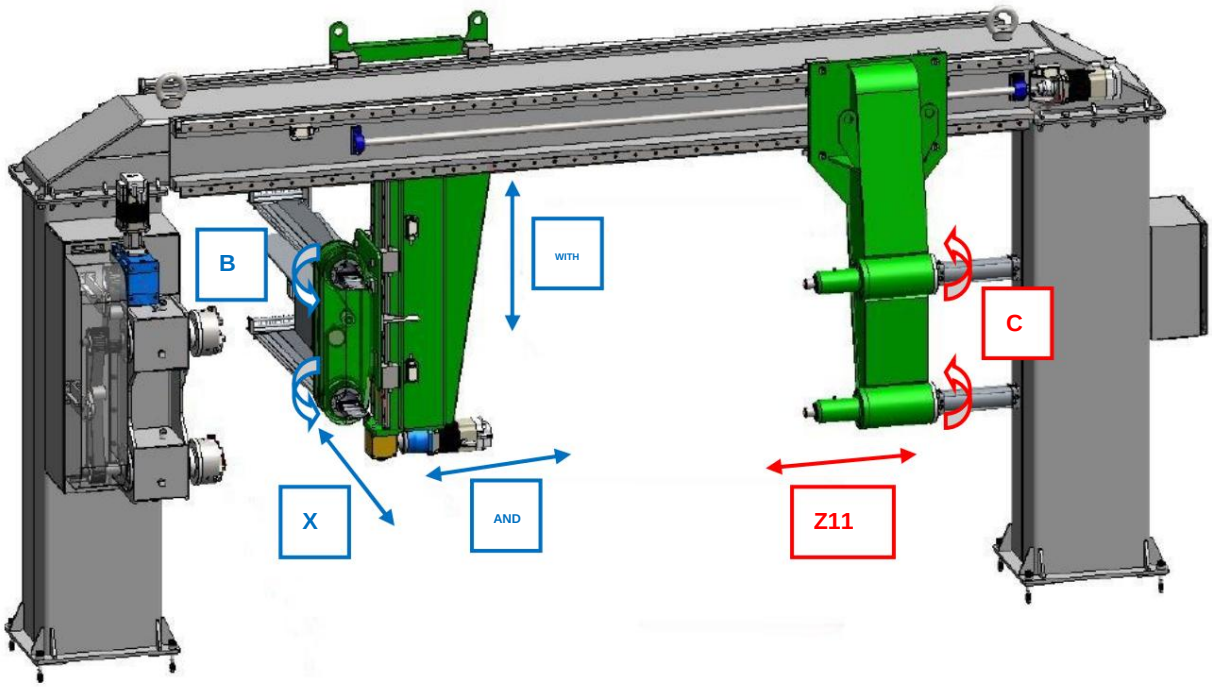


Figure 2 - Machine for Filament Winding, front view, indication of the 6 axes (C axis, Z11 axis for the tailstock, B axis, X axis, Y axis, Z axis for the fiber holder tool)

The machine is also equipped with 2 spindles, i.e. two motorized rotating spindles corresponding to two rotating tailstocks actuated by as many pneumatic pistons, which allow you to produce 2 identical pieces on the machine at the same time.

The numerical control of the machine has 4 interpolated axes, i.e. a management of movement of the spindles by the numerical control on 4 axes at the same time, between those mentioned previously. The syntax of the ISO code that handles the control numeric therefore has on each command line at most 4 out of 6 axes. When passing from a staff of the numerical control to the next one, however it is not necessary to maintain the same four axes, therefore in successive phases it is possible to manage all the axes by the control.

The fiber impregnation tank is of the roller type, different from the technology of soak impregnation, and is carried out on a special structure located outside the area separated from the fixed and interlocked guards in which the Filament Winding machine is contained, in the vicinity of the fiber spools that feed the entire work process; the number maximum number of fibers considered in the input project phase is equal to 20, corresponding to number of small holes present on the front side of the trolley in which the impregnation is carried out of the fibers. The maximum quantity of resin contained in the tank is 2.5 kg.

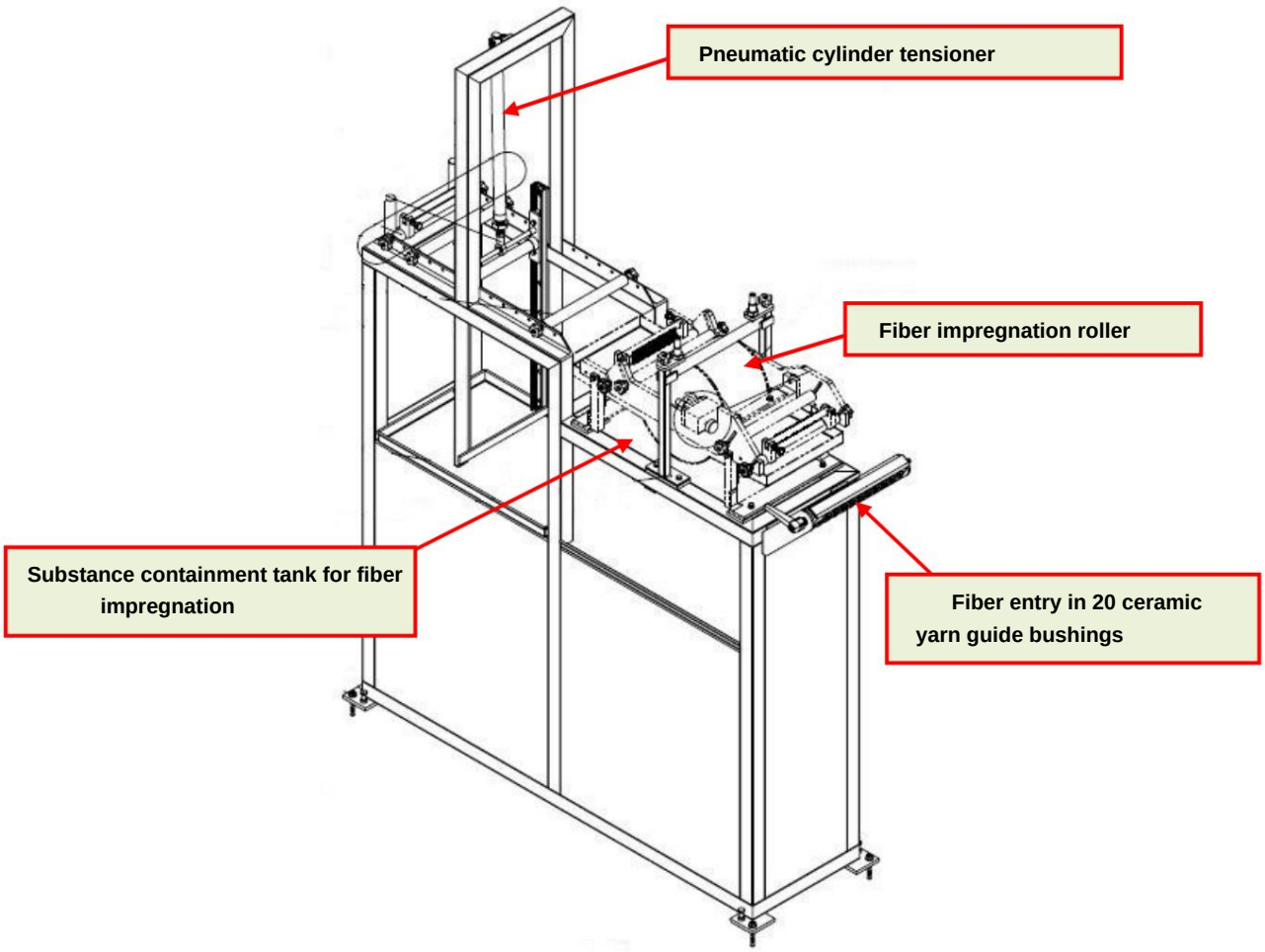


Figure 3 - Tool assembly for fiber impregnation with indication of main elements

Figure 4 - Wagon for fiber impregnation

Figure 5 - Detail of ceramic yarn guide bushings

Figure 6 - Tensioner detail

The control of the Filament Winding machine is ensured by two electrical panels:

- general electrical panel, located outside the area segregated by fixed guards e interlocked, with buttons and indicator lights, from which it is possible to manage the machine both in manual mode and in automatic mode;

Figure 7 - General electrical panel

- manual control panel on the machine, installed at the
  tailstock, from which it is possible to command the movements of the 6 main axes in
  manual mode (jog), after having given consent from the general electrical panel;
  each movement is carried out by means of a manual return selector
  automatic, holding down the enable button Enable, off-centre
  to the control panel.

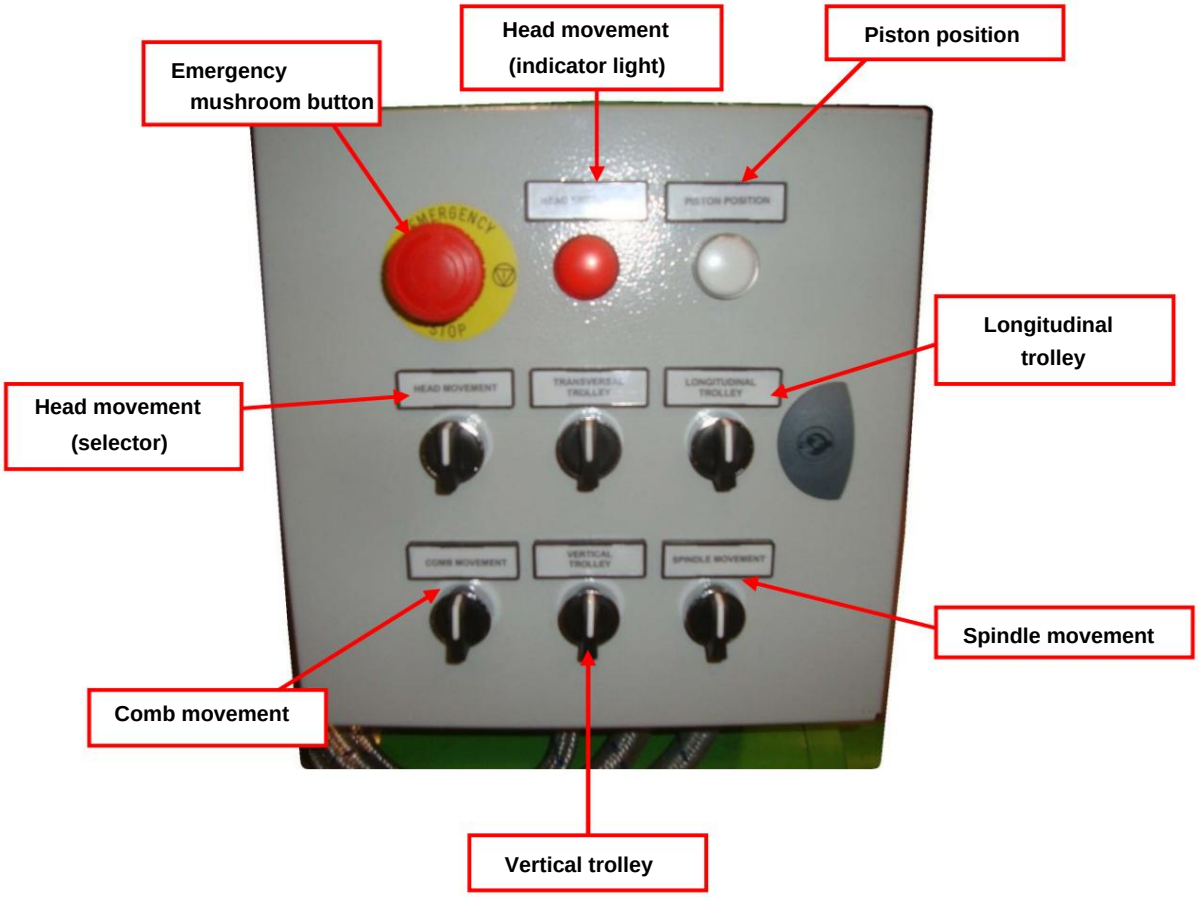


Figure 8 - Manual control panel on the machine

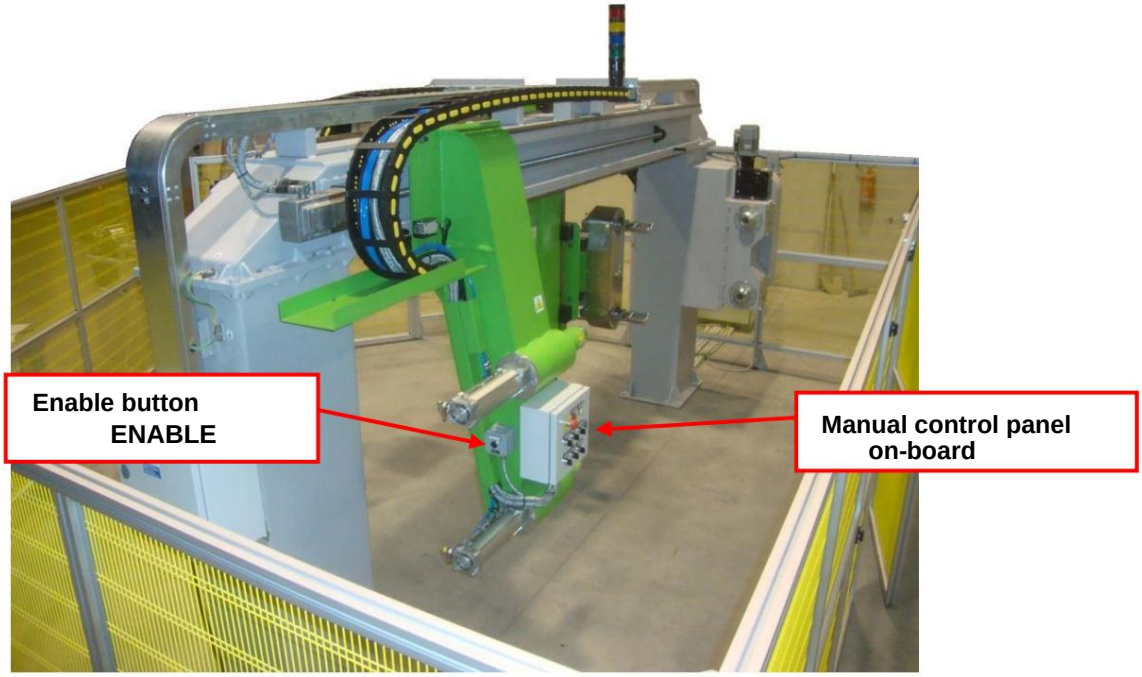


Figure 9 – Position of the manual control panel on the machine

4.1 Safety devices

The machine for Filament Winding is equipped with safety devices that break down the risk of contact with moving parts by the operator, or other mechanical risks such as crushing, shearing, impact. These devices are installed in combination with each other them, and include fixed guards, interlocked guards, emergency buttons and signage in various points of the machine. The following image shows the positions of the guards fixed and interlocked, and emergency buttons installed on the machine.

The fixed guards allow the machine to be completely segregated during the functioning in "Automatic" mode, by means of a spacer barrier which physically prevents contact with moving parts by virtue of its size e of its distance from the dangerous area, and kept in position through elements of fixings that make it impossible to remove them without the aid of tools.

The interlocked guards have been designed and placed along the perimeter of the barrier spacer, to allow operators access to the segregated area for machine set-up, cleaning, maintenance, tooling, etc. Functions of the machine dangerous for the operator ("Automatic" mode operation) until both interlocked guards have not been closed and if the latter are opened during the execution of the automatic work cycle of the machine is immediately given a stop order by means of devices installed at the interlocked guards e connected to the electrical system. When the guards are closed, it is necessary to reset of emergencies through the appropriate button located on the general electrical panel.

The emergency mushroom buttons are located in the following points of the machine for Filament Winding:

- on the general electrical panel outside the spacer barrier;
- on the manual control panel on the machine;
- on the right riser (on the rear side of the machine);
- on the left riser (on the rear side of the machine).

Similarly to the interlocked guards placed on the spacer barrier, the mushroom pushbuttons of emergency, if pressed at any time, they cause a stop of all the moving elements of the machine, and it is necessary to reset the emergency to give the consent to restart with the working cycle of the machine. During the course of the work cycle, a light device (traffic light) lights up in a manner consistent with the particular work phase in progress.

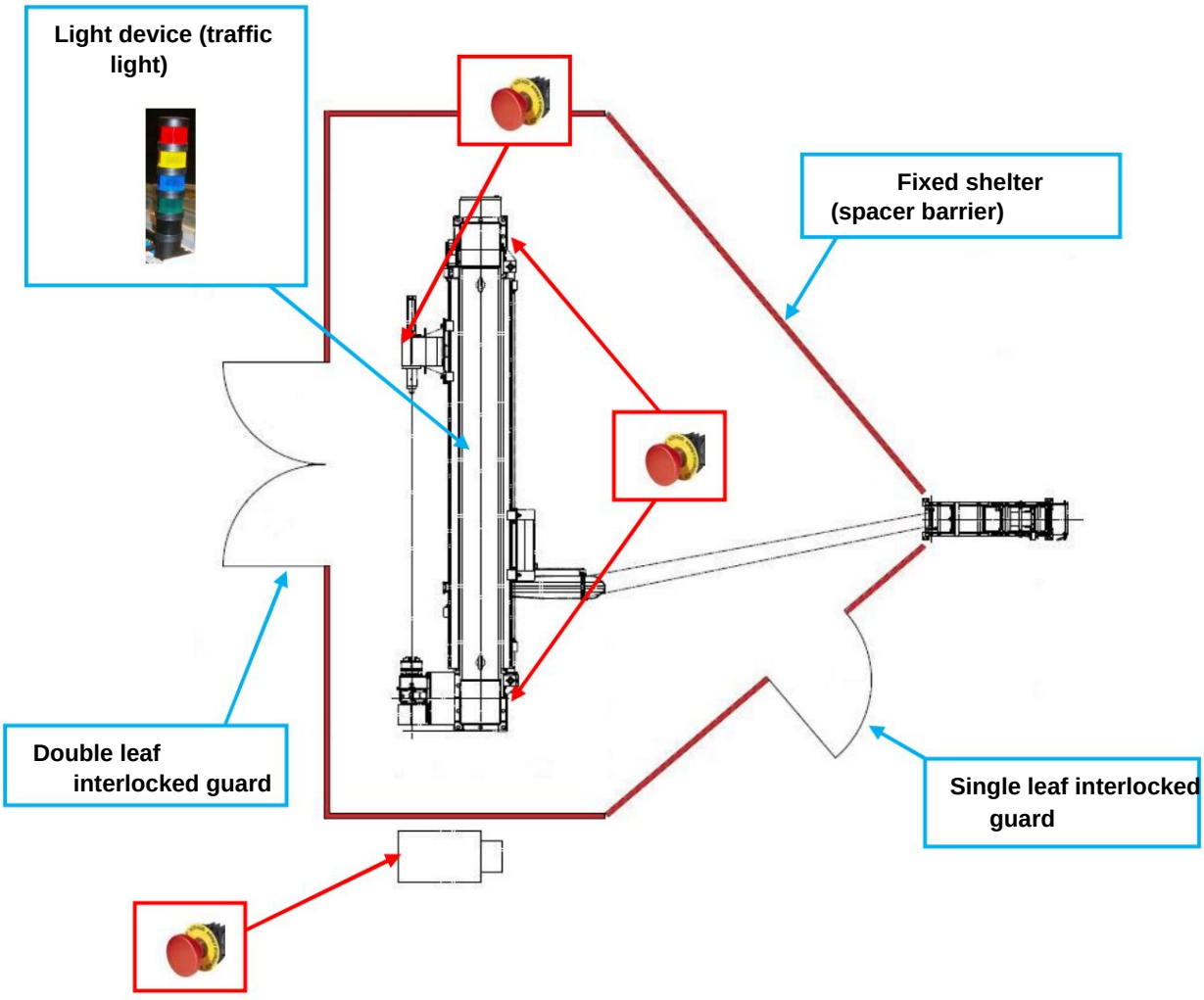
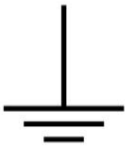


Figure 10 - Safety devices (fixed and interlocked guards and emergency buttons)

The health and safety risks that require minimum safety requirements for the protection of workers authorized to use the machine, as well as regarding the dangers explicit mechanics, may also concern potentially explosive atmospheres and substances dangerous, such as chemical agents or carcinogens, which depend on the particular types

of substances used during the work cycle of the machine, especially in correspondence
of the area and working volume around the tray containing the substance in which it is
they impregnate the substances subsequently used for processing. It is therefore prescribed to
pay the utmost attention to the methods of handling and action of these substances,
also using the mask (to be chosen according to the substance chosen by the user).
Furthermore, the use of open flames or any source of any kind is strictly prohibited
ignition potential, spark or hot spots, as well as a smoking ban. In
based on the mixtures of substances used on the machine, the area could be at risk
explosive atmospheres, for which it will be up to the end user to carefully evaluate the dangers
of explosion, for which it is necessary to divide the work area into zones in which
explosive atmospheres may occur and the consequent drafting of the document on
protection against explosions, provided for by the Consolidated Law on occupational health and safety.
For this and other risks, in addition to the safety devices already described and those
included and installed in the commercial components used for the construction of the machine,
safety signs are prescribed, including prohibition, warning and
prescription, partly present in the form of adhesive pictograms on the metal structure of the
machine and displayed in the following table:

	**ATTENTION!** GENERAL DANGER
	**ATTENTION!** HANDS SHEARING DANGER
	**ATTENTION!** SHEARING DANGER FEET
	**ATTENTION!** MOVING ORGANS

	**ATTENTION!** PRESSURE PNEUMATIC SYSTEM
	**ATTENTION!** DANGER OF CRUSHING IN THE DANGEROUS SPINDLE/TAILSTOCK/ FIBER HOLDER TOOL
	**ATTENTION!** NO ACCESS TO UNAUTHORIZED PERSONNEL
	**ATTENTION!** EQUIPMENT AND PROTECTIVE SYSTEMS INTENDED FOR USE IN POTENTIALLY EXPLOSIVE ATMOSPHERE (Based on the substances used in the machine's work cycle and the user's assessment of the risk of forming potentially explosive atmospheres)
	**ATTENTION!** DISCONNECT THE POWER BEFORE CARRYING OUT MAINTENANCE OPERATIONS
	**ATTENTION!** CONNECT THE ELECTRICAL SYSTEM WITH THE EARTH EQUIPOTENTIAL SYSTEM
	**ATTENTION!** SMOKING PROHIBITED
	**ATTENTION!** FORBIDDEN TO USE NAKED FLAMES
	**ATTENTION!** IT IS FORBIDDEN TO EXTINGUISH FIRE WITH WATER

	**ATTENTION!** WEAR THE PROVIDED SAFETY DEVICES: - HIGH SAFETY SHOES; - PROTECTIVE GLOVES; - PROTECTIVE MASK (Based on the substances used in the work cycle of the machine); - PROTECTIVE GLASSES (Based on the substances used in the machine work cycle).

4.2 Machine noise

For the machine in question, the parameters relating to the parameters were evaluated and characterized **noise emissions** in accordance with current legislation. In this regard, it has been noted that he follows:

Noise index = 67.5 db(A) Leq*

** Measurement conditions: machine running at full capacity in simulation of operation.*

The surveys carried out have no value in terms of noise risk assessment within the factory where the Filament Winding machine is installed and such for this purpose, the user is recommended to provide for an internal noise detection pursuant to of Legislative Decree 81/08 (which repealed the previous Legislative Decree 277/91).

In particular, in terms of regulatory analysis, it should be noted that the evaluation of the noise risk in the workplace is regulated by Legislative Decree 81\08 and subsequent amendments implementing Directive 2003/10/EC; on the basis of article 190 of the aforementioned Decree Legislative the employer must evaluate personal daily occupational exposure of each individual worker. The calculation of this parameter can be achieved through measurement of the noise of the machines and equipment present in the company then compared to the time of permanence of the worker in the workplace.

5. Installation and handling of the machine

5.1 Ground fixing and tightening torques

The machine for Filament Winding is equipped with two main columns and must be installed and used on flat industrial floors, with ergonomic characteristics e adequate resistance.

Before installing the machine it is necessary to identify an area with a surface of adequate hardness and strength, able to bear the weight and the particular position of the center of gravity with respect to the axis of the main columns, slightly off center and corresponding to a moment to balance with the fixings to the ground, as shown in the image following.

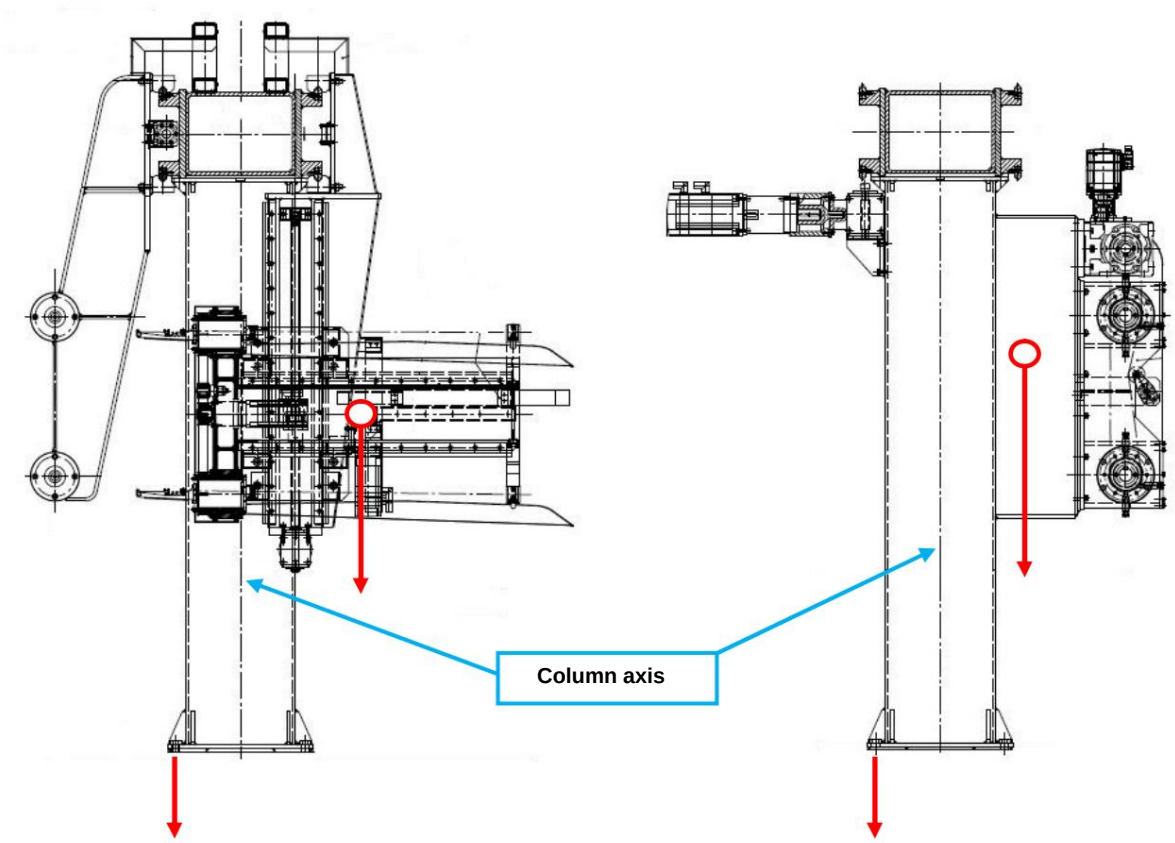


Figure 11 - Center of gravity of the carriage for head translation and spindle support with respect to the axis of the columns

It is advisable to leave adequate space around the machine to ensure correct maintenance and cleaning of all parts of the machine (see also relevant par. 8 to maintenance).

The machine can be used in closed work environments (production departments, sheds, etc.), i.e. sheltered from bad weather and where there is no danger of fire or explosion; if these risks are not negligible, it will be the responsibility of the employer carry out a thorough risk assessment in order to ensure the health and safety of workers.

The use temperature is within the range +5 / +50°C.

The room must also be sufficiently lit (at least 300 recommended lux).

The Filament Winding machine must be fixed to the industrial floor by means of log bolts or mechanical plugs, tightening the locknuts with an adequate torque tightening, to be checked using a torque wrench. All the nuts and bolts that are used for the removable bolted connections of the machine must be tight according to a specific tightening torque, in order to avoid the risk of loosening, in case of low tightening torque, or a deformation with dangerous risk of breakage in the case in high tightening torque.

Below is a general reference table with the values of the pairs of tightening to be applied to the bolted fasteners, in relation to the following parameters:

- A Coefficient of friction of the thread;
- B Underhead friction coefficient;
- Thread;
- Resistance class.

The resistance class is identified by two numbers: the first (x 100) indicates the load tensile failure, in MPa; the product of the two numbers (x 10) indicates the yield strength (elastic deformation limit); the second number (/10) is the ratio of the load yield strength and tensile strength (MPa = Newton/m ^{2}).

To tighten a nut or bolt to the correct torque values, use a wrench click torque.

		FORZA DI PRECARICO N Tensile Load N				COPPIA DI SERRAGGIO Nm Tightening Torque Nm			
FILETTATURA Thread	mm	A	TENSIONE SUL BULLONE Tension On The Fastener CLASSI DI RESISTENZA Resistance grade 8.8	10.9	12.9	B	COPPIA Torque CLASSI DI RESISTENZA Resistance grade 8.8	10.9	12.9
M 1,6	3,2	0,10	555	815	954	0,10	0,128	0,189	0,221
		0,15	499	732	857	0,15	0,160	0,235	0,275
		0,20	447	657	769	0,20	0,183	0,269	0,315
M 2	4	0,10	921	1352	1582	0,10	0,270	0,396	0,463
		0,15	829	1217	1424	0,15	0,339	0,498	0,582
		0,20	744	1093	1279	0,20	0,390	0,573	0,671
M 2,5	5	0,10	1533	2251	2634	0,10	0,556	0,82	0,96
		0,15	1382	2030	2375	0,15	0,705	1,04	1,21
		0,20	1242	1824	2134	0,20	0,816	1,20	1,40
M 3	5,5	0,10	2298	3376	3951	0,10	0,95	1,40	1,64
		0,15	2075	3048	3567	0,15	1,21	1,79	2,09
		0,20	1866	2740	3207	0,20	1,41	2,07	2,43
M 4	7	0,10	3985	5853	6849	0,10	2,20	3,23	3,78
		0,15	3594	5279	6178	0,15	2,78	4,09	4,79
		0,20	3230	4744	5552	0,20	3,22	4,74	5,5
M 5	8	0,10	6514	9568	11196	0,10	4,34	6,3	7,4
		0,15	5886	8645	10116	0,15	5,5	8,1	9,5
		0,20	5293	7774	9098	0,20	6,4	9,4	11,0
M 6	10	0,10	9195	13506	15805	0,10	7,5	11	12,9
		0,15	8302	12194	14269	0,15	9,5	14,0	16,4
		0,20	7464	10962	12828	0,20	11,1	16,3	19,1
M 8	13	0,10	16863	24768	28984	0,10	18,2	26	31
		0,15	15242	22388	26198	0,15	23	34	40
		0,20	13710	20137	23565	0,20	27	39	46
M 10	17	0,10	26838	39418	46128	0,10	36	52	61
		0,15	24275	35655	41724	0,15	46	67	79
		0,20	21843	32082	37542	0,20	53	78	92
M 12	19	0,10	39119	57457	67236	0,10	62	91	106
		0,15	35401	51995	60845	0,15	79	116	136
		0,20	31860	46795	54760	0,20	92	136	159
M 14	22	0,10	53707	78882	92309	0,10	99	145	170
		0,15	48618	71408	83563	0,15	127	187	219
		0,20	43763	64277	75218	0,20	148	218	255
M 16	24	0,10	73808	108406	126858	0,10	153	225	263
		0,15	66955	98340	115079	0,15	198	291	341
		0,20	60331	88611	103694	0,20	232	341	399
M 18	27	0,10	92440	131897	154348	0,10	220	313	366
		0,15	83746	119454	139787	0,15	283	402	471
		0,20	75421	107549	125856	0,20	330	469	549
M 20	30	0,10	119003	169385	198216	0,10	311	440	515
		0,15	107941	153657	179811	0,15	402	570	667
		0,20	97253	138456	162023	0,20	471	667	781
M 22	34	0,10	148374	211534	247540	0,10	424	602	704
		0,15	134806	192157	224865	0,15	552	783	917
		0,20	121574	173269	202762	0,20	648	920	1077
M 24	36	0,10	171437	243914	285432	0,10	534	758	887
		0,15	155489	221266	258928	0,15	691	981	1148
		0,20	140084	199376	233313	0,20	809	1148	1343
M 27	41	0,10	225110	320832	375442	0,10	784	1114	1304
		0,15	204577	291534	341157	0,15	1022	1452	1700
		0,20	184517	262920	307672	0,20	1201	1706	1997
M 30	46	0,10	274030	390072	456467	0,10	1067	1515	1773
		0,15	248811	354209	414500	0,15	1387	1969	2305
		0,20	224292	319331	373685	0,20	1628	2311	2704
M 33	50	0,10	341347	485926	568637	0,10	1442	2048	2397
		0,15	310343	441828	517033	0,15	1884	2676	3132
		0,20	279953	398593	466438	0,20	2216	3148	3684

Figure 12 - Table of tightening torques

5.2 Warehouse Storage

In case the machine needs to be stored and stored for a certain period of time before being put into service, to avoid damage and/or deterioration proceed as follows:

1. Protect the machined parts with protective liquid and/or grease;
2. Keep in a dry place, away from dust and contaminants.

Recommended climatic conditions for storage:

Temperature: - 15° / + 55° C;

Maximum humidity: 95% (non-condensing).

5.3 Machine handling

The movement of the machine can be carried out with the aid of vehicles and/or of industrial means of transport, such as trucks, with containers of sufficient size for contain the machine itself, previously disassembled into its components. The car must be suitably anchored to the means of transport (for example with the aid of ropes).

During transportation, the machine must be protected from rain, snow, hail, wind and any other possible adverse weather condition. In this regard it is recommended to use means of transport with closed containers (vans, tilt trucks, etc.) od possibly cover it with waterproof tarpaulins.

The writer declines all responsibility regarding any damage to persons and/or things deriving from incorrect transport of the machine performed by unsuitable personnel, with inadequate lifting means and without following the instructions and procedures operations described in this manual.

If it is necessary to move the machine within the factory, proceed to unscrew the lock nuts of the bolts of the support plates of the columns main ones, carefully replacing the removed nuts. It is possible to move the machine using the special eyebolts located in the upper area, adequately sized to support the weight of the Filament Winding machine, and indicated in the following image.

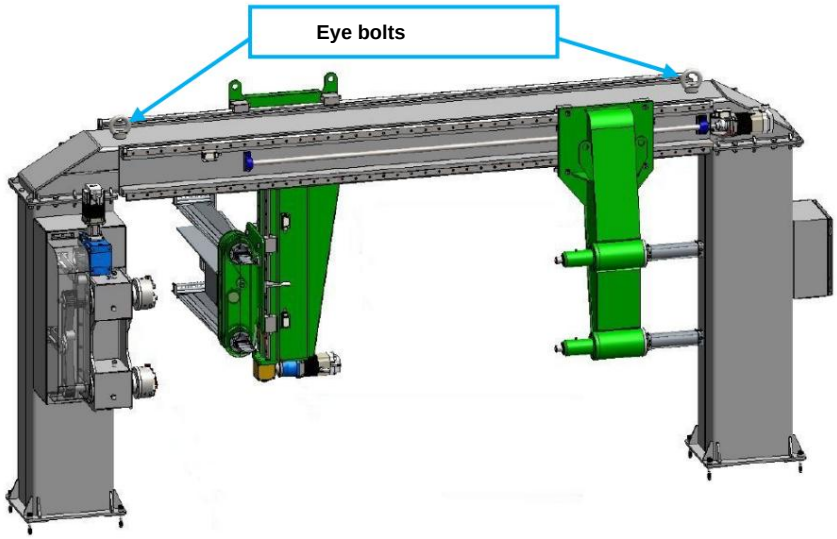


Figure 13 - Movement of the Filament Winding machine using eye bolts

6. Use of Filament Winding machine

The work cycle of the machine can be summarized as follows:

1) Setting up the machine: in this phase the operator performs the preparation of the machine, while the same is stopped in the state of emergency. The main set-up activities are:

- Passage of the fibers from the unwinding reel, through the tank impregnation and the different combs of the carriage, up to the fiber guide tool. The operation must be performed wearing gloves to avoid contact of the fibers with the skin and other personal protective equipment (PPE) possibly prescribed (see table in the previous paragraph);

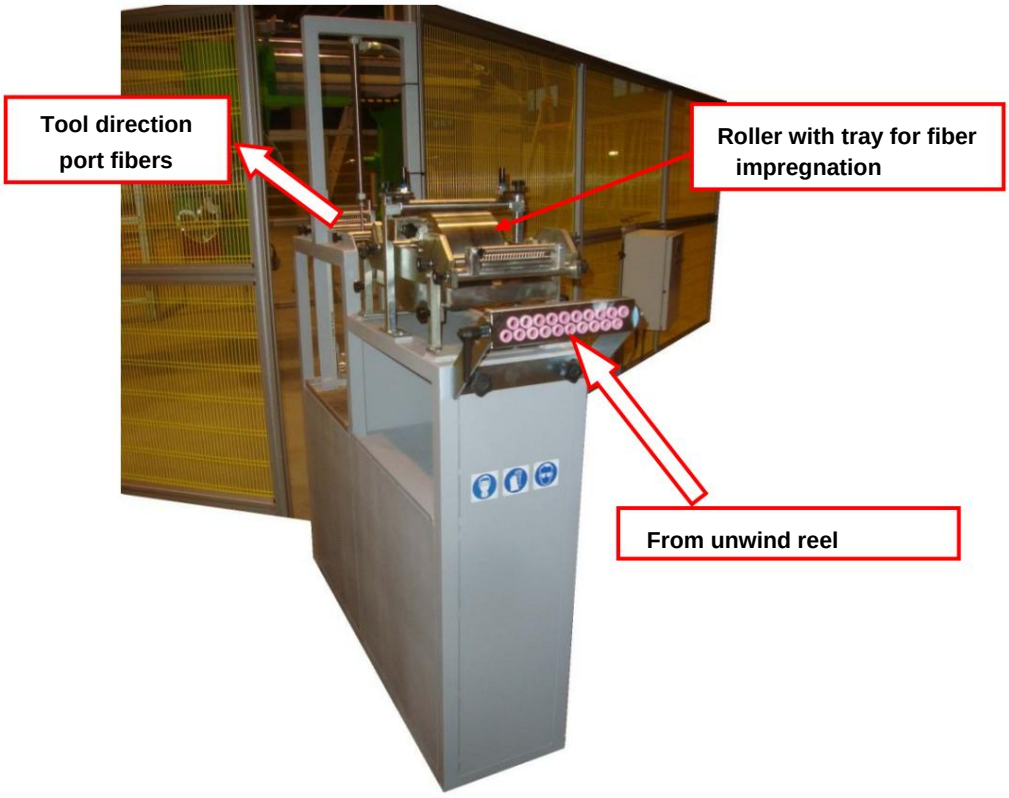


Figure 14 - Wagon for fiber impregnation

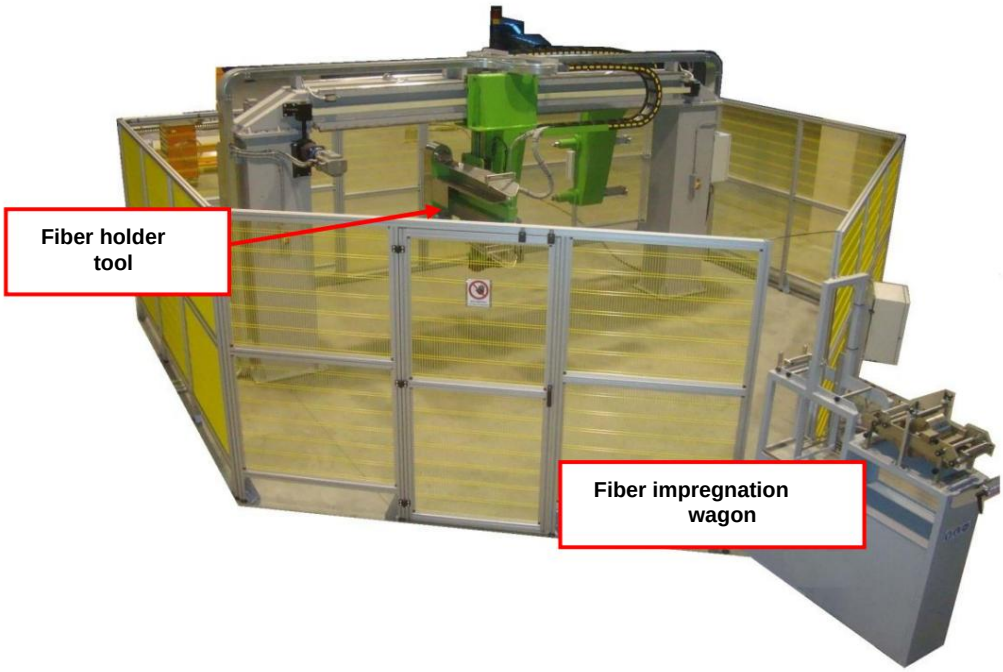


Figure 15 - Front view of the machine - fiber holder tool/fiber impregnation carriage

- Assembly of the dies and tools foreseen for the type of component from produce: this operation is performed by replacing mechanical components, light, mainly using tools such as Allen keys and/or screwdrivers;

Figure 16 - Fiber holder tool detail

2) Loading of the mold on which to perform the fiber winding cycle. In this phases the operator, with the aid of lifting equipment if it concerns moulds heavy, or by hand in the case of light moulds, load the mold onto the machine. First it inserts one end into the attachment of the rotating chuck, equipped with quick coupling device.

Figure 17 - Detail of rotating spindles

The machine is activated with the main door lock switch located on the general electrical panel; the auxiliaries are then engaged with the appropriate selector a key, then press the "Alarm reset" button to reset the emergencies. The "Local/Remote" key selector allows the panel to be enabled manual controls on the machine for the manual preparation of the moulds spindle and tailstock.
Through it the pneumatic piston of the tailstock is activated, for fix the mold on the other side as well; a micro signals the occurrence positioning of the pneumatic piston by lighting up a white light, called "Piston position" on the manual control panel on the machine.
These operations are also carried out with the machine stopped. The control panel manual (see previous par.) is then used for the initial phase of manual preparation of the molds on the machine, and is equipped with return selectors automatic that allow the movements of the six axes with an enabling button (Enable) decentralized with respect to the panel; if the "Enable" button is not pressed,

it is not possible to make any movement of the moving parts of the machine. In this way the operator uses both hands to operate in mode the moving parts of the machine manually. If the micro associated with arming in the mold is deactivated, the machine also receives a stop order during operation in automatic mode;

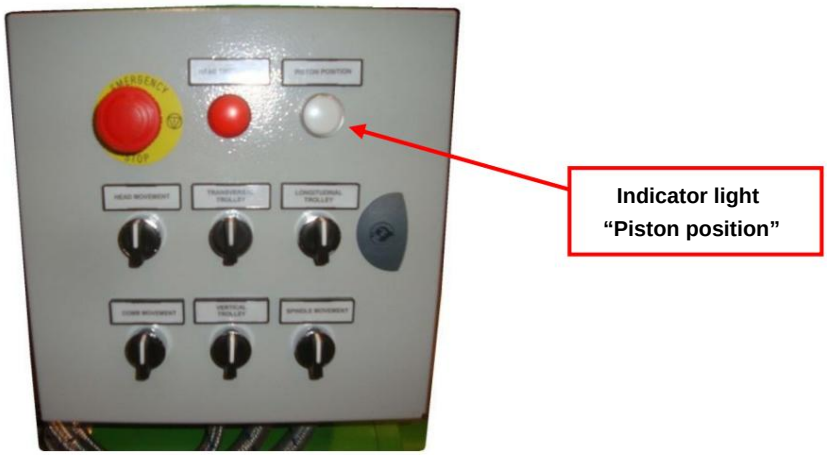


Figure 18 - Manual control panel on the machine, with "Piston position" indicator light

3) Filling the tank with resin: this operation can be done by hand o with special equipment, not part of the machine; it is necessary pay particular attention to this operation, according to the technical data sheet and the resin safety data sheet. Always use PPE.

4) Positioning of the fiber holder tool at the cycle start point: this operation it can be done with the machine in manual mode or even with the machine in automatic mode. In the latter case, after the positioning command at the starting point, the machine will stop, waiting for a cycle start command.

5) Fixing of the fibers on the mould: with the machine in stand-by in the position of beginning of the cycle, the operator grabs the bundle of fibers and pulls towards himself, until the resin impregnated fibers reach the mould. Right now the operator performs a fixing of the fibers on the mold, by means of a suitable number of turns

or other system that prevents the fibers from slipping in the first moments of execution of the cycle.

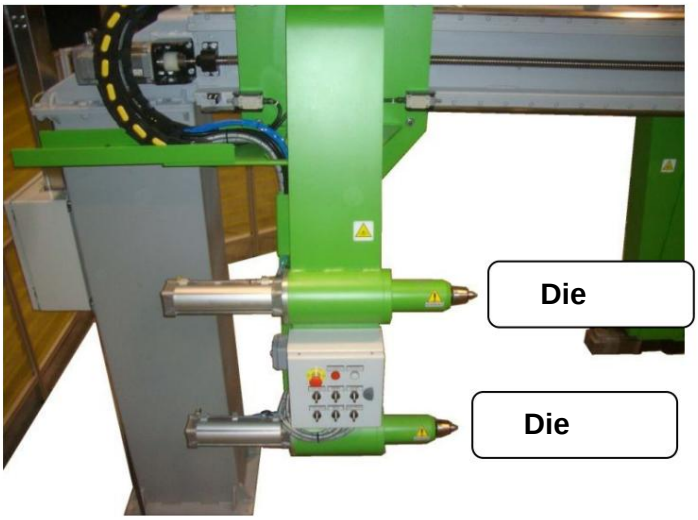


Figure 19 - Tailstock detail

The operator can start the expected wrapping cycle by activating the appropriate one "Start cycle" command from the general electrical panel located outside the segregated area of the machine. Before giving consent to the general electrical panel of the machine, it is necessary close the interlocked guards and release all the emergency buttons (safety reset). The work cycle will be carried out until the expected end, activated and possibly interrupted with "Start" and "Stop" buttons located on the left side of the general electrical panel, after programming via keyboard, with which the numerical control program is called up dedicated to the single mold (see Sinumerik manual for further details). During execution of the work cycle of the machine, operator intervention is not foreseen a less than exceptional events such as fiber breakage, slippage of fibers on the die, etc. In in these cases the operator stops the cycle, putting the machine on pause, and resetting the problem that occurred before restarting the cycle. If there is no load device automatic resin in the tank, the operator will have to fill from time to time with fresh resin. The operator also intervenes on the resin dosing device, by moving a small handwheel which allows the dosing blade to supply more or less resin to the fibers that pass through the tank. From the point of view of the running loop, the only one

The adjustment that the operator can make is the one on the speed of execution, operando on the appropriate cursor on the main panel or on any remote control.

During the execution of the machine work cycle, the device is active traffic light safety features above the filament winding machine, also equipped with safety buzzer. The colors of the device are associated with the various phases of the cycle of work and in particular to the following configurations:

- RED: presence of alarms blocking the machine;
- GREEN: machine in automatic cycle;
- YELLOW: machine operable in manual cycle (gate safety devices excluded);
- BLUE: operator intervention required (reset and acknowledge alarms).

6.1 Safety warnings

For correct use of the machine, observe the following instructions:

- Consult the technical documentation before using the machine;
- Protection and safety devices must always be used;
- Protection and safety devices must be regularly maintained and immediately replaced in case of abrasions, malfunction or failure;
- For carrying out certain types of ordinary maintenance operations and for those performing extraordinary maintenance on the machine, he must intervene exclusively qualified personnel, who must operate in accordance with the indications contained in this manual for installation, use and maintenance;
- Use the following PPE (Personal Protective Equipment): shoes safety shoes, protective gloves, protective mask (according to the substances used in the work cycle of the machine), protective glasses (in based on the substances used in the work cycle of the machine);
- Do not bring items with you that could get caught on the roller or on others elements of the wagon for the impregnation of the fibers, such as chains, buckles, etc.;
- Operate the manual handling carefully checking that it is correct arrangement of the molds on the spindles and tailstocks, and the correct positioning of the pneumatic pistons in the moulds;
- Do not lean on, climb or climb over the machine;
- Pay attention to the machine even when it is not being used;
- Do not tamper with the metal structure of the machine, or any component of the pneumatic system (manometers, valves, etc.);
- Pay particular attention to the phase of connecting the machine to the factory compressed air system; pneumatic components have a maximum pressure of 10 bar.

7. Normative references

7.1 Machine safety directives

- 98/37/EC published in the Official Gazette No. L 207 of 23/07/1998 and subsequent amendments;
- Directives 89/656/CE and 89/686/CE and subsequent amendments relating to the use of individual protection;
- Directive 2006/95/EC of 12 December 2006 relating to electrical equipment intended for use to be used within certain voltage limits;
- Directive 2004/108/EC of 15 December 2004 relating to compatibility electromagnetic;
- Directive 99/92/EC relating to the minimum requirements for the improvement of protection of the safety and health of workers who may be exposed to risk of explosive atmospheres.

7.2 National Standards and Laws

- Legislative Decree 459/96 (implementation of the Machinery Directive 98/37/EC);
- Legislative Decree 626/94 relating to workplace safety;
- Legislative Decree 6 November 2007, No. 194 - Implementation of Directive 2004/108/EC on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC;
- Legislative Decree 12 June 2003, n° 233 - Implementation of the relative directive 1999/92/CE to the minimum requirements for improving the protection of safety and health of workers exposed to the risk of explosive atmospheres;
- Presidential Decree March 23, 1998, No. 126 - Regulation containing rules for the implementation of Directive 94/9/EC on equipment and protective systems intended for be used in a potentially explosive atmosphere.

7.3 Harmonized standards

- UNI EN 12100 - Machinery safety - General design principles - Risk assessment and risk reduction;
- UNI EN 1050: 1998 - Safety of machinery. Principles for the evaluation of risk;
- UNI EN 414 - Safety of machinery - Rule for the drafting and editing of safety rules;
- UNI EN ISO 4414 - Pneumatics - General rules and safety requirements for i systems and their components;
- EN ISO 13850 – Safety of machinery – Emergency stop – Principles of design (ISO 13850:2006);
- EN 547-2: 1996 - Safety of machinery - Measurements of the human body - Part 2: Principles for determining the required dimensions of access openings;
- EN 574: 1996 - Safety of machinery - Two-hand control devices - Functional aspects – Principles for design;
- EN 953: 1997 - Safety of machinery - Guards - General requirements for design and construction of fixed and mobile shelters;
- EN 1037: 1995: Safety of machinery - Prevention of starting unexpected;
- EN 1088: 1995 – Safety of machinery – Associated interlocking devices take cover – Principles of design and choice.

8. Personnel training

Personnel using the machine must be adequately trained on the methods set-up, management of the work cycle and maintenance. Within the company training moments will therefore have to be organised, on the occasion of the insertion of new personnel using the machine or substantial changes to it.

8.1 Staff training register

Below is a table in which the sessions must be noted personnel training and information held in the company.

DATA	NOTES ON THE MACHINE

9. Maintenance and testing

9.1 Maintenance

	**FAILURE TO OBSERVE THE TIMES AND RULES DECIDED FOR MAINTENANCE AFFECTS THE CORRECT FUNCTIONING AND DURATION OF THE FILAMENT WINDING MACHINE, CAUSING MALFUNCTIONS IN THE OPERATION AND DAMAGE TO PARTS WITH CONSEQUENCES, EVEN SERIOUS. FAILURE TO OBSERVE THE MAINTENANCE RULES WILL VOID THE VALIDITY OF THE GUARANTEE.**
	**ALL MAINTENANCE AND CHECK OPERATIONS WHICH MAY BE NECESSARY MUST ALWAYS BE CARRIED OUT WITH THE MACHINE STOPPED AND WITH THE ELECTRIC SUPPLY DISCONNECTED. PLEASE NOTE THAT THE CONSISTENCY ON SAFETY (DPR 547/55) EXPRESSLY FORBIDDEN LUBRICATING AND GREASING MOVING PARTS.**

Machine maintenance is essential for maintaining a high standard safety and operating efficiency. Also consult the installation manuals, use and maintenance of the individual components in the attachment for information complete.

The Filament Winding machine must necessarily undergo operations of ordinary and extra-ordinary maintenance. In case of maintenance or repair work of faults on the machine, only qualified personnel must intervene, who must operate in accordance with the instructions indicated in this manual.

PICTOGRAM	MEANING
	**Operator:** personnel instructed and trained by the Manufacturer and authorized to carry out maintenance operations of low complexity
	**Specialized technician:** technician qualified by the manufacturer authorized to carry out maintenance operations of a complex and extraordinary mechanical/pneumatic nature

TABLE OF PERIODIC CHECKS AND MAINTENANCE INTERVENTIONS					
TYPE OF INTERVENTION	FREQUENCY				
	Daily / Every use	Weekly	Monthly	Annual	**View**
General visual inspection of the metal structure, of the mechanical components					
General check of the pneumatic plant supplied with the machine					
Device control and safety signs					
Ground cleaning around the machine					
Functionality and integrity check of the Protection Devices Individual					
Greasing and/or lubrication of the sliding guides					
Checking pneumatic safety devices (safety valves, etc.)					
Component abrasion check					
Painting of superficially damaged parts					
Replacement of worn or malfunctioning elements					
Thorough check of the pneumatic system					

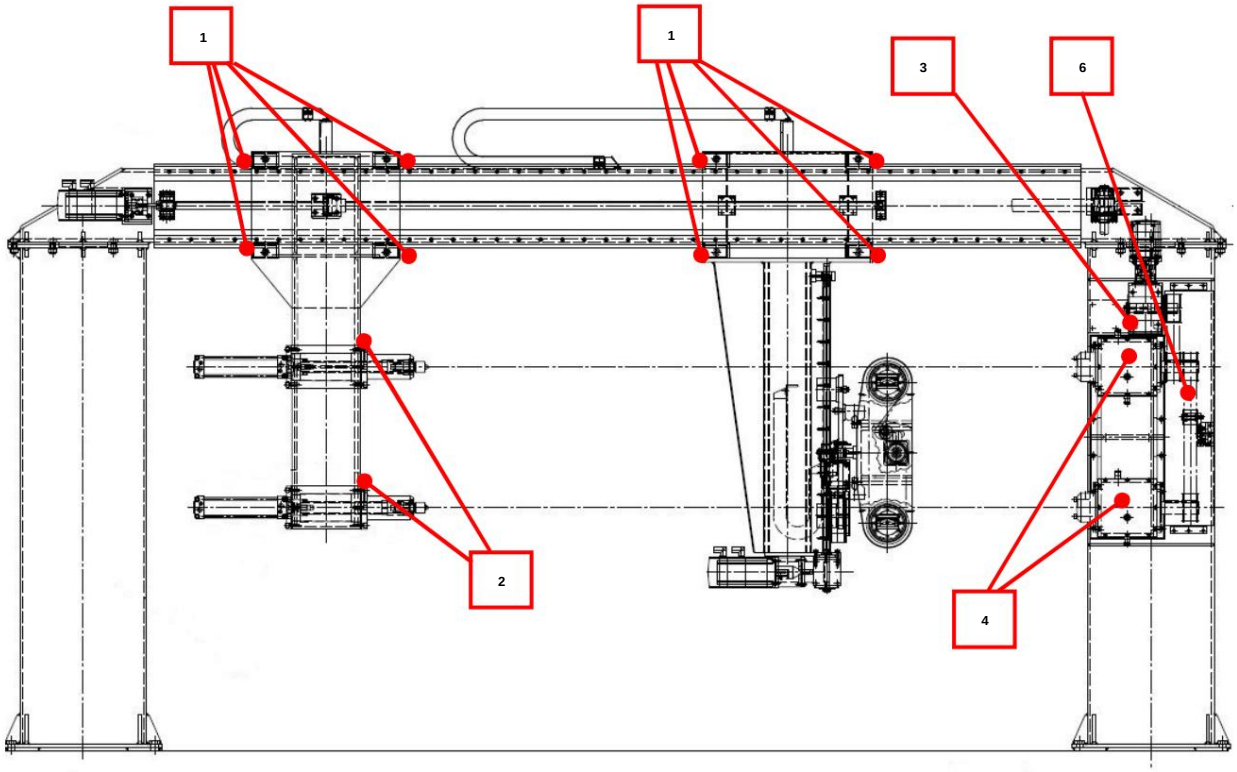
TABLE OF PERIODIC CHECKS AND MAINTENANCE INTERVENTIONS					
TYPE OF INTERVENTION	FREQUENCY				
	Daily / Every use	Weekly	Monthly	Annual	**View**
Checking the correct functioning and possible replacement of the pressure gauges (yearly)					
Checking the pneumatic hoses and their joints (yearly)					

In the event of deterioration, malfunction or damage to accessories or commercial components, replace them immediately. In case of problems on the welding of the metal base, the machine must be immediately placed in a state of detention and conducted under extraordinary maintenance, ensuring and certifying with new declaration of conformity the correct arrangement of the machine, together with a new test certificate.

In addition to the general routine maintenance provisions listed in the previous table, yes indicates in the following table a series of critical points of the machine, where it is necessary intervene in different ways (greasing/lubrication, oil change or inspection visual).

PICTOGRAM	MEANING
	**Operator:** personnel educated and trained by the Manufacturer and authorized to carry out maintenance operations of low complexity

TABLE OF SPECIFIC INTERVENTIONS ON CERTAIN POINTS OF THE MACHINE					
TYPE INTERVENTION	Codes	Temperature range	Amount	Work hours	**View**



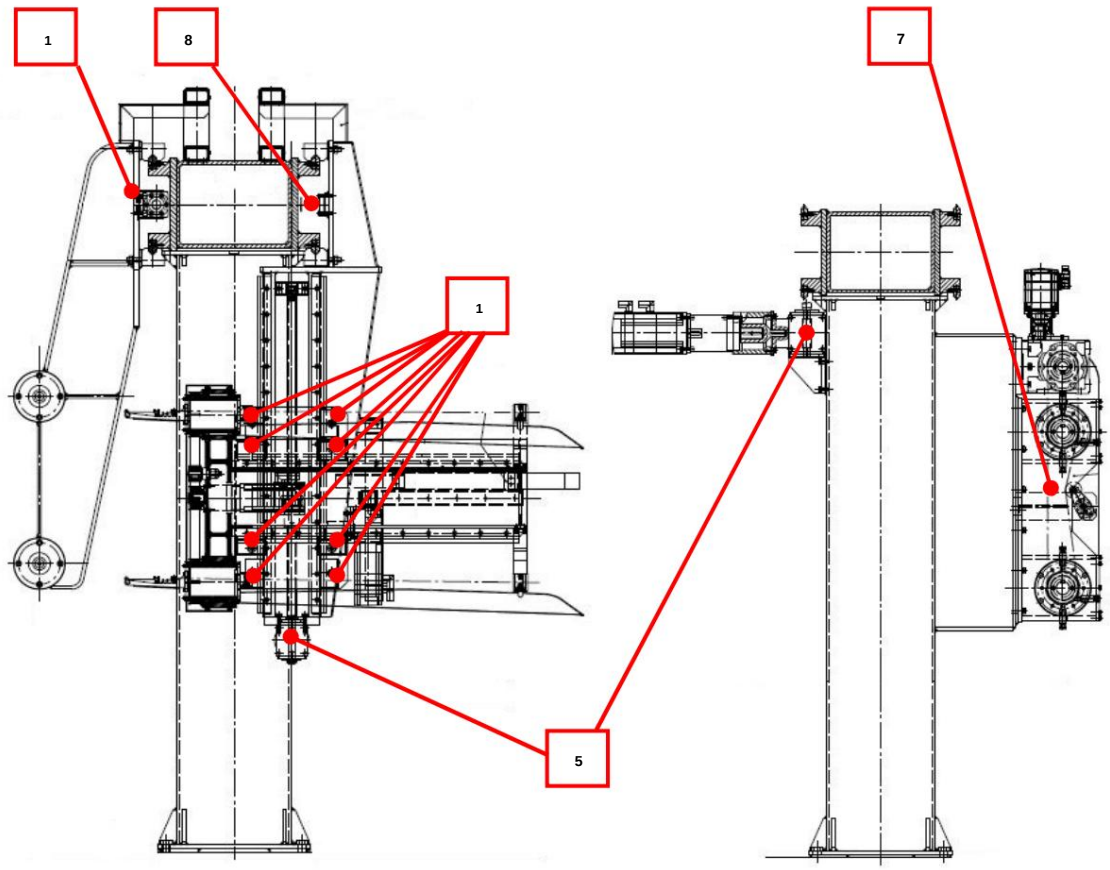
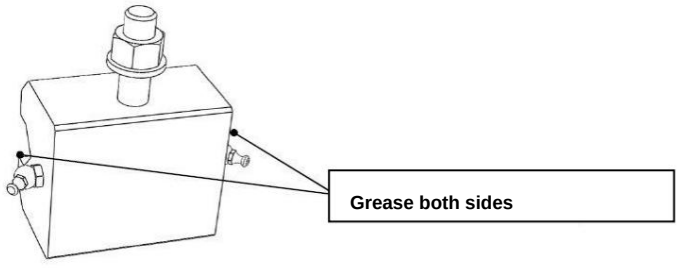


TABLE OF SPECIFIC INTERVENTIONS ON CERTAIN POINTS OF THE MACHINE

TYPE INTERVENTION		Codes	Temperature range	Amount	Work hours	View
1	**Replacement fat**	EMF code, brand and type of grease 18200266 SKF LGMT 2	-30/120 °C	0,200 kg	200	



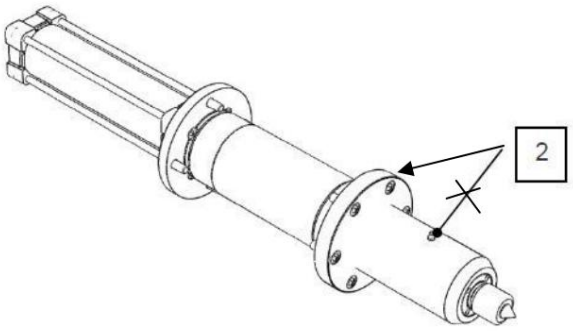
2	**Replacement fat**	EMF code, brand and type of grease 18200266 SKF LGMT 2	-30/120 °C 0,050 kg		200	
						

TABLE OF SPECIFIC INTERVENTIONS ON CERTAIN POINTS OF THE MACHINE

TYPE INTERVENTION		Codes	Temperature range	Amount	Work hours	**View**
3	**Oil replacement**	EV code, brand and type of oil 18200275 KLUBER KLUBERSYNTH GH 6-220	-20/50 °C	2,2 l	18000	
4	**Oil replacement**	EV code, brand and type of oil 18200275 KLUBER KLUBERSYNTH GH 6-220	-20/50 °C	0,4 l	18000	
5	**Oil replacement**	EV code, brand and type of oil 18200275 KLUBER KLUBERSYNTH GH 6-220	-20/50 °C	0,2 l	18000	
6	**Visual inspection**	EV code, belt type 13090125 TIMING BELT DOWN ALL THE TIME DD330H-220	-	1	3000	
7	**Visual inspection**	EV code, belt type 13090005 TIMING BELT CHIARAVALLI PU-T10-890-32	-	1	3000	
8	**Visual inspection**	EV code, belt type 13090126 TIMING BELT POGGI HTD 8M-50-6760	-	1	3000	

9.2 Trouble-shooting

- 510008

HOLD ASSI.

HOLD AXES

- 510009

SPINDLE HOLD.

HOLD MANDREL

- 510010

HEAD KEYPAD ENABLED.

REMOTE PANEL ENABLED.

The current control location is from the remote.

Change the control location using the LOC/REM key on the main board.

- 510100

COMMANDS OFF EMERGENCY MODULE.

EMERGENCY CIRCUIT IS DISABLED.

Remove all the emergency conditions then enable the emergency circuit again with the button on the main board. Check all the emergency circuits for an open condition.

- 510101

ELECTRIC CABINET EMERGENCY MUSHROOM -306S1-

EMERGENCY PUSH BUTTON ENGAGED ON THE MAIN BOARD 306S1

The emergency push button is engaged on the main board or the electrical circuit is open (see 306S1).

- 510102

RIGHT SIDE EMERGENCY MUSHROOM -320S2-

EMERGENCY PUSH BUTTON ENGAGED ON RIGHT HAND SIDE OF THE MACHINE 320S2

The emergency push button is engaged on the right hand side of the machine or the electrical circuit is open (see 320S2).

- 510103

LEFT SIDE EMERGENCY MUSHROOM -320S3-

EMERGENCY PUSH BUTTON ENGAGED ON LEFT HAND SIDE OF THE MACHINE 320S3

The emergency push button is engaged on the left hand side of the machine or the electrical circuit is open (see 320S3).

- 510104

EMERGENCY MUSHROOM HEAD -320S4-

EMERGENCY PUSH BUTTON ENGAGED ON THE TAILSTOCK 320S4

The emergency push button is engaged on the tailstock or the electrical circuit is open (see 320S4).

- 510108

TAILSTOCK PISTONS AT THE END OF THE STROKE -350S5-350S6-

TAILSTOCK PLUNGERS AT FORWARD LIMIT -350S5-350S6-

The position of the plunger(s) is(are) not correct. The correct position is in the middle. Check the electrical circuit (350S5, 350S6), check that the sensors which detect the position are in the correct position.

- 510201

PISTONS POSITION BACK -350S3S4-

TAILSTOCK PLUNGERS AT BACKWARD LIMIT -350S3-350S4-

The position of the plunger(s) is(are) not correct. The correct position is in the middle. Check the electrical circuit (350S5, 350S6), check that the sensors which detect the position are in the correct position.

- 510109

MACHINE GUARDS OPEN -360K2-

THE GATES ARE OPEN 360K2.

To start the automatic cycle, all the gates must be closed. Check the electrical circuit and position sensors.

- 510200

NO CYLINDER PRESSURE -350K1-

LOW AIR PRESSURE 350K1

Check the air pressure supply to the machine. Check the current setting of the air pressure, check the electrical circuit.

- 510208

AXIS DRIVE FAULT -DRIVE READY

FAULT OF THE AXES DRIVE UNIT.

See the drive unit manual. Check the circuit to the PLC I/O.

- 510210

AXIS DRIVE FAULT - OVERLOAD

FAULT OF THE AXES DRIVE UNIT (OVERLOAD).

See the drive unit manual. Check the circuit to the PLC I/O.

- 510216

THERMAL CABINET AIR CONDITIONER -93QF1

AUTOMATIC BREAKER OF COOLING UNIT OFF

Check for overloads on the cooling unit. See unit manual. Check the breaker.

- 510217

CABINET AIR CONDITIONER FAULT

FAULT FROM THE COOLING UNIT

Check the cooling unit. See unit manual. Check the I/O to the PLC..

9.3 Testing

The machine is subjected to a general and accurate visual inspection every 3 months or in case of replacement and/or intervention on parts of the same, and the test is carried out loaded every 12 months, according to the rule of art and current legislation. The load test of the machine takes place by applying a mold having a weight equal to 1.5 times that maximum allowed, moving the moving parts of the machine along the 6 axes both in manual mode and automatic mode.

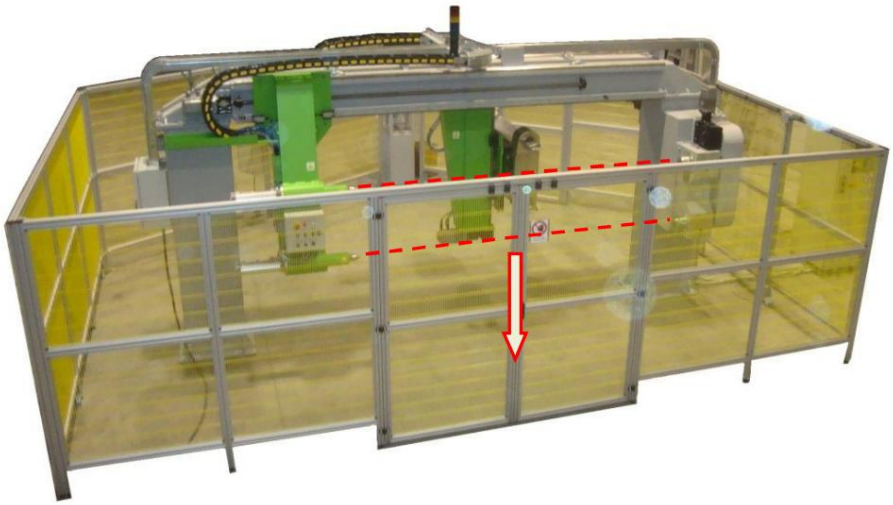


Figure 20 - Filament Winding machine testing

9.4 Maintenance activity log

Record in the following table all the maintenance interventions carried out on the machine machine.

DATA	ACTIVITY CARRIED OUT	NAME, SURNAME AND SIGNATURE OF THE EXECUTOR

10. Attachments

This section of the Manual contains the attachments related to the activities of construction and compliance of the Filament Winding machine.

- Manufacturer's declaration of conformity with the CE mark;
- Certificates of provenance of materials;
- Technical documentation of commercial details;
- Technical drawings of interest to the user;
- Pneumatic diagram with indication of all components;
- Wiring diagrams with indication of all components;
- List of improvements for safety purposes.